# AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

# CHAPTER 3

# 3.0 Affected Environment and Environmental Consequences

## Introduction

This chapter summarizes the changes in the affected environment and environmental consequences described in the 1991 Betze Project EIS and 2003 Betze Project SEIS for the Proposed Action and alternatives analyzed in this SEIS. It includes a description of the past, present, and reasonably foreseeable future actions (RFFAs) that may result in cumulative impacts with the Proposed Action or alternatives.

The baseline information summarized in this chapter was obtained from published and unpublished materials; discussions with local, state, and federal agencies; from field and laboratory studies conducted in the project area and on-site experience with mining and reclamation. The affected environment for individual resources was delineated based on the area of potential direct and indirect environmental impacts for the proposed project. For resources such as soils and vegetation, the affected area was determined to be the physical location and immediate vicinity of the areas to be disturbed by the proposed project. For other resources such as water quality, air quality, wildlife, social and economic values, the affected environment was more extensive (e.g., airshed, local communities, etc.).

This chapter also describes the anticipated direct and indirect impacts of the Proposed Action and the alternatives as well as potential cumulative impacts. The analysis of potential impacts from the Proposed Action assumed the implementation of the applicant-committed environmental protection measures that would be implemented in association with the proposed project (see Section 2.2.1.13, Applicant-committed Environmental Protection Measures). Mitigation and monitoring developed in response to anticipated impacts are recommended by the BLM for individual resources, and are discussed at the end of each resource section.

The proposed project may result in cumulative effects associated with other past and present actions and RFFAs in the area. For resources where project-specific impacts are identified, the cumulative effects associated with the proposed project were evaluated together with other past and present actions and RFFAs. The period of potential cumulative impact is defined as the approximately 23-year life of the project (4-year extension of mining and 15 years of ore processing plus 4 years for reclamation). The cumulative effects analysis for each resource addressed the potential cumulative effects within resource-specific cumulative effects study areas.

The Proposed Action does not require dewatering of the Betze Pit; therefore, there are no resource impacts from dewatering under the Proposed Action. Pit dewatering impacts were addressed in the Betze Project SEIS (BLM 2000a, 2003a) through Year 2011. The potential impacts associated with dewatering for an additional 4 years, through 2015, from current State of Nevada authorizations for the Meikle underground mine are analyzed under the No Action Alternative. The BLM has no decision-making authority regarding dewatering operations. Impact analysis of dewatering operations under the No Action Alternative is provided to inform the public of the environmental consequences of this action. Dewatering will occur regardless of the alternative selected.

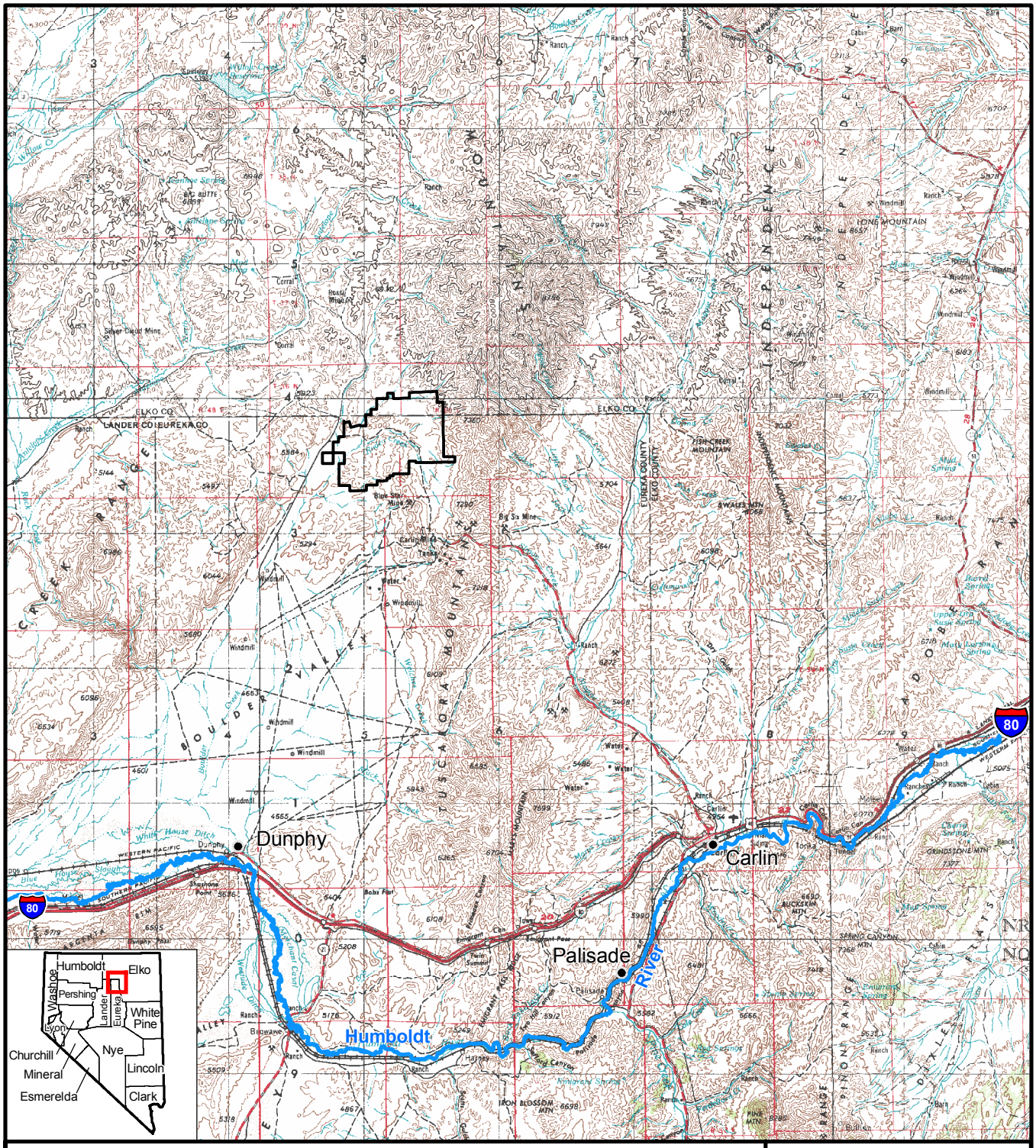
Section 2.2.1, Current Mining Operations or Facilities that will Continue Unchanged, summarizes mine operations including current drilling and blasting; loading and hauling ore and waste rock; ore stockpiling and processing; existing infrastructure and ancillary support facilities; exploration; and safety and fire protection. These activities or facilities are currently authorized under existing operations at the Goldstrike Mine and impacts were previously evaluated in the Betze Project EIS (BLM 1991a,b). These activities or facilities would continue to operate for an additional 4 years under the Proposed Action. There would be no substantive impacts associated with these actions under the Proposed Action that would differ from the alternatives. Therefore, impacts associated with these mining operations or facilities will not be discussed further in this SEIS.

This chapter is organized according to 13 affected resource topics. Subsections for each resource include:

1. Affected Environment
2. Environmental Consequences (of each alternative)
3. Cumulative Impacts
4. Mitigation and Monitoring

## General Setting

The Goldstrike Mine is located near the north-central portion of the Great Basin in the Boulder Flat Watershed Subbasin floristic region (**Figure 3.0-1**). The surrounding terrain consists of alternating mountain ranges and sagebrush-covered valleys, with the mine site situated in the Basin and Range physiographic province. This region is characterized by large, extensive valleys located between the Tuscarora Mountain Range to the north of the Boulder Flat and the Sheep Creek Range to the southwest. Elevations at the project location range from approximately 5,500 feet to 7,000 feet amsl. The climate is marked by extreme weather conditions characterized as arid and accompanied by temperatures ranging from -20 degrees Fahrenheit (°F) to more than 100°F. Overall precipitation is very low, with erratic rainfall patterns that tend to be localized.




**LEGEND**

— Goldstrike Mine Operations Boundary

N

0 2.5 5 Miles

Source: BLM 2007b,c.

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**Betze Pit Expansion Project**

Figure 3.0-1

General Setting

## 3.1 Past, Present, and Reasonably Foreseeable Future Actions

Cumulative impacts are defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and RFFAs regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR 1508.7).

Related projects and actions are defined for the SEIS as those past and present actions and RFFAs that could interact with the Proposed Action or alternatives in a manner that would result in cumulative impacts, resulting primarily from mining, commercial activities, and public uses. The past, present, and RFFAs previously identified in the Betze Project EIS (BLM 1991a,b), Betze Project SEIS (BLM 2000a, 2003a), and the CIA of Dewatering and Water Management Operations for the Betze Project, South Operations Area Project, and Leeville Project (BLM 2000b) have been updated for this analysis. The mining-related surface disturbances are identified in **Table 3.1-1**.

**Table 3.1-1 Mining-related Surface Disturbance Associated with Past and Present Actions and RFFAs**

| Map Reference No. | Action | Past and Present Disturbance (acres) | RFFA Projected Disturbance (acres) | Total Approved/ Projected Disturbance (acres) |
|---|---|---|---|---|
| **Mining Projects** | | | | |
| 11 | Barrick - Meikle and Rodeo | 222 | -- | 222 |
| 11 | Barrick - Betze | 7,882 | 1,180 | 9,062 |
| 6 | Barrick - Storm Underground | 185 | -- | 185 |
| 7 | Barrick - South Arturo | 0 | 100 | 100 |
| 1 | Newmont - Great Basin Gold-Hollister/Ivanhoe | 268 | 100 | 368 |
| 3 | Halliburton - Rossi | 408 | 300 | 708 |
| 8 | Goldcorp - Dee Mine | 1,315 | -- | 1,315 |
| 10 | Newmont - Bootstrap | 1,900 | -- | 1,900 |
| 12 | Newmont - Blue Star/Genesis, Section 36, Deep Star, Lantern, North Lantern, Bullion Monarch | 2,797 | 137 | 2,934 |
| 12 | Newmont - North Area Leach | 1,526 | -- | 1,526 |
| 12 | Newmont - Carlin Mine/Mill 1, Pete | 3,673 | -- | 3,673 |
| 13 | Newmont - Leeville | 566 | -- | 566 |
| 17 | Newmont - Gold Quarry/South Operations Area Project (SOAP), MC Reservoir, N-S Haul Road | 9,961 | -- | 9,961 |
| 19 | Newmont - Rain | 961 | -- | 961 |
| 20 | Newmont - Emigrant | 0 | 1,603 | 1,603 |
| 17 | Newmont - South Waste Rock Disposal Facility | 0 | 100 | 100 |
| 9 | Centerra Gold Inc./Barrick - Ren | 0 | 100 | 100 |
| 16 | Newmont - Mike | 0 | 100 | 100 |

**Table 3.1-1 Mining-related Surface Disturbance Associated with Past and Present Actions and RFFAs**

| Map Reference No. | Action | Past and Present Disturbance (acres) | RFFA Projected Disturbance (acres) | Total Approved/ Projected Disturbance (acres) |
|---|---|---|---|---|
| -- | Sand and Gravel Operations | 395 | -- | 395 |
| **Exploration** | | | | |
| 1 | Great Basin Gold - Ivanhoe | 15 | -- | 15 |
| 2 | Hecla - Hollister Development Block | 51 | -- | 51 |
| 4 | Trio Gold Corp - Rodeo Creek | 42 | -- | 42 |
| 5 | Barrick - Meridian JV - Rossi | 51 | -- | 51 |
| 9 | Centerra - Ren | 30 | -- | 30 |
| 11 | Barrick - Goldstrike Project | 233 | -- | 233 |
| 12 | Newmont - Carlin | 255 | -- | 255 |
| 14 | Newmont - Chevas | 168 | -- | 168 |
| 15 | Newmont - High Desert | 164 | -- | 164 |
| 16 | Newmont - Mike | 48 | -- | 48 |
| 18 | Newmont - Woodruff Creek | 66 | -- | 66 |
| 20 | Newmont - Emigrant Springs | 63 | -- | 63 |
| 21 | Royal Standard Minerals - Railroad - Piñon | 20[1] | 200[1] | 220[1] |
| **Total** | | 33,265 | 3,920 | 37,185 |

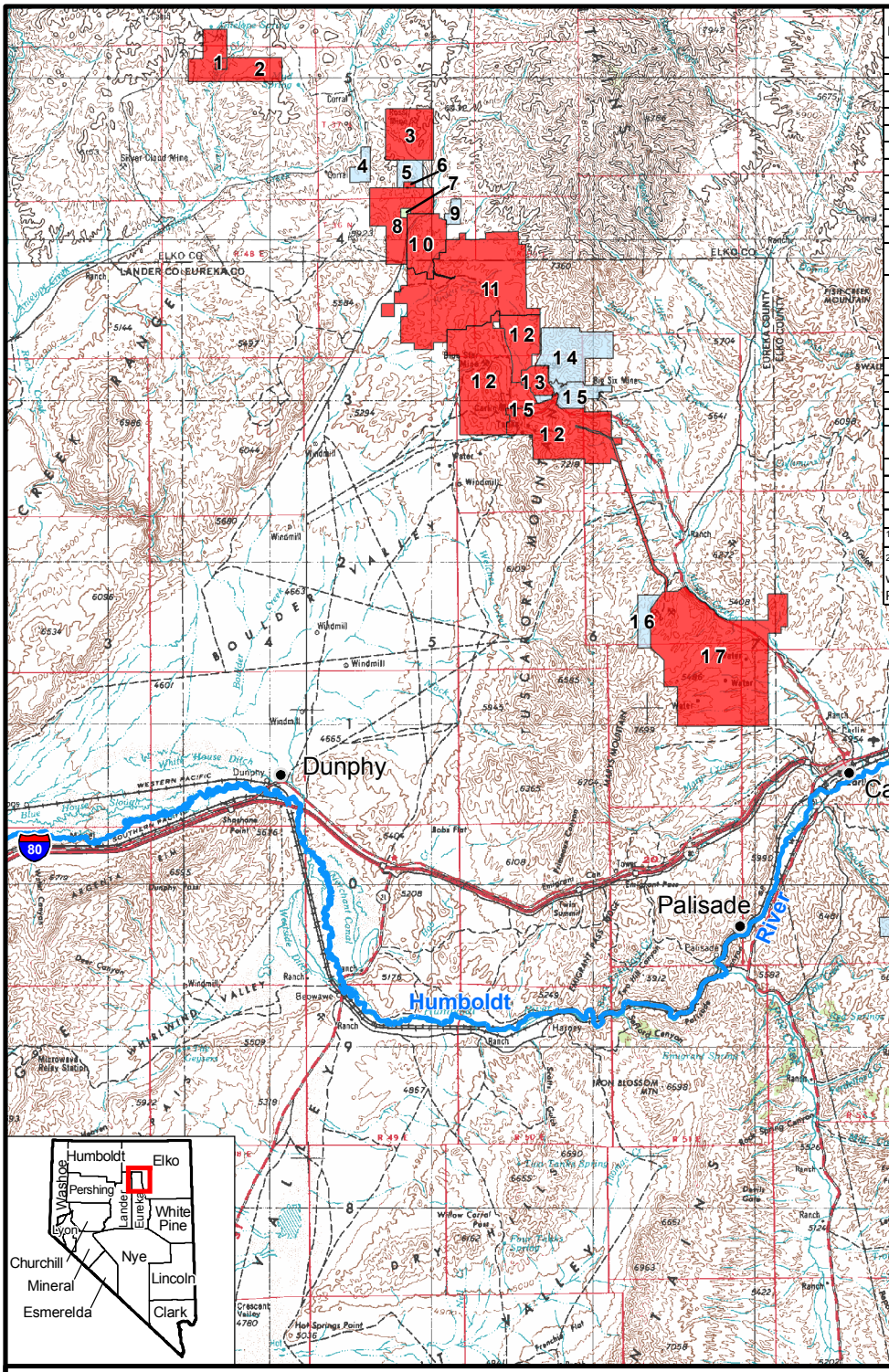
[1]Approximate acreage.

Source: BLM 2007a,b.; BGMI 2007a.

The geographic area for potential cumulative effects is determined by the type of resource potentially affected. **Figures 3.1-1** and **3.1-2** show the distribution of the primary surface-disturbing actions throughout the Cumulative Effects Study Areas (CESAs). Information on these actions is presented below. The area of concern for cumulative effects varies by resource, with impacts for certain resources being restricted to the actual area of disturbance. Resource-specific CESAs and rationale were developed for each resource, as appropriate, and are discussed in Sections 3.2 through 3.14. The Carlin Trend is the CESA for several resources. The Carlin Trend is a mineralized zone approximately 50 miles long by 5 miles wide in north central Nevada where multiple mining operations have been developed.

### 3.1.1 Past and Present Actions

The past and present projects and actions considered in the cumulative effects analysis are described below. Their associated acreages are presented in **Table 3.1-1**. Included in this category are the historic and ongoing projects and actions found within the general vicinity of the proposed project.




| Map Reference No. | Facility[1] |
|---|---|
| **Mining Exploration and Development** | |
| 1 | Newmont/Great Basin Gold-Hollister/Ivanhoe |
| 2 | Hecla-Hollister Development Block |
| 3 | Halliburton-Rossi |
| 4 | Trio Gold Corp-Rodeo Creek |
| 5 | Barrick-Meridian JV-Rossi |
| 6 | Barrick-Storm Underground |
| 7 | Barrick So. Arturo |
| 8 | Goldcorp - Dee Mine |
| 9 | Centerra-Ren |
| 10 | Newmont-Bootstrap |
| 11 | Barrick-Betze, Meikle, Rodeo, Goldbug |
| 12 | Newmont-Blue Star/Genesis, Section 36, Deep Star, Lantern, North Lantern, Bullion Monarch |
| | Newmont-North Area Leach |
| | Newmont-Carlin Mine/Mill I, Pete |
| 13 | Newmont-Leeville |
| 14 | Newmont-Chevas |
| 15 | Newmont-High Desert |
| 16 | Newmont-Mike |
| 17 | Newmont-Gold Quarry/SOAP, MC Reservoir, N-S Haul Road |
| 18 | Newmont-Woodruff Creek |
| 19 | Newmont-Rain |
| 20 | Newmont-Emigrant Springs |
| 21 | Royal Standard Minerals Railroad-Pinon[2] |

[1]Projects permitted by BLM as of April 2007

[2]Location approximated based on www.RoyalStandardMinerals.com. POO Submitted in 2007.

## LEGEND

- Area of Current Major Exploration
- Areas of Existing and Reasonably Foreseeable Development as Defined by Mine Plan Boundary
- Locations of Reasonably Foreseeable Mine Developments

N

0 2.5 5 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.1-1

Past, Present, and Reasonably Foreseeable Future Mining Activities - Carlin Trend in Nevada

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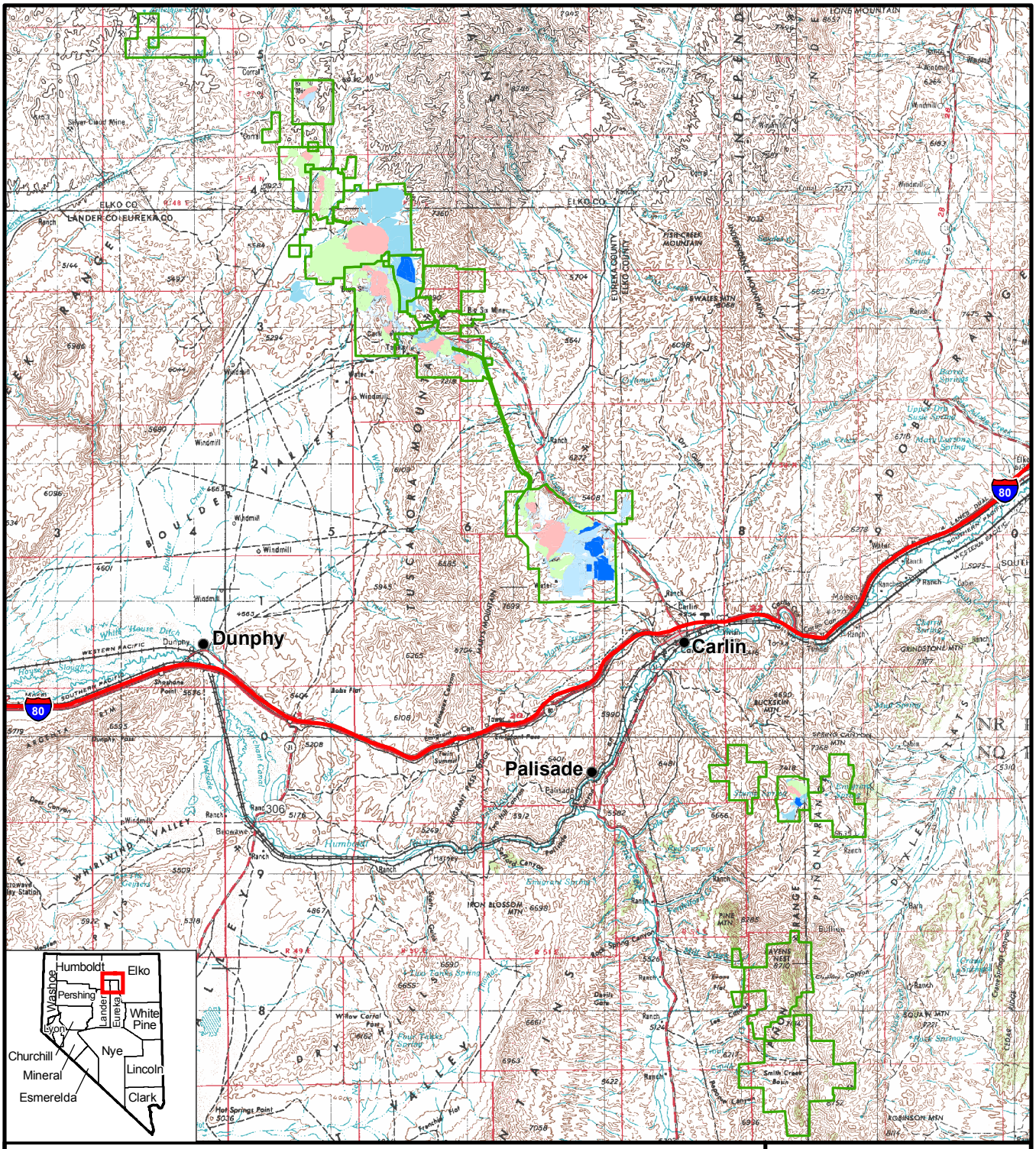


**LEGEND**

- Ancillary
- Leach Pad
- Pits
- Waste Rock Dumps
- Mine Plan Boundaries

N

0 2.5 5 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.1-2

Mine Disturbance - Carlin Trend in Nevada

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#### 3.1.1.1 Mining-related Disturbance

Gold was first discovered in 1907 in Lynn Creek, 19 miles northwest of Carlin, within what would later become known as the Carlin Trend (Tingley 1998). Placer gold deposits also were discovered in Sheep, Rodeo, and Simon creeks around the same time period. Prior to the 1907 gold discovery, claims in the Carlin Trend produced silver and lead. More modern and larger scale mining activities began with Newmont's Carlin Pit in 1965 and BGMI's Betze/Post Mine in 1986. Brief descriptions of the past and present mines considered in the cumulative effects analysis are presented below.

Polar Resources initiated mining in the area of the Betze/Post Mine in 1974. BGMI acquired the mine in 1986, expanded operations, and has continued mining to the present at what is now known as the Goldstrike Mine. The Goldstrike Mine includes the Betze Pit, Meikle and Rodeo underground mines, processing facilities, waste rock and tailings facilities, and ancillary support facilities, as described in Chapter 2.0. Current disturbances are associated with the Betze open-pit, waste rock facilities, roads, reclaimed leach pad, mill and processing facilities, and ancillary support facilities.

The Dee deposit was discovered in 1981 and put into production in 1984 by the operating partnership of the Dee Gold Mining Company with Rayrock Mines Inc. Glamis Gold Ltd. became operator of the Dee open-pit mine in 1999 and initiated underground production from the Dee Deep North deposit that same year. Both the open-pit and underground mines were shut down in December 2000. Goldcorp Inc. acquired the Dee Mine when it recently acquired Glamis Gold Ltd.

The Storm underground mine (Storm Decline) is located a few miles northwest of the Goldstrike Mine. BGMI developed the Storm Decline from the lowest level of the Dee open pit in March 1999. The Storm Decline Mine was developed to explore ore bodies and identify potential gold-bearing ore reserves on the Barrick-Meridian joint-venture. It is currently used to extract ore from that joint venture, which began commercial production in April 2007. The open pit barite Rossi Mine is located above the Storm Decline Mine. This open-pit mine is currently operated by Haliburton and has been producing barite since 1947.

Newmont Mining Corporation (Newmont) began its mining activities in the North Operations Area at the Blue Star Mine in 1974. The North Operations Area includes all of Newmont's mining operations located between the Bootstrap and Pete mines (North Star, Genesis, Bobcat, Lantern, Carlin, Beast, Sold, and Deep Star). Mining operations at the Bootstrap open-pit mine were initiated in 1974 and continued until 1984. Closure and reclamation were completed at the mine in 1988. Mining operations were reinitiated by Newmont at the Bootstrap Mine in 1994 with development of the Capstone and Tara gold deposits. Newmont's Blue Star/Genesis open-pit mines began operations in 1986. In 1988, Newmont constructed and began operations at the North Area Leach Facility and Mill #4 process facilities.

In 1979, Newmont discovered gold on their South Operations Area property. Open-pit mining began in 1980 and has expanded periodically. Newmont's South Operations Area consists of the Gold Quarry, Mac, and Tusc open-pits; a mine dewatering and water treatment and management system; waste rock disposal facilities; tailings disposal facilities; ore processing facilities; heap leach facilities; access and haul roads; and ancillary support facilities. In 1993, the BLM prepared an EIS and issued a ROD approving expanded mining operations in the South Operations Area Project (SOAP). The BLM prepared an EIS and issued a ROD in 2002 approving additional mine expansion for the South Operations Area Project Amendment (SOAPA). BLM released the draft cumulative effects SEIS for the SOAPA in August 2007 (BLM 2007c). Newmont's SOAP is located approximately 14 miles southeast of the Goldstrike Mine.

Dewatering and discharge activities in the Maggie Creek Basin result from Newmont's SOAP mining operation. The SOAP mitigation plan is currently in place to address potential adverse impacts from dewatering. Details of the dewatering and mitigation plan can be found in the SOAPA, August 2007, document (BLM 2007c). The Gold Quarry Mine currently discharges via Maggie Creek to the Humboldt River. This discharge was previously evaluated by BLM in the CIA of Dewatering and Water Management Operations for the Betze Project, SOAP, and Leeville Project (BLM 2000b).

Newmont's Leeville Project began mine development and operations in 2002 after the BLM issued an EIS and ROD in 2002. This underground gold mine is located approximately 3 miles southeast of the Goldstrike Mine project boundary. Major project components include the underground mine with one hoist and one ventilation shaft and underground access; the mine dewatering system, including a water treatment facility and pipeline system to convey groundwater from the Leeville Mine to BGMI's water management facility; a waste rock disposal facility; access and haul roads; shipment of ore to Newmont's Mill 6 facility in the South Operations Area; and ancillary support facilities. The BLM issued a draft cumulative effects SEIS on the Leeville Project in August 2007 (BLM 2007b).

Newmont acquired the Rain claims in 1979 and conducted exploratory drilling in the early 1980s to define the gold reserves. These deposits consisted mainly of Emigrant, Gnome, Snow Peak, Southern Mineralized Zone, Rain Extension, Tess, NW Tess, and Saddle. Mining operations were initiated at the Rain property in 1987. Mining operations consisted of open-pit and underground mining, waste rock disposal, ore processing, a tailings facility, heap leaching facility, and ancillary facilities. Open-pit mining at Rain continued through 1994. Underground operations began in 1994 and continued through 1998. Mining activity has ceased at the Rain Mine while heap leach processing and reclamation continues.

The Newmont/Great Basin Gold-Hollister/Ivanhoe mine occurs at the northwest end of the Carlin Trend. The property consists of an open-pit gold mine and exploration activities. The Hollister Development Block Exploration Project currently has dewatering and discharging activities of up to 350 gpm within Boulder Valley.

In addition to precious metal mines, sand and gravel mines also operate in the Carlin Trend. Approximately 395 acres of private land have been disturbed by sand and gravel operations in the Carlin area. These operations have been used to support construction maintenance of area roads (particularly Interstate 80 [I-80] and State Highway [SH] 766) (BLM 2007b,c).

#### 3.1.1.2 Exploration-related Disturbance

Exploration activities include access road and drill pad construction and drilling. Exploration operations have resulted in isolated areas of land disturbance, as summarized in **Table 3.1-1**.

#### 3.1.1.3 Utilities and Community Actions

Present utility and community actions resulting in surface disturbance in the CESAs include state, county, and public roads; the TS Power Plant; powerlines; and development primarily associated with the communities of Carlin, Elko, and Spring Creek. The TS Power Plant, transmission lines, and associated facilities are currently under construction 3 miles north of Dunphy in Eureka County, Nevada. The TS Power Plant is owned by Newmont's subsidiary Newmont Nevada Energy Investment, LLC. This 200-megawatt (MW) coal-fired power plant is expected to become operational in mid-2008 and provide power for Newmont's mining operations throughout northeast Nevada. Approximately 600 acres of surface disturbance is associated with the TS Power Plant (BLM 2007b,c).

Surface disturbance from roads has not been quantified for this analysis. Surface disturbance has occurred within the CESAs due to power line upgrades and ROWs establishment that support ongoing mining activities. Although there is a designated ROW associated with transmission lines and distribution lines, the associated surface disturbance typically is minimal (e.g., restricted to the pole locations and maintenance access, as needed).

Surface disturbance associated with residences, commercial development, and the supporting infrastructure exist in the towns of Carlin, Elko, and Spring Creek. Approximately 565 acres have been platted for development in the areas between I-80 and the Humboldt River in and adjoining the Town of Carlin. Other development is occurring east of SH 766 near its intersection with I-80. Another 23 acres have been platted at Palisades, midway between Carlin and Dunphy. Development in the Dunphy area consists of approximately 6 acres (BLM 2007b,c). Additional disturbances associated with these activities have not been quantified.

#### 3.1.1.4 Other Development and Actions

Other development activities and actions considered in the cumulative effects analysis include fuel reduction programs and wildfires and wildlife management activities.

Wildfires

Between 1999 and 2007, approximately 38 percent (941,793 acres) of wildlife and livestock grazing habitat in the Wildlife and Vegetation Resources CESA has been impacted by fire. Since then, public and private entities have worked to restore 382,787 acres of range habitat for wildlife and livestock on areas affected by wildfire. Some tracts were allowed to revegetate naturally while critical habitat areas were being reseeded with forbs, grasses, and shrubs (BLM 2007b).

Wildlife Management Programs and Habitat Improvements

Several restoration projects for wildlife and riparian habitats have been implemented within the Carlin Trend area. Primary projects/programs include the following (BLM 2007b):

- BGMI Riparian/Wetland Conservation and Mitigation Fund - 1991 Betze Project
- Maggie Creek Watershed Restoration Project - Mitigation Plan for 1993 SOAP
- Mitigation Plan for 2002 SOAPA
- Mitigation Plan for 2002 Leeville Project
- BGMI Upper Willow Creek Habitat Enhancement Plan - Mitigation Plan for 2003 Betze Project
- Susie Creek Riparian Restoration Project
- Mule Deer Transition Range Seeding Project
- T Lazy S Sage-grouse Habitat Improvements
- 709-acre Mule Deer Habitat Improvement Project in the Sheep Creek Range
- NDOW Mule Deer Population Management Programs
- Trout Unlimited Strategies for Restoring Native Trout Program
- Beaver Creek Riparian Pasture

### 3.1.2 Reasonably Foreseeable Future Actions

In order to qualify as a RFFA for the cumulative effects analysis, a project or action must impact the same resources as the Proposed Action, must occur within the life of the Proposed Action (including reclamation), and must have a reasonable likelihood of going forward. The RFFAs identified in this cumulative effects analysis are discussed below; their associated disturbance acreages are presented in **Table 3.1-1**.

#### 3.1.2.1 Mining-related Actions

Mining activities are expected to continue in the area in the foreseeable future. Reasonably foreseeable mine development in the area includes:

- Newmont/Great Basin Gold-Hollister/Ivanhoe: Foreseeable future actions include the operation of an underground gold mine and associated facilities at the same location as the Hollister Development Block Project.
- Halliburton-Rossi Mine: Planned activities include the expansion of Queen Lode and Sage Hen areas and possibly the expansion of surface exploration for open pits and waste rock dumps.

- Barrick-South Arturo: A 60/40 percent joint venture project with BGMI and Goldcorp Inc. A foreseeable future open pit gold mine at the former Dee gold mine.
- Newmont
  - North Area Leach Facility - RFFAs include the expansion of the existing heap leach pad.
  - North Lantern #3 - RFFAs include an open pit gold mine and the expansion of the Lantern Mine at the Blue Star-Genesis Plan Area.
  - Genesis Project - RFFAs include the continued mining of the Genesis Area, which includes open-pit mining, sequential backfill and increased height of existing external waste rock facilities.
  - Mike - RFFAs include the operation of a gold mine.
  - South Waste Rock Disposal Facility - RFFAs include the expansion of a leach pad and the construction of Property Pad.
  - Emigrant Project - RFFAs include the development of a new open-pit mine consisting of a waste rock disposal facility, heap leach, stream channel diversion, and construction of ancillary mine facilities. The proposed mine is located along the eastern slopes of the Piñon Range in the Dixie Creek Basin.

#### 3.1.2.2 Exploration-related Actions

Mineral exploration activity would be expected to continue in the project region. Exploration drilling, trenching, and road construction at current and proposed mine operations would be expected to continue.

#### 3.1.2.3 Community Actions

Community development activities will increase or decrease depending upon the strength of the local economy, employment levels and population. Development, both commercial and residential, is expected to continue at current levels in Carlin, Elko, and Spring Creek.

#### 3.1.2.4 Other Development and Actions

<u>Wildfires</u>

Wildfires are likely to continue in the future in the project area. Prescribed burns will continue to be used to help reduce fuel loads in selected areas on public lands.

<u>Wildlife Management Programs and Habitat Improvements</u>

Habitat restoration activities in the area include reseeding areas disturbed by mining activities, fire, or livestock; limiting livestock access to riparian areas through strategic fencing and grazing management practices; and general restoration of seeps and springs. These activities are undertaken by both private and public entities and are expected to continue and even increase within the project area in the future. Habitat restoration measures are anticipated to improve habitat for terrestrial and aquatic species, including threatened and endangered species and species of concern. Sage-grouse habitat restoration will continue in the project region through programs implemented by NDOW and other organizations.

## 3.2 Geology and Minerals

### 3.2.1 Affected Environment

The study area for the direct and indirect impacts to geology and minerals encompasses the Goldstrike Mine operations boundary (**Figure 3.2-1**). The CESA encompasses the mine operations boundary and includes surface disturbance associated with past and present actions and RFFAs within the Carlin Trend (**Figure 3.2-2**). The Carlin Trend is an appropriate CESA boundary for geology and minerals since it incorporates an approximately 50-mile-long by 5-mile-wide district area of multiple major mineral deposits with similar emplacement and origin.

The geologic setting in the vicinity of the Goldstrike Mine has been discussed in detail in previous NEPA documents for the Betze Project (BLM 1991a,b, 1993, 2000a, 2003b). The discussion below provides a summary of regional and study area geology. Potential acid rock drainage formation issues are discussed in Sections 3.3, Groundwater Resources and Geochemistry and 3.4, Surface Water Resources.

#### 3.2.1.1 Physiography and Topography

Major mountain ranges within the study area include the Sheep Creek Range and portions of the Tuscarora Mountains, Independence Range, and Adobe Range. The elevation ranges from approximately 8,700 feet amsl in the Tuscarora Mountains near the central portion of the study area to approximately 4,500 feet amsl along the Humboldt River in the southwestern corner of the study area.

The study area is located within the Basin and Range physiographic province and is characterized by a series of generally north-trending mountain ranges separated by broad basins. The Basin and Range physiography has developed from normal faulting that began approximately 17 million years ago and continues to the present (Stewart 1980). The extensional block faulting uplifted the mountains, which consist of Precambrian to Tertiary age bedrock units. The basins are filled with thick accumulations of unconsolidated and consolidated sediments that are derived from erosion of the adjacent mountain ranges.

#### 3.2.1.2 Geological Setting

The geology of the area is shown in **Figure 3.2-1**. During the Late Devonian or Early Mississippian time, marine deposition was interrupted, and the Paleozoic sediments were uplifted, folded, and thrusted by the Antler Orogeny (orogeny is a geologic term for mountain building event). During the Antler Orogeny, the siliciclastic rocks were thrust over the carbonate rocks along the Roberts Mountain Thrust (Roberts 1966; Stewart 1980), a major structural feature within the region. The clastic rocks form the upper plate while the carbonate rocks form the lower plate of the thrust. The marine carbonate rocks underlie the siliciclastic assemblage throughout the study area. Stewart (1980) notes the clastic rocks in the upper plate have been displaced to the east by as much as 90 miles and are composed of interleaved broad, thin thrust sheets that are oriented sub-parallel to the bedding.

The Antler Orogeny also created a highland that persisted during much of the Mississippian period and perhaps during parts of the Pennsylvanian and Permian periods (Stewart 1980). During the Late Paleozoic Era, sediments shed from the highland resulted in deposition of clastic and carbonate rocks (Antler Sequence). These rocks are grouped by Maurer et al. (1996) with the Paleozoic marine carbonate rocks, although the rocks are primarily siliciclastic.

During the Mesozoic and Early Cenozoic eras, the area was subjected to compression, which resulted in the Tuscarora Mountain anticline and may have fractured the rocks in the vicinity of the anticline, providing pathways for mineral-bearing fluids and groundwater. Intrusive igneous activity accompanied this compression. The Marys Mountain intrusive complex, long postulated on the basis of geophysics and recrystallization, is composed of rocks that span from Jurassic through Tertiary (Evans 1974).

Beginning in the late Cenozoic Era, the area was block-faulted by a series of normal and listric faults that created the Basin and Range topography that characterize the region. Broad valleys in the regional study area, such as Boulder Valley and the Maggie Creek basin, were formed as down-dropped blocks between uplifted mountain ranges. Major normal faults bound the southeastern flank of the Sheep Creek Range, the eastern flank of the Tuscarora Mountains, and the northern side of the Argenta Rim (Maurer et al. 1996). These normal faults drop the basin side down relative to the mountain side, may have displacements of thousands of feet, and are usually at high angles.

The Tertiary Carlin Formation consists of tuffaceous fluvial and lacustrine sediments. Uplift and subsequent erosion of the mountains during the late Cenozoic Era have partially filled the basins with poorly consolidated to unconsolidated silty clay, silt, clayey sand, sand, gravel, and boulders deposited primarily as a series of coalescing alluvial fans. These basin-fill deposits are mapped as two types: 1) older basin-fill deposits, and 2) younger basin-fill deposits (Maurer et al. 1996). The older basin-fill deposits are Miocene to Pliocene in age and consist of fluvial and lacustrine sediments, volcaniclastic rocks, and volcanic rocks. In Boulder Flat, the older basin-fill deposits may be as thick as 3,000 feet, while in the Maggie Creek basin the older basin-fill deposits may be in excess of 5,000 feet (BLM 2000a, 2003a). The younger basin-fill deposits (alluvium) consist of unconsolidated alluvium deposits that underlie present-day streams, flood plains, and associated stream terraces. These deposits are highly variable and consist of silty clay, sandy clay, silty sand, clayey sand, gravel sand, and conglomerate (BLM 2000b). The thickness ranges from a few tens of feet in the mountains to 1,000 feet in the southern part of Boulder Flat.

#### 3.2.1.3 Site Geology

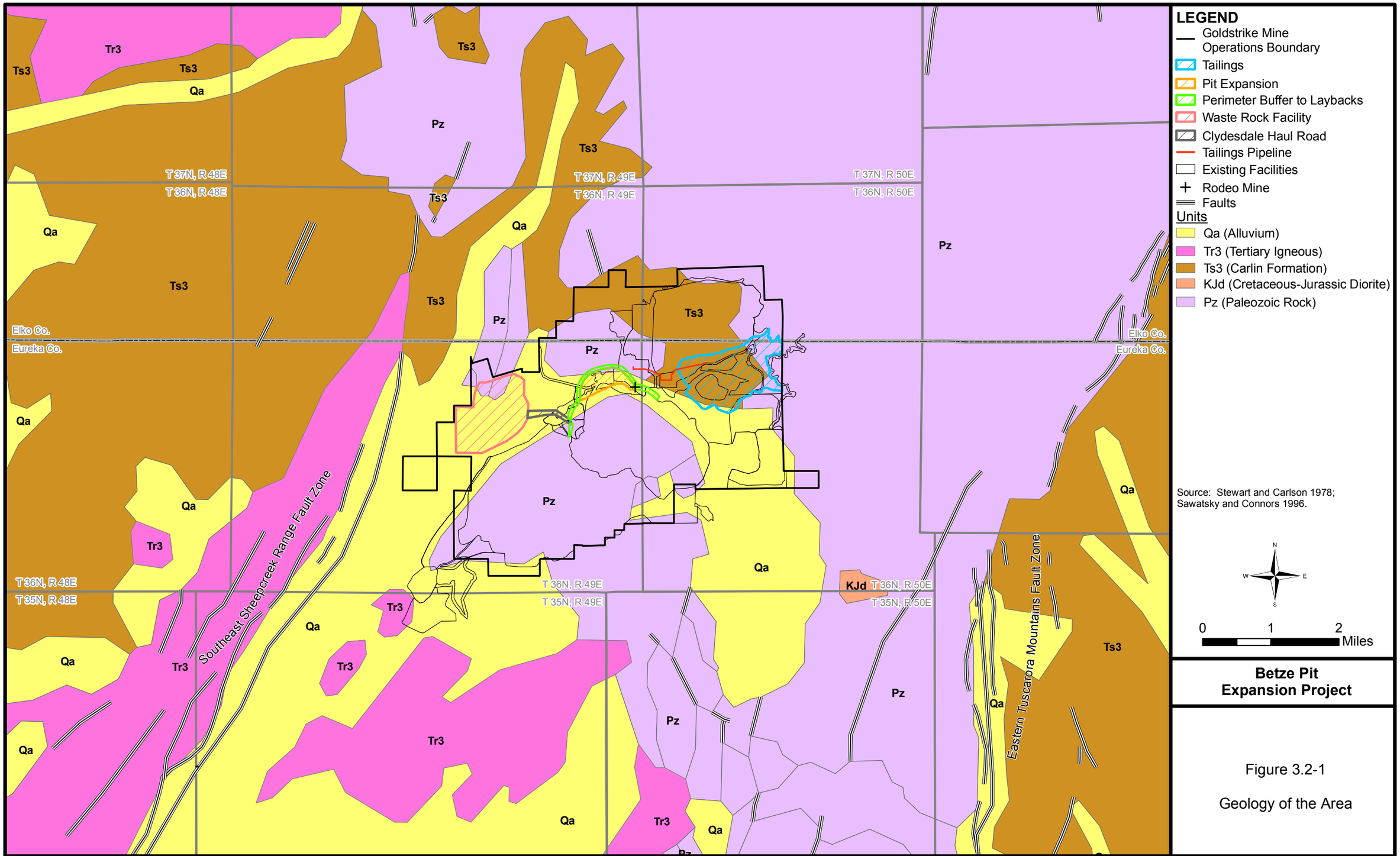
The project site is located at the northern end of Boulder Valley, on the west side of the Tuscarora Mountains (BLM 1991a,b). The area is cut by numerous north-trending faults that have resulted from several episodes of deformation and igneous intrusion. The geologic setting is composed of Lower Paleozoic marine sedimentary rocks, a Jurassic intrusive, Late Tertiary tufaceous deposits (Carlin Formation), and Quaternary fluvial and colluvial sediments.

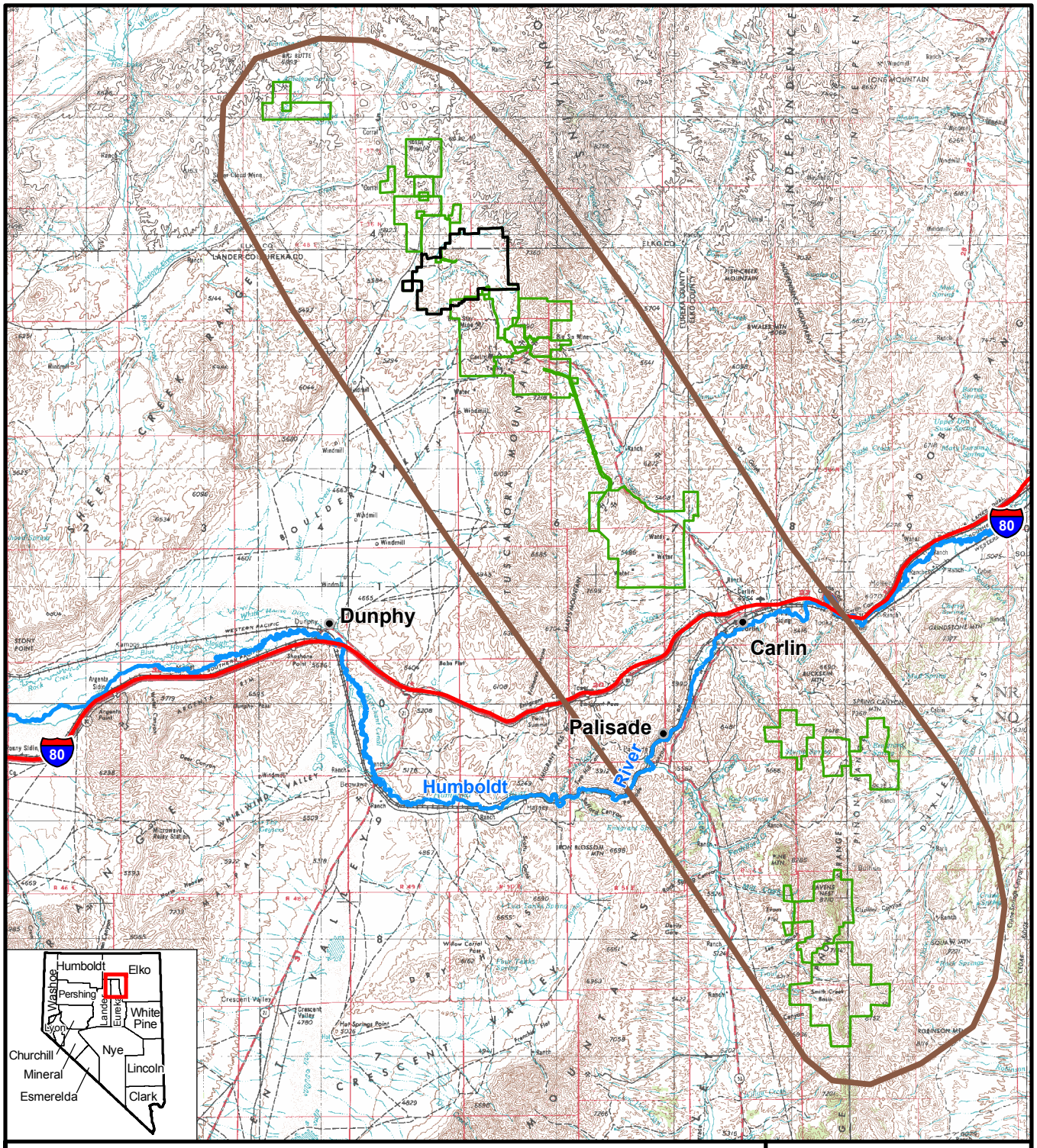
The granodioritic Jurassic Goldstrike Stock intrudes the Lower Paleozoic Age sedimentary formations in the project area (BLM 1991a,b). Contact metamorphism, as a result of the intrusion, has developed minor skarn (lime-bearing silicates) along the contacts of the intrusive with the calcareous sedimentary rock. Numerous dikes and sills have intruded the sediments along structural zones.

The host rocks of the Betze orebody are Ordovician through Devonian rocks of the Vinnini Formation, and Devonian and Silurian and consist of the lower Rodeo Creek unit, Popovich limestone, and upper Roberts Mountains Formation (Peters et al. 1998). These units are composed of limestone, dolomite and siliciclastic material and also contain sedimentary breccias. These rocks host the Betze orebody and other orebodies along much of the north-central Carlin Trend. The rocks in the area have been altered and deformed by the intrusion of the hydrothermal solutions that emplaced the ore body. The Betze ore body is associated with north-northwest striking faults (Peters et al. 1998). The ore in the Betze orebody is highly sheared and fractured, and the host rocks are highly thermally altered.

#### 3.2.1.4 Mineralization and Mineral Resources

The major mineral resource in the project area is precious metal gold deposits. The mine is located in the Carlin Trend, an approximately 50-mile-long assemblage of gold deposits in northeast Nevada (Teal and Jackson 2002). The trend is aligned northwest to southeast and contains gold deposits that are largely hosted in carbonate rocks. The Carlin trend contains a number of active mines that were responsible for 50 percent of Nevada's gold production in 2005 and had cumulatively produced over 60 million ounces of gold (Price et al. 2006). Ultimate production could top 100 million ounces from the trend. The Goldstrike property (Betze-Post open pit and the Meikle and Rodeo underground mines) had cumulatively produced over 30 million ounces of gold as of mid-2006 (Barrick Gold Corporation 2007). In 2006, the property produced 1.9 million ounces of gold. Proven and probable reserves at the Betze-Post pit were about 13 million ounces of gold as of December 31, 2006.


LEGEND
Goldstrike Mine Operations Boundary
Tailings
Pit Expansion
Perimeter Buffer to Laybacks
Waste Rock Facility
Clydesdale Haul Road
Tailings Pipeline
Existing Facilities
Rodeo Mine
Faults
Units
Qa (Alluvium)
Tr3 (Tertiary Igneous)
Ts3 (Carlin Formation)
KJd (Cretaceous-Jurassic Diorite)
Pz (Paleozoic Rock)
Source: Stewart and Carlson 1978; Sawatsky and Connors 1996.
N
W
E
S
0
1
2
Miles
Betze Pit Expansion Project
Figure 3.2-1
Geology of the Area
T 37N, R 48E
T 36N, R 48E
T 37N, R 49E
T 36N, R 49E
T 37N, R 50E
T 36N, R 50E
T 36N, R 48E
T 35N, R 48E
T 36N, R 49E
T 35N, R 49E
T 36N, R 50E
T 35N, R 50E
Elko Co.
Eureka Co.
Southeast Sheepcreek Range Fault Zone
Eastern Tuscarora Mountains Fault Zone
Tr3
Ts3
Qa
Pz
KJd




**LEGEND**

- Geology Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries

N

0 2.5 5 10 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.2-2

Geologic Resources Cumulative Effects Study Area

06/13/2008

The gold deposits within the Carlin Trend largely resulted from the emplacement of igneous intrusions during Eocene time (39 million years ago), but also other minor gold episodes occurred in late Jurassic and Devonian times (Bettles 2002). The gold deposits are primarily in Paleozoic carbonate rocks and the gold occurs as very minute particles in the lattices of pyrite and arsenopyrite (Teal and Jackson 2002).

The other major mineral resource in the area is barite. The Rossi Mine, a few miles northwest of the Betze mine is owned by Halliburton (Baroid Drilling Fluids), which shipped about 169,000 tons in 2005 (Castor 2006). Geothermal resources occur within the Carlin Trend. Two tracts of land have been issued leases for geothermal resources (BLM 2007b). The potential for oil and gas reserves within the Carlin Trend is relatively low; most of the leases in the vicinity occur to the northeast of Carlin (BLM 2007b,c).

#### 3.2.1.5 Faulting and Seismicity

The study area is located in a region that is characterized by active and potentially active faults and a relatively high level of historic seismicity. For the purposes of this evaluation, an active fault is one that shows evidence of displacement during the Holocene period (last 10,000 years), and a potentially active fault is one that shows evidence of surface displacement during the late Quaternary period (last 1.6 million years) (Hart and Bryant 1999). Historically, surface displacement along faults occurred in Nevada during major earthquakes in 1869, 1903, 1915, 1932, and three events in 1954 (Stewart 1980). All of these events occurred along a north-trending zone called the Nevada Seismic Belt, located over 40 miles southwest of the study area. A review of the USGS fold and fault database indicated that potentially active faults are present in the study area, and active faults or historic faulting has occurred (Adams and Sawyer 1999; Adams et al. 1999; Anderson 2000; Oswald and Sawyer 1998). As shown in **Figure 3.2-1**, Quaternary faults occur along the southeastern edge of the Sheep Creek Range, and the southwestern flank of the Tuscarora Mountains. Major faults and hydrostructural features in the vicinity of the Goldstrike Mine are shown in **Figure 3.2-3**.

The closest known historic surface fault displacement to the regional study area was in 1915, approximately 60 miles to the southwest (Von Hake 1974). The study area is located in a region that has experienced moderate seismic activity in historic time. Earthquake records from 1977 to present indicate that 15 earthquakes have been recorded within an approximate 60-mile radius of the study area (USGS 2007). These earthquakes registered magnitudes of 3.0 to 4.6. The proposed project is in an area that is not likely to experience strong ground motions in the event of a large magnitude earthquake (Frankel et al. 1997).

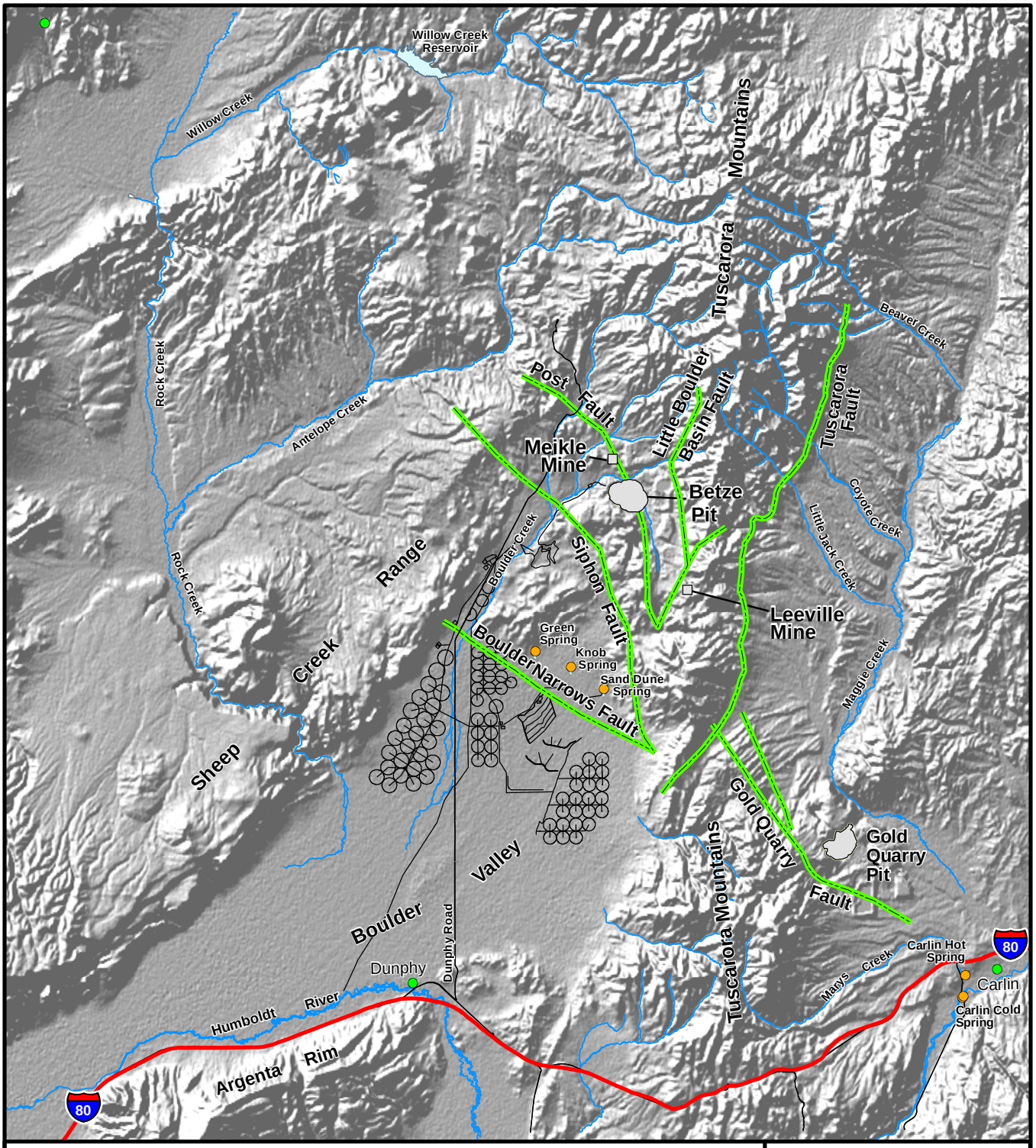
#### 3.2.1.6 Subsidence

As documented in BLM's CIA (2000b), there are areas that may be susceptible to ground subsidence and sinkhole development resulting from de-watering. The ground subsidence probably occurs when drawdown of the water table from dewatering causes piping and collapse of unconsolidated deposits into to pre-existing voids or fractures in carbonate bedrock. Three sinkholes developed from 1993 to 1998, but no sinkholes have been reported since then. It is probable that the drawdown has progressed through thin layers of alluvium and that if there are voids present in the carbonates rocks in the zone of influence of dewatering, the alluvium or overlying strata are sufficiently thick to attenuate surface manifestation of subsidence.

### 3.2.2 Environmental Consequences

Major issues related to geology and minerals include:

- Extent of mineral extraction and amount of materials associated with precious metals development;
- Geologic hazards created or exacerbated by development of the proposed project;
- Surface subsidence resulting from the lowering of the groundwater table; and
- Exclusion of future mineral resource availability caused by the placement of facilities.




**LEGEND**

- Streams
- Faults (Includes Inferred Faults)
- Springs
- Center Pivots
- Towns

N

0 2 4 8 Miles

Source: BLM 2000a.

**Betze Pit Expansion Project**

Figure 3.2-3

Major Hydrostructural Features

05/20/2008

#### 3.2.2.1 No Action Alternative

Under the No Action Alternative, the proposed Betze Pit Expansion Project would not be developed, and the potential impacts due to mineral extraction to geologic and mineral resources would not occur. However, a mineable reserve would be left in the ground and may not be available in years hence because the mine infrastructure would not be available to extract and process the ore. Under this alternative, dewatering operations to maintain the current water table below the Meikle Mine will continue through 2015 under existing permits and authorizations from the State of Nevada. No dewatering-induced surface subsidence impacts are anticipated due to dewatering operations. As described in Section 3.2.1.6, sinkhole development has probably reached equilibrium given the absence of sinkhole development in the last 10 years. Based on the foregoing, there is low potential for recurrence in sinkhole prone areas, with dewatering operations continuing through 2015. The existing mining and ore processing activities associated with current operations would continue under existing authorizations. Potential impacts to geologic and mineral resources previously were analyzed in the Mill and Tailings Pond EA (BLM 1988); Betze Project EIS (BLM 1991a,b); Meikel Mine EA (BLM 1993); and Betze Project SEIS (BLM 2000a, 2003a).

#### 3.2.2.2 Proposed Action

Direct impacts of the Proposed Action on geologic and mineral resources would include the generation and disposal of 315 million tons of waste rock and 12.44 million tons of tailings; the removal of 0.5 million tons of Carlin Formation material suitable for reclamation use; and the extraction of 12.44 million tons of ore.

The Proposed Action would result in an extension of the permanent alteration of the landscape and disturbance of approximately 1,180 acres. This disturbance includes unreclaimed areas disturbed by the open pit (Betze Pit), reclaimed waste rock disposal areas, and tailings impoundment that would permanently alter the natural topographic and geomorphic features in the area.

There are several potentially active faults in the proposed project vicinity that could cause ground motion in the event of an earthquake. USGS ground motion hazard maps indicate that there is a low probability that ground motion presents a hazard at the site. There are no identified geologic conditions that would be exacerbated by project activities that would result in geologic hazards. Pit wall, waste rock dump, and the tailings facility would be constructed to conform to regulatory standards to minimize instability.

The pit slopes, tailings facility, and waste rock facilities have been designed to provide for long term stability and safety (BGMI and SRK 2007). The design of the open pit has taken in to account BGMI's knowledge of the rock materials, geotechnical tests, and MSHA design standards. As mining occurs, design parameters and assumptions would be tested against actual conditions. Monitoring of the conditions would be accomplished through geological and geotechnical evaluation involving geologic structure mapping, groundwater monitoring, and slope stability monitoring and analysis.

The Goldstrike No. 3 Tailings Facility would consist of a dam and geosynthetic lined impoundment behind the dam. An internal drain system would be installed in the upstream face of the dam to prevent the buildup of fluid within the embankment. The liner under the impoundment would be designed to exceed NDEP and BLM standards. An underdrain system under the liner would be used to capture flows from seeps and springs in the drainage. Flow would be collected and diverted down stream of the dam.

A slope stability analysis of the Clydesdale Waste Rock Facility was conducted. The waste rock facility would be terraced, where appropriate to accommodate recontouring and reclamation. Bench heights would be in lifts of approximately 100 feet and during reclamation, terraces would be incorporated into the slopes resulting in a stable slope configuration of 2.5-2.8H:1V.

The proposed waste rock and tailings facilities are not located in areas that have been susceptible to subsidence. The proposed project would not affect access to other mineral resources.

#### 3.2.2.3 Bazza Waste Rock Facility Alternative

Under this alternative, waste rock from the proposed pit expansion would be disposed of in the existing Bazza Waste Rock Facility and in the Betze Pit as backfill; the Clydesdale Waste Rock Facility and haul road would not be constructed. Potential impacts under this alternative would be similar to the Proposed Action, with the following exceptions:

- The addition of the waste rock would not increase the total topographic footprint of the Bazza Waste Rock Facility;
- The Bazza facility capacity would be increased by 350 million tons to 2,280 million tons and have a maximum height of approximately 800 feet; and
- Under this alternative, 572 acres of disturbance associated with the proposed Clydesdale Waste Rock Facility and haul road would not occur.

The placement of waste rock would conform to the Bazza Waste Rock Management Plan (Schafer and Geosystems 2006) and slope stability requirements as approved by NDEP. As a result, significant slope instability of the Bazza Waste Rock Facility is not anticipated. Waste rock disposal would not preclude access to mineral resources since it is an existing facility.

### 3.2.3 Cumulative Impacts

#### 3.2.3.1 No Action Alternative

The CESA for geology and minerals is shown in **Figure 3.2-2**. The past and present actions and RFFAs in this area are identified in Section 3.1, their locations are shown in **Figures 3.1-1** and **3.1-2** (see Section 3.1, Past, Present, and Reasonably Foreseeable Future Actions). Primary mineral production in these areas has included gold, silver, barite, and lead. Most of the mineral production has come from gold mining operations. Gravel has been mined for road construction. Surface mining activity affects geology and mineral resource by excavating, modifying, or covering natural topographic and geomorphic features and by removing mineral deposits.

Mining disturbance in the CESA has included exploration (drilling, trenching, sampling, and road construction), open-pit and underground mining, and construction of waste rock, heap leaching, ore milling and processing, and tailings disposal facilities. For the purposes of this evaluation, disturbed areas (or geologic disturbance) is defined to include mine components such as open pits, waste rock areas, leach pads, and tailings impoundments that permanently alter the natural topographic and geomorphic features in the area, even if reclaimed.

Based on available information, past and present and reasonably foreseeable future mining-related activities have resulted, or would result, in approximately 38,000 acres of disturbance within the CESA, of which approximately 6,500 acres would remain as unreclaimed open pits with some partially filled with water (BLM 2007b,c). Approximately 1,500 acres of disturbance likely would remain for access roads and maintenance facilities to support post-closure activities, resulting in approximately 30,000 acres that would be reclaimed to approved post-mine uses in the reasonably foreseeable future.

#### 3.2.3.2 Proposed Action

The Proposed Action would incrementally increase the permanent alteration of topography in the CESA by approximately 1,180 acres, which represents only 0.2 percent of the cumulative effects area.

#### 3.2.3.3 Bazza Waste Rock Facility Alternative

The cumulative effects to geology and mineral resources associated with the Bazza Waste Rock Facility Alternative would be similar except that 608 acres of additional disturbance and permanent alteration of topography would occur, approximately 572 fewer acres than under the Proposed Action.

### 3.2.4 Mitigation Measures and Monitoring

No additional mitigation measures or monitoring requirements for geology and mineral resources are proposed.

### 3.2.5 Residual Impacts

Residual impacts would occur to the topography of the project area due to permanent alteration of the landscape.

## 3.3 Groundwater Resources and Geochemistry

Baseline water quantity and quality in the vicinity of the Goldstrike Mine have been described in past reports including the Betze Project Draft EIS (BLM 1991a,b), the Betze Project SEIS (BLM 2000a, 2003a), and the CIA of Dewatering and Water Management Operations for the Betze Project, South Operations Area Project, and Leeville Project (BLM 2000b), SOAPA (BLM 2007c), and Leeville Project (BLM 2000b). This section summarizes pertinent data on water resources from these reports and presents current information related to water management and water levels in the project area. Current information is available on seeps and springs from AATA International, Inc. (AATA) (2007) and on surface and groundwater in Boulder Valley from BGMI (2007f).

### 3.3.1 Affected Environment

The Goldstrike Mine is located within the Humboldt River basin in north-central Nevada. The Humboldt River basin covers an area of approximately 17,000 square miles; upstream of the project facilities, the river drainage occupies approximately 7,500 square miles. The Humboldt River flows within the Great Basin of Nevada and terminates in the Humboldt Sink south of Lovelock, Nevada.

The project-related study area for direct and indirect impacts to water resources is Boulder Flat (Hydrographic Area 61). It is bounded on the east and north by the Tuscarora Mountains and on the west by the Sheep Creek Range. Boulder Flat is bounded on the south by the Humboldt River (**Figure 3.3-1**). The CESA for water resources occupies approximately 2,073 square miles and includes six designated groundwater basins. These six groundwater basins are shown in **Figure 3.3-1** and are listed in **Table 3.3-1**. All six groundwater basins drain southward to the Humboldt River. The CESA for water resources in this SEIS is identical to the CESA analyzed in the CIA (BLM 2000b) and Betze Project SEIS (BLM 2000a, 2003a). The CESA is bounded by the Tuscarora Mountains on the north, the Adobe Range and the Independence Mountains on the east, and the Humboldt River on the south. As shown in **Figure 3.3-1**, the western boundaries of the Willow Creek and Rock Creek groundwater basins form the western boundary of the hydrologic study area. Elevations range from 8,800 feet amsl in the Tuscarora Mountains to 4,500 feet amsl along the Humboldt River.

**Table 3.3-1 Major Subregions Within the Hydrologic Study Area**

| Nevada Designated Groundwater Basin | Basin Number | Approximate Land Area (square miles) |
|---|---|---|
| Susie Creek | 50 | 220 |
| Maggie Creek | 51 | 410 |
| Marys Creek | 52 | 60 |
| Boulder Flat | 61 | 560 |
| Rock Creek Valley | 62 | 450 |
| Willow Creek Valley | 63 | 420 |

Source: Nevada State Engineer's Office 1992; Maurer et al. 1996.

#### 3.3.1.1 Hydrogeologic Setting

Hydrogeologic investigations have been undertaken by BGMI on an ongoing basis since 1990 to provide information on the existing groundwater conditions in the project area as mining advances and to estimate the potential impact of proposed changes in the mine plan where groundwater is involved. The details of these investigations can be found in BLM (2000a,b, 2003a). Studies have involved: 1) evaluation of the potential

effects of mine dewatering; 2) compilation of the effects of groundwater use along the Carlin Trend; 3) development and updating of a groundwater flow model for the project area; 4) evaluation of the effects of water use on the Humboldt River; 5) cumulative evaluation of the effects of dewatering at the Gold Quarry Mine and other mines in the project cumulative impact area; 6) studies of groundwater quality and chemistry; and 7) estimation of final pit lake chemistry for the Betze Pit after cessation of mining (Schafer 2003, 2007).

Groundwater flow, recharge, storage, and discharge are dependent on the geology of the water-bearing units. In consolidated bedrock geologic units, groundwater flow and storage are dependent on the secondary porosity developed by fractures, faults, solution cavities in carbonate units, folds, and bedding planes. In alluvial basin geologic units, groundwater flow and storage depend more on primary porosity determined by grain size distribution, cementation of the grains, and the interconnection of pores and available pore space. Because geology controls groundwater flow, the geologic units in the project area have been grouped into hydrostratigraphic and hydrostructural units. For a more complete discussion of the geology of the project area the reader is referred to Section 3.2, Geology and Minerals.

Hydrostratigraphic Units

The geology of the project area can be divided into six hydrostratigraphic units. These units are discussed below and their hydrologic properties are summarized in **Table 3.3-2**.

**Table 3.3-2 Summary of Hydrostratigraphic Unit Hydraulic Properties**

| Hydrostratigraphic Unit | Yield (gpm) | Estimated Hydraulic Conductivity (feet/day) | Estimated Transmissivity ($feet^2$/day) | Estimated Specific Yield (no units) |
|---|---|---|---|---|
| Younger Basin Fill | Up to 3,600 in Boulder Valley[2] | 1 to 100[2] | 4,500[1] – 13,400[2] | 0.15 – 0.25[2] |
| Older Basin Fill | <100 – 1,000[1] | 0.05 – 5.0[2] | 20 – 14,000[2] | 0.01 – 0.10[2] |
| Intrusive Rocks | Generally <100[2] | 0.01 – 1.0[2] | NA | NA |
| Volcanic Rocks | Up to 5,800 in Boulder Valley[2] | 0.1 – 200[2] | 300 – 100,000[2] | 0.0007 – 0.07[2] |
| Marine Clastic Rocks | 10 – 600[2,3] | 0.01 – 0.5[2] | 30 -800[2] | 0.0001 – 0.004[2] |
| Marine Carbonate Rocks | 500 – 5,000[2] | 0.1 - 100[2] | 13 – 300,000[2] | 0.0002 – 0.03[2] |

[1]Maurer et al. 1996.

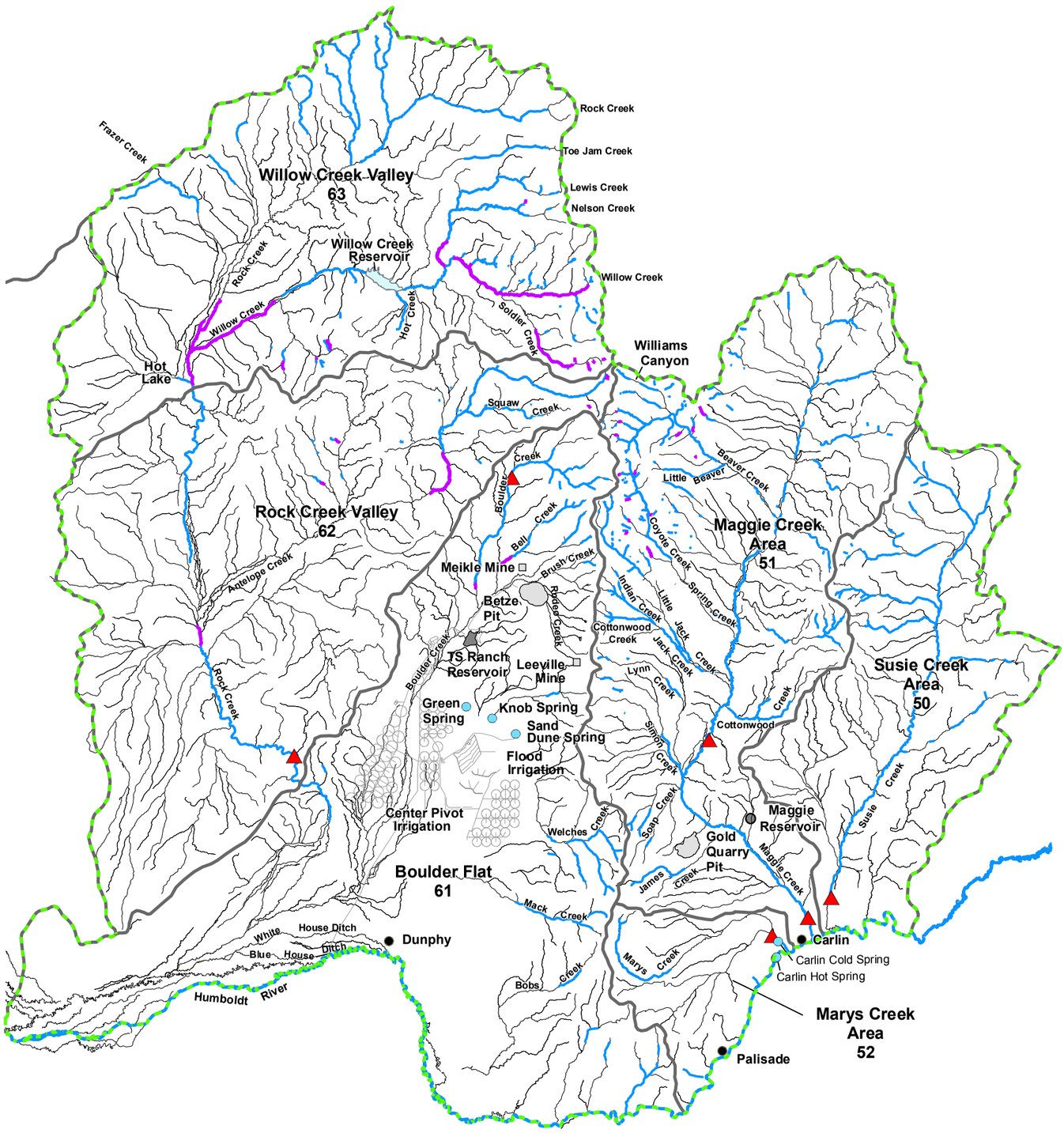
[2]McDonald Morrissey Associates, Inc. 1996a,b, 1998.

[3]Where highly fractured, may yield more than 600 gpm.

NA – No data available.

*Paleozoic Marine Carbonate Rocks*

These rocks consist of Paleozoic-age limestone and dolomite with lesser amounts of interbedded sandstone, shale, and quartzite. They are mainly Cambrian to Devonian in age but locally include carbonate rocks of Pennsylvanian and Permian age. These rocks are part of the Carbonate Rock Aquifer Province (Prudic et al. 1995) of eastern Nevada, a major bedrock carbonate aquifer that consists of marine platform carbonate rocks deposited in Paleozoic seas over millions of years. This Carbonate Rock Aquifer Province has its western-most boundary approximately 6 miles northwest of the Betze Pit. These carbonate rocks are exposed in the Tuscarora Mountains south of the Betze Pit and in bedrock outcrops in the Maggie Creek and Susie Creek basins.




3.3-3

Figure 3.3-1

Water Resources
Cumulative Effects
Study Area

**Betze Pit**
**Expansion Project**

**LEGEND**

- Water Resources Cumulative Effects Study Area
- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinous Flowing Stream Reach
- Location of Baseflow Predictions
- Center Pivot Irrigation
- Springs
- Towns

Note: Hydrographic Area boundary locations are approximate.
Source: BLM 2003a; USGS linegraph database.

N

0 5 10 Miles

05/20/2008

Marine carbonate rocks have a low primary, or matrix permeability. Secondary permeability developed by faults, fractures, bedding planes, and solution cavities can raise the bulk hydraulic conductivity of these rock units significantly. Secondary permeability can raise the hydraulic conductivity of the marine carbonate rocks to around 100 feet per day and result in a transmissivity as high as 300,000 feet squared per day. The specific yield for these rocks ranges from 0.0002 to 0.03. Yields from wells range from 500 to as much as 5,000 gpm due to secondary permeability.

*Paleozoic Marine Clastic Rocks*

These rocks consist of interbedded shale, siltstone, chert, quartzite, and some limestone. They consist of sediments that were deposited west of the Paleozoic platform carbonate rocks in subsiding basins. These stratigraphic units have been thrust eastward over the carbonate rocks by the Roberts Mountain Thrust throughout most of the project area and underlie the alluvial sediments and Tertiary volcanics. These clastic rocks are exposed in the Tuscarora Mountains, the Independence Range, and the Adobe Range. Their thickness ranges from 50 to 5,000 feet. The hydraulic conductivity is quite low, with reported values ranging from 0.01 to 0.50 feet per day. Transmissivity ranges from 30 to 800 feet squared per day and the specific yield ranges from 0.0001 to 0.004. Well yields are low and in the range of 10 to 600 gpm.

*Jurassic-Tertiary Intrusive Rocks*

These rocks are not abundant in the project area and range in composition from granodiorite to quartz monzonite and diorite, and form a relatively impermeable boundary immediately south of the Betze Pit. They also mark the southern extent of mineralization in the mine area. Hydraulic conductivities range from 0.01 to 1.0 feet per day, and well yields are generally less than 100 gpm.

*Jurassic-Tertiary Volcanic Rocks*

These rocks range from basalt flows to rhyolite ash-fall and ash-flow tuffs. The volcanic rocks are found throughout the project area and are commonly exposed in the western, northern, and southern parts of the hydrologic study area. The hydraulic properties of the volcanic rocks vary considerably due to the range in composition of the rocks and due to secondary permeability caused by faults and fractures, which enhance the hydraulic conductivity of the volcanics Estimates of hydraulic conductivity range from 0.01 to 200 feet per day, with transmissivity ranging from 300 to as much as 100,000 feet squared per day. The specific yield has been estimated to range from 0.0007 to 0.07. Yields to wells can be up to 5,800 gpm in the case of the Boulder Valley rhyolite.

*Older Tertiary Basin-fill Deposits*

These Pliocene to Miocene age deposits consist of poorly consolidated shale, claystone, mudstone, siltstone, sandstone, conglomerate, and fresh water limestone interbedded with volcanic tuffs and lavas. These deposits accumulated in basins during the early stages of extensional faulting and basin development. In the upper Maggie Creek basin, these deposits are up to 6,000 feet thick. In the Susie Creek and lower Maggie Creek basins, these sediments are approximately 2,000 feet thick. Well yields range from less than 100 to 1,000 gpm in these sediments. In the Maggie Creek area, hydraulic conductivity ranges from 0.05 to 5 feet per day with transmissivity values ranging from 20 to 14,000 feet squared per day. In the northern part of Boulder Flat, transmissivity ranges from 70 to 300 feet squared per day. The estimated specific yield is in the range of 0.01 to 0.10.

*Quaternary Younger Basin-fill Deposits*

These deposits range from sandy clay to gravelly sand and are unconsolidated. The thickness and lateral extent of these deposits are quite variable. In the basins, these sediments can be up to 1,000 feet thick. Along the mountain fronts, these sediments are considerably thinner and can be only tens of feet thick. The highly

variable composition of these sediments creates both confined and unconfined aquifers within the various sedimentary units, although for the most part this unit is an unconfined aquifer. Well yields can range up to 3,600 gpm in Boulder Valley, with hydraulic conductivities ranging from 1 to 100 feet per day, transmissivity ranging from 4,500 to 13,400 feet squared per day, and a specific yield estimated to range from 0.15 to 0.25.

Hydrostructural Units

Faults can serve as pathways for groundwater flow, or act as barriers to flow depending on the nature of the brecciation along the fault and the permeability of units juxtaposed by the faulting. Fractures, bedding planes, and cavities in bedrock units often allow for local flow of groundwater and create increased permeabitlity over a defined area. Long-term monitoring of water level changes in the vicinity of the Goldstrike Mine has resulted in the recognition of three major fault zones that impede groundwater flow across, that is perpendicular to, the strike of the fault zone. These three fault zones are discussed below.

*Boulder Narrows Fault*

The Boulder Narrows Fault is found in Boulder Valley (**Figure 3.2-3**) and has no surface expression. Evidence for this fault zone includes: 1) offset of rhyolite units in the area of the fault by approximately 700 feet; 2) the presence of the Green, Knob, and Sand Dune springs that were created by discharge of mine water to an infiltration reservoir; 3) gravity surveys by Newmont suggesting that Boulder Valley becomes 3,000 feet deep just south of the inferred fault trace; and 4) groundwater potentiometric surfaces in the valley alluvial sediments that are noticeably steeper and associated with higher water levels on the north side of the fault trace. The Boulder Narrows fault is thus inferred from this evidence and impedes groundwater flow southward across the fault.

*Siphon Fault*

This fault separates highly permeable marine carbonate rocks on the north from highly permeable volcanic rocks on the south. As shown in **Figure 3.2-3**, the fault acts as a barrier that separates the drawdown cone developed from mine dewatering north of the fault from the groundwater mound produced by infiltration of mine water south of the fault. Wells on either side of the fault record dramatically different water levels, with pre-mining water levels often differing by as much as 400 feet and currently differing by up to 1,200 feet.

*Post Fault*

This fault trends from southeast to northwest and is exposed in the east wall of the Betze Pit. Vertical movement along this fault has juxtaposed low permeability marine clastic rocks against higher permeability marine carbonate rocks. Prior to dewatering of the Betze Pit, exploration drilling indicated about a 100-foot drop in groundwater elevations from east to west across the fault. Dewatering has produced more dramatic water levels declines on the west side of the fault than on the east side, with up to a 1,600-foot difference across the fault zone.

*Regional Faults*

Other faults with the potential to influence groundwater flow and groundwater dewatering are the Little Boulder Basin Fault, the Tuscarora Fault on the east side of the Tuscarora Mountains, and the Gold Quarry Fault (**Figure 3.2-3**).

#### 3.3.1.2 Geothermal System

A deep geothermal system exists in the Paleozoic carbonate rock aquifer. High-yield wells have reported temperatures at the well head of 140 to 145°F. This contrasts with wells drilled east of the Betze Pit in low permeability marine clastics that have well head temperatures of 70 to 90°F. This geothermal system, which

may be a remnant of Tertiary faulting and volcanism in this part of Nevada, may influence groundwater movement. To date, however, dewatering of the pit area has shown temperatures at the well head that have remained relatively constant.

#### 3.3.1.3 Groundwater Levels

Groundwater levels are discussed by comparing pre-dewatering water levels with more current water levels that are the result of dewatering operations since 1991.

Pre-dewatering Groundwater Levels (Prior to 1991)

Prior to 1991, only limited data were available on groundwater levels in the project area. Unconfined groundwater levels for this period are shown in **Figure B-1** in **Appendix B**. These water levels are based on records from wells in the Boulder Flat area in 1990 and in the Maggie Creek area in 1988 (BLM 2000a). Water levels ranged from 5,700 feet amsl along the western flank of the Tuscarora Mountains to less than 4,600 feet amsl in the lower part of Boulder Valley. Along the eastern flank of the Tuscarora Mountains, water levels were recorded at 5,900 feet amsl and declined to 4,900 feet amsl near Carlin.

Current Groundwater Levels (2007)

Groundwater levels for the first quarter of 2007 (BGMI 2007f) are shown in **Figure 3.3-2**. This figure shows the change in groundwater levels and this groundwater flow patterns since dewatering began at the Goldstrike Mine in 1989. Groundwater levels around the Betze Pit are down to 3,575 feet amsl since September 2000 (Zhan 2007). Groundwater north of the Siphon Fault now flows mostly toward the Betze Pit, rather than down Boulder Flat toward the Humboldt River. In the Sheep Creek Range, groundwater levels are in the range of 4,800 feet amsl; in the Tuscarora Mountains, groundwater levels are around 6,800 feet amsl. The Siphon Fault affects groundwater levels and drawdown south of the Betze Pit. Groundwater levels in Boulder Flat in the area of the TS Ranch Reservoir and the irrigation fields are in the range of 4,600 to 4,800 feet amsl.

**Figure 3.3-3** shows the changes in groundwater elevation in the Boulder Flat area since dewatering began in 1989. Drawdown in the area of the Betze Pit has been approximately 1,700 feet. In the area of groundwater reinjection in Boulder Flat, there is a groundwater mound in the Tertiary volcanics indicating an increase in water levels exceeding 30 feet and a groundwater mound in the Quaternary sediments indicating an increase in water levels of approximately 10 to 20 feet since 1990.

#### 3.3.1.4 Groundwater Flow and Water Balance

Pre-dewatering Groundwater Flow and Water Balance

As shown in **Figure B-1**, groundwater flow based on data available prior to 1991, from a variety of monitoring wells in both bedrock and alluvium, was generally southward from the mountains toward the Humboldt River. In the Boulder Valley area, groundwater flow was from the divide along the crest of the Tuscarora Mountains westward into Boulder Valley and then southwest toward the Humboldt River. From the Sheep Creek Range along the west side of Boulder Valley, groundwater flow was southeastward into Boulder Valley and then toward the Humboldt River, and flow merged with that from the Tuscarora Mountains. In the vicinity of the Betze Pit, groundwater flow was southwestward and then south down Boulder Valley toward the Humboldt River. In Maggie Creek, groundwater flow followed a similar pattern with flow from the Tuscarora Mountains and the Independence Range converging in Maggie Creek, and then flowing toward the Humboldt near Carlin. West of the Sheep Creek Range, in Antelope Creek and Willow Creek, groundwater flow was generally southwestward from the mountains into the valleys then westward down the valley.

**Table 3.3-3a** summarizes the water balance for Boulder Flat, Maggie Creek, Marys Creek, Susie Creek, Willow Creek, and Rock Creek basins under pre-dewatering conditions prior to 1991. Precipitation and

mountain-front runoff are the main sources of recharge to the hydrologic system in the Boulder Valley area. Precipitation falling in the mountainous areas that does not infiltrate or evaporate in the mountains becomes the mountain-front runoff that recharges the groundwater system in the valley alluvium. The total estimated inflow to the hydrologic study area is approximately 445,000 acre-feet per year (afy), including 56,700 afy of direct recharge, 62,400 afy of mountain-front recharge and 25,900 afy of recharge from the Humboldt River into Boulder Flat. Of this, approximately 203,100 afy recharges the Willow Creek, Rock Creek, and Boulder Valley areas, and the remaining 151,900 afy recharges the Maggie Creek, Marys Creek, and Susie Creek areas. In the Boulder Flat area, an estimated 25,900 afy comes from infiltration of Humboldt River water, approximately 24,900 afy arrives as surface water in Rock Creek, and approximately 17,100 afy comes from groundwater underflow and adjacent basins within the CESA (Zhan 2008).

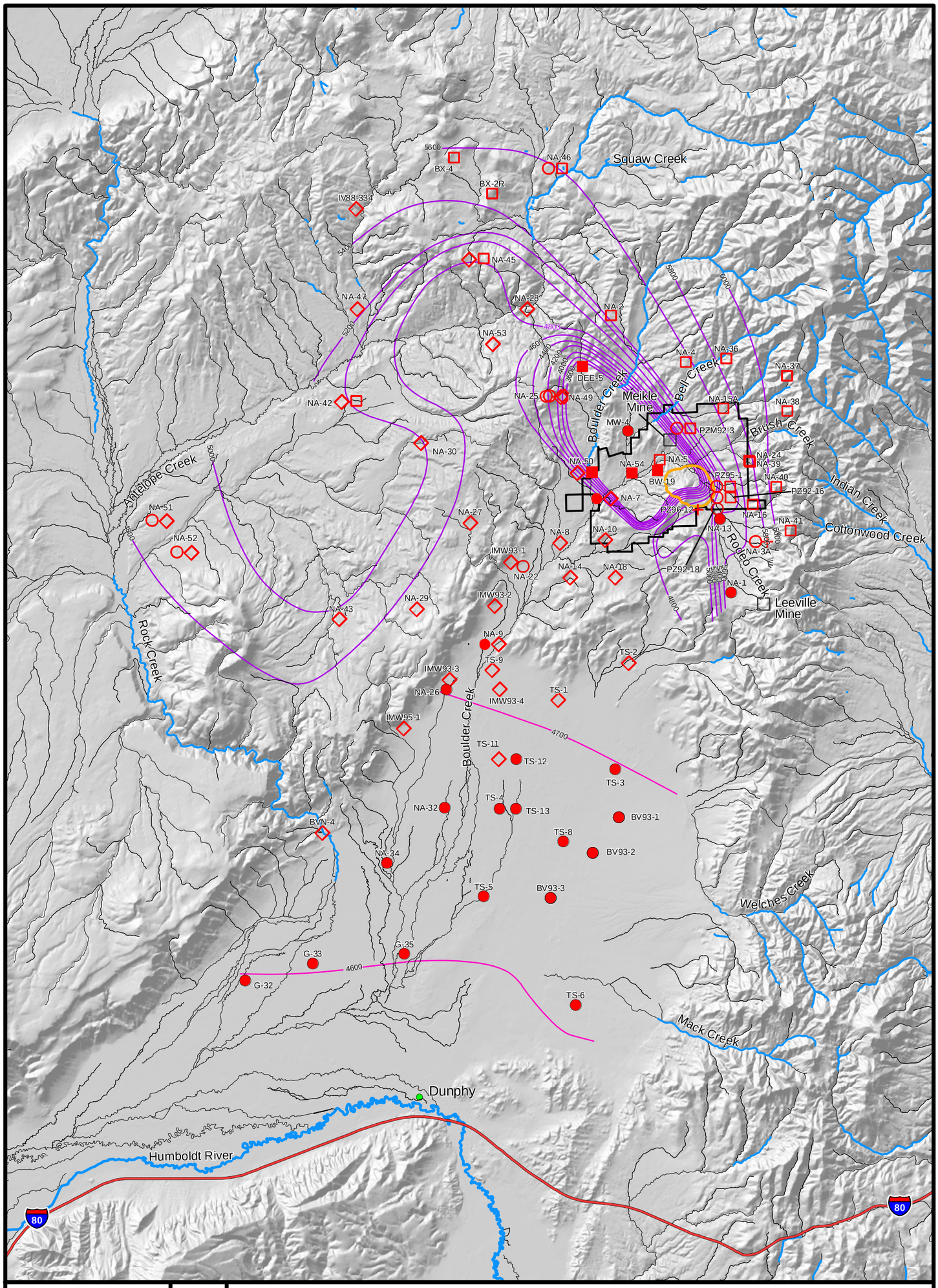
Discharge from groundwater comes from evapotranspiration by plants, subsurface outflow, discharge to springs and streams, and groundwater use through pumping. Evapotranspiration accounts for approximately 99,200 afy of outflow from the hydrologic study area (Zhan 2008). From Boulder Flat, an estimated 6,800 afy groundwater leaves the basin as groundwater outflow. An estimated 28,800 afy of discharge occurs from the Maggie Creek, Marys Creek, and Susie Creek Hydrographic Areas to the Humboldt River as stream flow. An estimated 11,500 afy of discharge occurs as groundwater outflow.

Current Groundwater Flow and Water Balance

The current water balance in Boulder Valley is affected by dewatering in the Betze Pit area and reinjection of water through the TS Ranch Reservoir and the use of excess flows through irrigation pivots. Natural recharge to the hydrologic system has not changed, but the redistribution of surface water and groundwater due to dewatering, sprinkler irrigation and evaporation, reinjection and evaporation has modified the water balance in Boulder Valley from prior to 1991. Also, water is lost to evaporation in the TS Ranch Reservoir. **Table 3.3-3b** shows the estimated current water balance for Boulder Valley and vicinity (Zhan 2008). For the project area in Boulder Flat, recharge from precipitation and mountain front run-off is approximately 19,100 afy. The total water influx to the basin from all sources is approximately 333,400 afy. The major sources of recharge are groundwater inflow, river leakage, and infiltration from the BGMI water management activities. Discharge due to evapotranspiration is approximately 106,500 afy from plants and crops combined, and approximately 63,500 afy due to mine pumping at the Goldstrike and Leeville mines. Willow Creek and Rock Creek basins are not affected by pumping, so recharge is from precipitation and river leakage, with discharge due to evapotranspiration along with surface water and groundwater outflow. Marys, Maggie, and Susie creeks are affected by mine dewatering at Gold Quarry, with increased outflows from the Marys Creek and Susie Creek basin, and decreased surface and groundwater outflow from Maggie Creek Basin.

#### 3.3.1.5 Groundwater Rights

According to the Nevada State Engineer's records, there are approximately 234 groundwater rights and applications for groundwater rights on file in the hydrologic study area. These are presented in the BLM's Betze Project SEIS (2000a). This inventory does not include rights and applications for rights by BGMI or Newmont that are classified as mining and milling. Because water rights are not required for domestic wells, this inventory does not include all domestic watering wells that may exist in the hydrologic study area. Included in the inventory are five known water supply wells that are used for domestic or stock water. The area around Carlin most likely includes many private domestic water wells that are not included in the inventory.




**LEGEND**

- Monitoring Well Quaternary Alluvium/Colluvium Layer
- Monitoring Well Tertiary Carlin Formation Layer
- Monitoring Well Tertiary Volcanics Layer
- Monitoring Well Jurassic/Cretaceous Granodiorite Layer
- Monitoring Well Paleozoic Siltstones Layer
- Monitoring Well Paleozoic Limestones Layer
- Tertiary and Paleozoic Rock Potentiometric Surface Elevation
- Boulder Valley Alluvium Potentiometric Surface Elevation
- Goldstrike Mine Operations Boundary
- Betze Pit
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Source: BGMI 2007f.

N

0 2.5 5 Miles

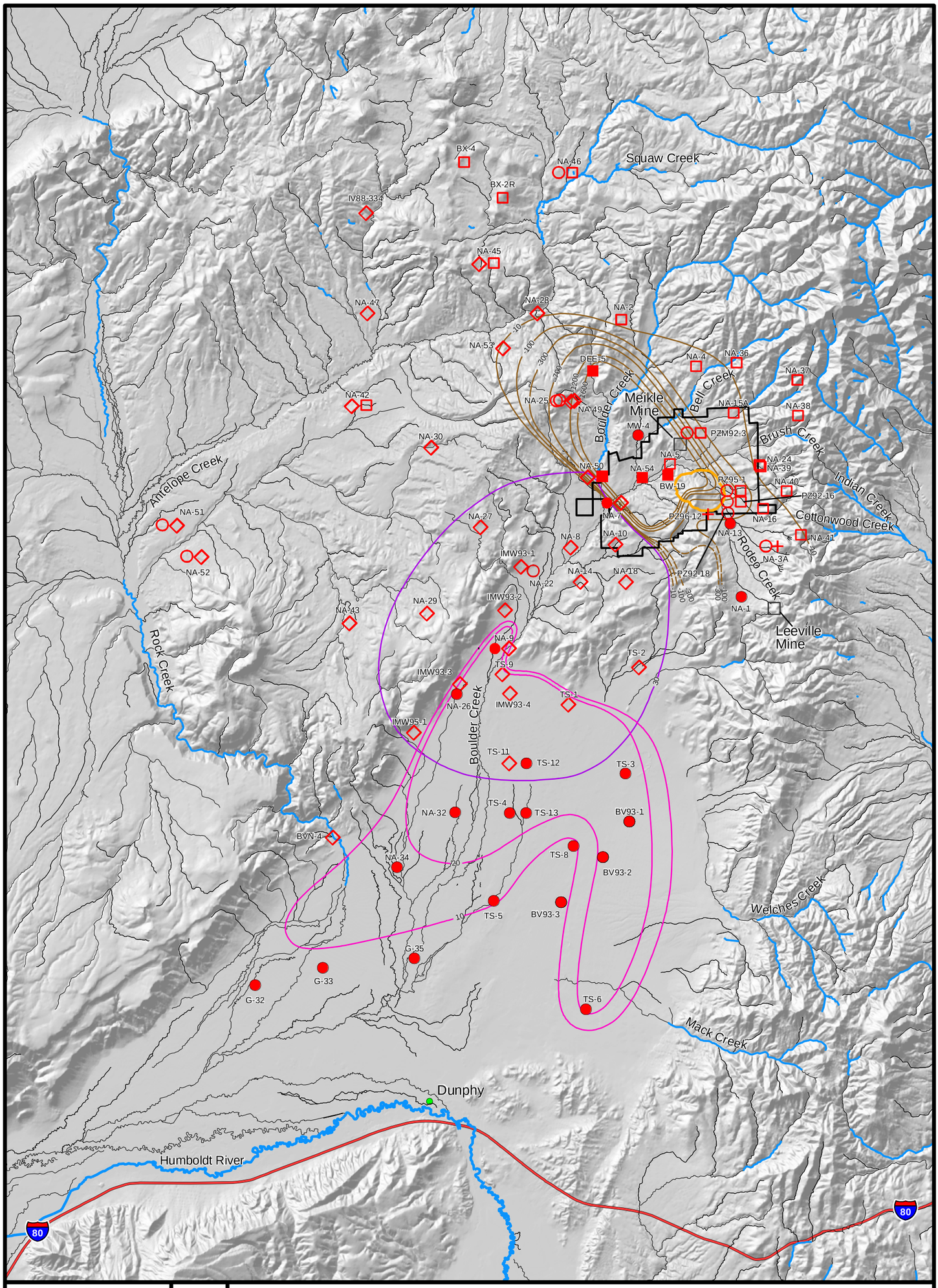
**Betze Pit Expansion Project**

Figure 3.3-2

Groundwater Elevation
Fourth Quarter 2006 and
First Quarter 2007



05/20/2008




**LEGEND**

- Monitoring Well Quaternary Alluvium/Colluvium Layer
- Monitoring Well Tertiary Carlin Formation Layer
- Monitoring Well Tertiary Volcanics Layer
- Monitoring Well Jurassic/Cretaceous Granodiorite Layer
- Monitoring Well Paleozoic Siltstones Layer
- Monitoring Well Paleozoic Limestones Layer
- Water Level Change In Tertiary Volcanics
- Water Level Change in Quaternary Alluvium/Colluvium
- Water Level Change In Paleozoic Bedrock Due To Pumping
- Goldstrike Mine Operations Boundary
- Betze Pit
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Source: BGMI 2007f.

N

0 2.5 5 Miles

**Betze Pit Expansion Project**

Figure 3.3-3

Changes in Groundwater Elevation
Fourth Quarter 2006 and
First Quarter 2007



06/25/2008

**Table 3.3-3a Pre-mining Simulated Water Balance (acre-feet)**

| Sources | Willow Creek | | Rock Creek | | Boulder Flat | | Marys Creek | | Maggie Creek | | Susie Creek | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | |
| **Recharge** | | | | | | | | | | | | | |
| Direct | 14,000 | | 9,800 | | 11,200 | | 1,500 | | 13,800 | | 6,400 | | 6,400 |
| Mountainfront | | 20,100 | | 5,900 | | 7,900 | | 1,300 | | 20,200 | | 7,000 | 7,000 |
| **Groundwater inflow** | 600 | | 6,800 | | 17,100 | | 4,300 | | 3,400 | | 1,500 | | 1,500 |
| **Surface water inflow** | | | | 21,000 | | 24,900 | | | | | | | 24,900 |
| **River leakage** | | | | | | | | | | | | | 0 |
| Humboldt | | | | | 25,900 | | | | | | | | 25,900 |
| Other | 12,400 | 13,300 | 12,000 | 10,000 | | | 3,500 | 5,900 | 29,400 | 25,700 | 5,400 | 7,300 | 77,200 |
| **Storage** | 8,800 | | 5,400 | | 32,700 | | 1,600 | | 10,400 | | 3,000 | | 3,000 |
| **TOTAL IN** | 35,800 | 33,300 | 34,000 | 36,900 | 113,500 | 39,600 | 10,900 | 7,200 | 57,100 | 45,900 | 16,400 | 14,400 | 445,000 |
| | | | | | | | | | | | | | |
| **Sinks** | | | | | | | | | | | | | |
| **Evapotranspiration** | | | | | | | | | | | | | |
| Natural ET | 11,400 | | 1,000 | | 68,300 | | 2,500 | | 12,500 | | 3,500 | | 3,500 |
| Crop ET | | | | | | | | | | | | | |
| **Runoff to Humboldt** | | | | | | 100 | | 100 | | | | 300 | 300 |
| **Surface water outflow** | | 21,000 | | 24,900 | | 13,000 | | 3,700 | | 16,500 | | 8,600 | 8,600 |
| **Groundwater outflow** | 2,500 | | 17,800 | | 6,800 | | 600 | | 8,600 | | 2,300 | | 2,300 |
| **River leakage** | | | | | | | | | | | | | |
| Humboldt | | | | | | | 200 | | 100 | | 300 | | 300 |
| Other | 13,300 | 12,400 | 10,000 | 12,000 | 6,800 | 26,600 | 5,900 | 3,500 | 25,700 | 29,400 | 7,300 | 5,400 | 158,300 |
| **Storage** | 8,700 | | 5,200 | | 31,700 | | 1,700 | | 10,200 | | 3,000 | | 3,000 |
| **TOTAL OUT** | 35,800 | 33,300 | 34,000 | 36,900 | 113,600 | 39,600 | 10,900 | 7,200 | 57,100 | 45,900 | 16,400 | 14,400 | 445,100 |

Note: Blank cells are not applicable.

Source: Zhan 2008.

**Table 3.3-3b Current Simulated Water Balance July 2005 – June 2006 (acre-feet)**

| Sources | Willow Creek | | Rock Creek | | Boulder Flat | | Marys Creek | | Maggie Creek | | Susie Creek | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | |
| **Recharge** | | | | | | | | | | | | | |
| Direct | 14,000 | | 9,800 | | 11,200 | | 1,500 | | 13,800 | | 6,400 | | 6,400 |
| Mountainfront | | 20,100 | | 5,900 | | 7,900 | | 1,300 | | 20,200 | | 7,000 | 7,000 |
| **Groundwater inflow** | 600 | | 7,100 | | 37,900 | | 4,000 | | 15,200 | | 1,700 | | 1,700 |
| **Surface water inflow** | | | | 21,000 | | 24,900 | | | | | | | 24,900 |
| **River leakage** | | | | | | | | | | | | | |
| Humboldt | | | | | 25,900 | | | | | | | | 25,900 |
| Other | 12,400 | 13,300 | 12,000 | 10,000 | | | 3,500 | 5,600 | 29,700 | 22,300 | 5,400 | 7,300 | 73,800 |
| **Storage** | 8,800 | | 8,500 | | 95,400 | | 2,000 | | 37,300 | | 4,100 | | 4,100 |
| **Infiltration** | | | | | | | | | | | | | |
| Irrigation | | | | | 25,200 | | | | | | | | 25,200 |
| Injection wells | | | | | | | | | | | | | |
| Reservoir | | | | | 45,000 | | | | | | | | 45,000 |
| Pond | | | | | 600 | | | | | | | | 600 |
| **TOTAL IN** | 35,900 | 33,300 | 37,400 | 36,900 | 275,200 | 58,200 | 11,100 | 7,000 | 95,900 | 42,500 | 17,600 | 14,400 | 665,400 |
| | | | | | | | | | | | | | |
| **Sinks** | | | | | | | | | | | | | |
| **Evapotranspiration** | | | | | | | | | | | | | |
| Natural ET | 11,400 | | 1,000 | | 88,800 | | 2,500 | | 12,300 | | 3,500 | | 3,500 |
| Crop ET | | | | | 17,700 | | | | | | | | 17,700 |
| **Runoff to Humboldt** | | | | | | 100 | | 100 | | | | 300 | 300 |
| **Surface water outflow** | | 21,000 | | 24,900 | | 13,100 | | 3,400 | | 12,800 | | 8,600 | 8,600 |
| **Groundwater outflow** | 2,500 | | 20,300 | | 17,200 | | 1,000 | | 26,900 | | 3,500 | | 3,500 |
| **River leakage** | | | | | | | | | | | | | |
| Humboldt | | | | | | | 200 | | 100 | | 300 | | 300 |
| Other | 13,300 | 12,400 | 10,000 | 12,000 | 25,300 | 34,100 | 5,600 | 3,500 | 22,300 | 29,700 | 7,300 | 5,400 | 180,900 |
| **Storage** | 8,700 | | 6,100 | | 62,800 | | 1,700 | | 10,200 | | 3,000 | | 3,000 |
| **Pumping** | | | | | | | | | | | | | |
| Barrick pumping | | | | | 33,300 | | | | | | | | 33,300 |
| Newmont pumping | | | | | 30,200 | | | | 24,200 | | | | 24,200 |
| **Pumpback (diversion)** | | | | | | 11,000 | | | | | | | 11,000 |
| **TOTAL OUT** | | | | | | | | | | | | | **372,100** |

Note: Blank cells are not applicable.

Source: Zhan 2008.

### 3.3.1.6 Seeps and Springs

Initially, two field investigations were undertaken to identify perennial seeps and springs located around the Goldstrike Mine (BLM 2000b). Both inventories were conducted in the fall to identify seeps and springs discharging groundwater at the low-flow time of the year. The first inventory was conducted in 1989 (JBR 1990) and covered an area within a 10-mile radius of the Goldstrike Mine. This inventory included the Boulder, Bell, Brush, and Rodeo Creek watersheds and identified 131 seeps and springs. The second inventory was conducted in 1993 (Riverside Technology, inc. [RTi] 1994) and covered approximately 600 square miles. This inventory included the Willow Creek, Rock Creek, and Antelope Creek watersheds and springs located in the northern, southern, and eastern portions of the Tuscarora Mountains. A total of 277 new seeps and springs were identified with perceivable flows and 211 seeps and springs with no flow. Spring inventories in the region around the Gold Quarry Mine (JBR 1992a) identified 200 seeps and springs. The most recent spring monitoring survey was completed by AATA (2007). This survey compiled spring flow rates and water quality.

Flows in springs identified in the region around the Goldstrike Mine, except for Green, Knob, and Sand Dune springs, ranged from less than 1 gpm to 140 gpm, with most having a discharge less than 3 gpm (BLM 2000a,b). Only four springs had flows greater than 10 gpm with 90 percent of the springs showing flows between 1 and 3 gpm during the fall months. Within a 10-mile radius of the Gold Quarry Mine, seeps and springs primarily have flow rates less than 5 gpm; only 12 springs exceeded 5 gpm, and 4 of these springs had flows greater than 50 gpm.

Springs inventoried in the northern part of the Tuscarora Mountains, Boulder Flat, Rock Creek, and Willow Creek basins had temperatures ranging from 38 to 78°F. No springs with temperatures greater than 90°F were identified. In the Maggie Creek, Marys Creek, and Susie Creek basins, five hot springs were identified (BLM 2000b).

### 3.3.1.7 Groundwater Quality

The NAC 445A.453 establishes primary water quality standards, and NAC 445A.455 establishes secondary standards for water quality. Nevada water standards applicable to this SEIS are summarized in **Appendix B**, **Table B-1**. Primary standards are based on the potential use of groundwater for drinking water and are established to protect human health; the secondary standards are for aesthetic qualities. Because groundwater in the project area has the potential to be used for drinking water, the Nevada primary standards would apply to mine-related activities that affect groundwater.

Groundwater quality near the Goldstrike Mine is based on sampling conducted for the original Betze Project EIS (BLM 1991a,b) and from 61 wells sampled as part of the Betze-Screamer Pit Lake Study (Radian International and Baker Consultants 1997). In addition, 36 regional wells were selected to characterize the groundwater in the Boulder Valley alluvium and Tertiary volcanics (BGMI 1998). The general groundwater chemistry for the major hydrostratigraphic units is presented in **Appendix B**, **Table B-2**, and is shown on a trilinear diagram in **Figure B-2**. In **Appendix B**, **Table B-3** summarizes the groundwater quality in the first-quarter 2007 round of sampling of monitoring wells in Boulder Valley. BGMI routinely samples groundwater quality as part of its Boulder Valley Monitoring Plan (BVMP), and the data in **Table B-3** come from the latest round of sampling under the BVMP (BGMI 2007c).

The Paleozoic marine clastic rocks near the Betze Pit primarily contain calcium-magnesium-bicarbonate water with elevated sulfate and silica. The total dissolved solids (TDS) in this water are approximately 305 mg/L, and pH is around 7.6 standard units. The Paleozoic marine carbonate rocks contain a strong calcium-bicarbonate water type that is relatively low in sodium and sulfate; average TDS are approximately 566 mg/L, and average pH is around 6.75 standard units. The Jurassic-Tertiary igneous rocks contain calcium-sulfate water with elevated chloride, and TDS of approximately 392 mg/L. Samples from the Tertiary volcanic rocks show a mean TDS of 375 mg/L in a calcium-sodium bicarbonate water. The Tertiary older alluvial rocks

(Carlin Formation) contain a calcium-bicarbonate water with silica and sulfate. Water in the Quaternary alluvium is also mainly a calcium-sodium bicarbonate water with TDS of around 330 mg/L.

Betze Pit Area

Groundwater sampled near the Betze Pit area can be divided into two general types: 1) calcium-bicarbonate water found in the Paleozoic marine carbonate rocks; and 2) calcium-bicarbonate water with elevated silica, manganese, and chloride found in the Carlin Formation and the Paleozoic marine clastic rocks. In addition, arsenic, barium, boron, fluoride, iron, and manganese are commonly detected in groundwater near the Betze Pit. Arsenic concentrations average around 0.06 mg/L and are highest in the Paleozoic marine clastic rocks and the Jurassic-Tertiary intrusive rocks. Barium, boron, and fluoride concentrations are elevated in the thermal water found in the Paleozoic marine carbonate rocks and the Carlin Formation. The mean concentration of iron is highest (1.6 mg/L) in the Carlin Formation. Manganese concentrations are approximately an order of magnitude greater in the Paleozoic marine clastic rocks and the intrusive rocks than in other formations. Average antimony concentrations are between 0.03 and 0.04 mg/L in the Paleozoic marine carbonate rocks and the intrusive rocks. The average concentration of zinc in groundwater near the pit is approximately 0.02 mg/L.

Boulder Valley Area

Most groundwater samples from the alluvium and volcanics of Boulder Valley were within Nevada drinking water standards for major ions and trace metals. Six groundwater samples exceeded the standard for pH, and drinking water standards for TDS were exceeded in 24 samples. Trace metals detected in the alluvium include arsenic, barium, boron, copper, fluoride, iron, lead, manganese, selenium, and zinc. Exceedences of Nevada drinking water standards for trace metals were infrequent but were detected for arsenic, iron, and manganese. The maximum concentration for arsenic was 0.14 mg/L, for iron was 100 mg/L, and for manganese was 2.8 mg/L. Groundwater samples from volcanic rocks detected aluminum, arsenic, barium, boron, chromium, copper, fluoride, iron, lead, manganese, selenium, thallium, and zinc; concentrations of aluminum, arsenic, fluoride, iron, lead, and manganese slightly exceeded drinking water standards. The maximum concentrations follow: aluminum was 0.7 mg/L, arsenic was 0.21 mg/L, fluoride was 3.0 mg/L, iron was 59 mg/L, lead was 0.018 mg/L, and manganese was 2.9 mg/L.

Current groundwater quality data from monitoring wells and springs in Boulder Valley (BGMI 2007f) indicate arsenic concentrations up to 0.04 mg/L and barium up to 0.104 mg/L. The TDS for monitoring wells ranges from 159 to 571 mg/L. Sulfate is below 100 mg/L, and the waters are calcium-sodium bicarbonate dominated. The Boulder Valley springs TDS range from 286 to 357 mg/L, and waters are dominated by calcium bicarbonate. Mean concentrations of arsenic are approximately 0.01 mg/L, and are barium approximately 0.1 mg/L. These results indicate the spring waters are similar in major cation chemistry to the groundwater in the monitoring wells. Boulder Valley monitoring data (BGMI 2007f) are summarized in **Table B-3** in **Appendix B**.

Seeps and Springs Water Quality

Measured temperatures for inventoried springs ranged from 38 to 78°F. This temperature range is strongly influenced by ambient air temperature because most of the springs sampled had flow rates less than 3 gpm. No hot springs were encountered during the inventories. The pH in 399 sampled springs ranged from 6.4 to 8.9 standard units, and two springs in upper Antelope Creek located below old mine workings had pH values between 3.0 and 4.0 standard units. TDS in most sampled springs ranged from 32 to 550 mg/L (RTi 1994). The springs with low TDS tended to be located at the higher elevations in the Tuscarora Mountains. Tritium samples taken from selected springs showed that water discharging from springs on the eastern slope of the Tuscarora Mountains have low residence times, while tritium concentrations in samples from the upper Antelope Creek-Squaw Creek area suggest the groundwater is pre-1954 in age. Other samples taken in the

hydrologic study area were intermediate between tritium concentrations found in pre-1954 and very recent water, suggesting a mixing of older and younger waters.

A recent survey of seeps and springs by AATA (2007) found flow rates in 2006 ranging from less than 1 gpm to a maximum of 281 gpm (not including Rock Creek). The results of this survey are summarized in **Tables B-4** through **B-6** in **Appendix B**. Most springs had flow rates less than 5 gpm. The TDS ranged from a low of 45 mg/L in Beaver Creek to a high of 478 mg/L in Brush Creek. Each drainage basin had its own distinctive range in TDS values and flow rates. The pH in the sampled springs was mainly between 7.0 and 8.0 standard units. Most arsenic concentrations were less than 0.01 mg/L, but up to 0.0781 mg/L was recorded. The springs were dominated by bicarbonate water. Sulfate concentrations were generally less than 100 mg/L but ranged up to 154 mg/L. The survey found that only two springs in Boulder Creek (springs #6 and #88) showed definite impact from mine dewatering. All other springs often showed a relationship between precipitation and flow rate but no measurable impact due to mine dewatering at the Betze Pit.

#### 3.3.1.8 Waste Rock Geochemistry

Exposure of rocks to air and water during and after mining may cause increased weathering reactions. These weathering reactions could result in the mobilization of constituents from the exposed rocks, potentially affecting surface and groundwater resources. A key concern related to mine waste rock is the potential for acid generation through oxidation of sulfide minerals such as pyrite. Acid generated by sulfide mineral oxidation and associated metals releases from waste rock can, in some cases, affect water quality.

Characterization of waste rock from the Betze Pit and proposed laybacks was described by Schafer (2008b). Waste rock was characterized by determining its acid generation potential using static acid-base accounting (ABA) analyses and geochemical composition through whole-rock chemical analyses. Static ABA measurements indicate whether waste rock is a likely net producer or consumer of acid that is generated by sulfide oxidation. Whole-rock chemical analyses measure the concentrations of constituents in the rocks and indicate potential sources of constituents of concern. Leachate from the waste rock was characterized by performing kinetic tests that included both humidity cell and column leach tests. These leachate characterization results were used to establish the expected variations in leachate chemistry over time.

Static ABA tests estimate the acid producing potential of a material based on the acid generating and acid neutralizing minerals present in the sample. Acid-generating potential is expressed as AGP, and acid-neutralizing potential is expressed as ANP. The difference between the ANP and the AGP is the NNP. If the NNP is a negative less than -20 kilograms per ton of calcium carbonate (kg/t $CaCO_3$), the material is often classified as having the PAG. If the NNP is greater than 20 kg/t $CaCO_3$, then the material is often classified as non-acid generating (NAG). Materials that fall between these two values are often classified as being “Uncertain” as to their potential for acid generation (U.S. Environmental Protection Agency [USEPA] 1994).

The method of waste rock classification used by BGMI for static ABA test results divides materials into two categories based on NNP and percent sulfide sulfur. Under the BGMI method, waste rock is classified as PAG if the NNP is less than 0.0 tons per kiloton (t/Kt) $CaCO_3$ and the sulfide sulfur is greater than 0.3 percent. If the waste rock has an NNP greater than or equal to 0 t/Kt and a sulfide sulfur of less than 0.3 percent, then the material is classified as NAG. The NNP is defined as the ANP minus the AGP and is expressed in $CaCO_3$ (t/Kt).

The BLM classifies waste rock based on static ABA tests as NAG if the NNP is equal to or greater than 20 t/Kt and the ANP/AGP ratio is 3:1 or greater (BLM IM No. 96-79 [BLM 1996]). Any material that does not meet these criteria is classified as “Uncertain” and considered potentially acid generating and must be evaluated by kinetic methods such as humidity cell tests or column leach tests to determine the potential for acid generation. A method commonly used in western mines that is a modification of the BLM guidelines assumes that if the NNP is less than -20 t/Kt, the material is PAG. Under this modification, any material that falls between an NNP

of -20 t/Kt and an NNP of +20 t/Kt is classified as “Uncertain” for potential acid generation. This material is subjected to kinetic tests to determine the potential for acid generation. Materials that have an NNP less than -20 t/Kt also are subjected to kinetic tests.

The BGMI method for classifying waste rock from static ABA tests is similar to, but not directly comparable to the BLM guidelines. **Tables 3.3-4** through **Table 3.3-6** present data from Schafer (2008a) with the BGMI method and the BLM method for classifying rocks by the static ABA test results displayed together in the same table. **Table 3.3-4** presents the 1997 column test samples. This table shows that out of 15 samples, 5 of the samples (33 percent) classified as NAG by BMGI would be classified as Uncertain by the BLM. Also, this table shows that two of the samples (13.3 percent) classified as NAG by the BGMI method had pH values below 5.0 standard units, suggestive of potential acid generation. On this same table, the BLM method of classification had no difference in the classification of NAG rocks. **Table 3.3-5** presents 2002 column test charge samples. In this table, four of the samples (18.2 percent) classified as NAG by the BGMI method would be classified as Uncertain by the BLM method. No rocks classified as NAG under the BGMI method had a pH of less than 5.0 in this table.

Schafer (2008b) summarized the results of BGMI’s extensive humidity cell and column leach tests of waste rock that would be sent to either the proposed Clydesdale Waste Rock Facility, the Bazza Waste Rock Facility, or disposed of in the proposed expanded Betze Pit. BGMI has performed static ABA tests on over 30,000 samples from exploration boreholes and on over 100,000 blasthole pulps since the inception of mining at Goldstrike. **Table 3.3-6** presents a condensed summary of BGMI kinetic test data (Schafer 2008b, Table A-2) along with the BLM and BGMI static ABA classifications of the samples and the BGMI acid risk classification of kinetic results. The BGMI acid risk classification method for determining PAG from kinetic data involves pH, sulfate, and the “acidity” indicated in the test data, as summarized at the bottom of **Table 3.3-6**. BGMI considers a rock to be PAG from kinetic data if the pH is greater than 5.0 standard units, and the sulfate is greater than 20 mg/kg with an NNP from the static ABA test of greater than -5.0 t/Kt. Acid generating is defined as a pH of greater than 5.0 standard units with sulfate greater than 20 mg/kg, but with an NNP of less than -5.0 t/Kt. Strongly acid generating is defined as having a pH in the kinetic data of less than 5.0 standard units. The BGMI method for classifying kinetic data defines NAG as having a pH of greater than 5.0 standard units and sulfate less than 20 mg/kg. The BLM does not have guidelines for classifying kinetic data into varying degrees of acid generation. For the purpose of comparing the BLM and BGMI methods, any level of acid generation in the BGMI acid risk classification scheme is considered as indicating the potential for acid generation.

An analysis of **Table 3.3-6** shows rocks classified as NAG by BGMI had some degree of potential acid generation in approximately 22.2 percent of the samples for which there was NNP data. For samples where the pH was below 5.0 standard units, the BGMI NAG classification differed for 7.9 percent of the samples. For samples classified as PAG by the BGMI method, there was a 20.0 percent difference in classification in that the PAG samples were classified as NAG by the kinetic data. Using the BLM criteria for classifying rocks from the static ABA test results, rocks classified as NAG by the BLM method indicated some degree of potential acid generation in 20.8 percent of the samples. For samples where the kinetic data showed a pH of less than 5.0 standard units, the BLM method classified these rocks as NAG 8.3 percent of the time.

A review of **Tables 3.3-4** through **3.3-6** indicates that neither the BGMI method nor the BLM method for classifying waste rock from static ABA test data is consistent 100 percent of the time. Both methods differ in the classification of NAG rocks approximately 8 percent of the time based on kinetic data showing a pH of less than 5.0 standard units for the last 5 weeks of testing for rocks classified as NAG. The BGMI method has rocks classified as NAG showing some degree of potential acid generation based on the kinetic data approximately 20 percent of the time. The BLM method also differed in the classification of NAG rocks approximately 20 percent of the time in terms of some potential for acid generation in the kinetic data.

**Table 3.3-4 Lithology, Static ABA, and Column Test Data – 1997 Column Samples**

| Column Number | Bulk Sample Label | Formation | Paste pH (SU) | AGP (t/Kt) | ANP (t/Kt) | NNP (t/Kt) | ANP: AGP | BGMI Class | BLM Class | Column pH (SU) | Column EC (µmhos/cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 1-CAR | Carlin | 7.1 | 0.6 | 2.5 | 1.9 | 4.17 | NAG | Uncertain | 7.53/7.72 | 3,940/182 |
| 17 | 4-GD | Intrusive | 7.6 | 10 | 65 | 55 | 6.50 | NAG | NAG | 7.61/7.56 | 2,950/172 |
| 18 | 5B-GD | Intrusive | 7.8 | 10 | 82.5 | 72.5 | 8.25 | NAG | NAG | 7.75/7.28 | 2780/97 |
| 19 | 7-ARG | Unox Rodeo Creek | 3.3 | 43.1 | 4.2 | -38.9 | 0.10 | PAG | Uncertain (PAG) | 2.33/2.62 | 14,400/1,410 |
| 20 | 7-SIL | Unox Rodeo Creek | 2.5 | 24.4 | 31.7 | 7.3 | 1.30 | NAG | Uncertain | 2.33/2.92 | 13,500/1,050 |
| 21 | 8-DRC | Ox Rodeo Creek | 2.9 | 0.3 | 0.8 | 0.5 | 2.67 | NAG | Uncertain | 6.67/6.5 | 2,670/77.9 |
| 22 | 8-LVIN | Unox Vinini | 6.1 | 23.1 | 90 | 66.9 | 3.90 | NAG | NAG | 6.82/7.79 | 18,200/773 |
| 23 | 8-MVIN | Unox Vinini | 7.4 | 0.3 | 197.4 | 197.1 | 658.00 | NAG | NAG | 7.66/7.53 | 3,270/255 |
| 24 | 9-VIN | Ox Vinini | 7.3 | 0.3 | 4.2 | 3.9 | 14.00 | NAG | Uncertain | 7.25/6.44 | 693/17.6 |
| 25 | 12-POX | Ox Popovich | 7.2 | 0.9 | 4.1 | 3.2 | 4.56 | NAG | Uncertain | 6.77/6.32 | 1,560/23.7 |
| 26 | 13-POC | Unox Popovich | 5.9 | 60 | 58.4 | -1.6 | 0.97 | PAG | Uncertain | 6.36/7.41 | 11,400/414 |
| 27 | 13-POS | Unox Popovich | 4.1 | 62.5 | 4.3 | -58.2 | 0.07 | PAG | Uncertain (PAG) | 3.26/3.1 | 10,500/948 |
| 28 | 14-CZH | Contact zone rock | 2.6 | 94.4 | 4.3 | -90.1 | 0.05 | PAG | Uncertain (PAG) | 1.88/2.61 | 33,500/2,020 |
| 29 | 14-CZS | Contact zone rock | 5.6 | 47.5 | 14.2 | -33.3 | 0.30 | PAG | Uncertain (PAG) | 6.29/7.03 | 3,980/490 |
| 30 | 15-OR | Unox Popovich | 3.3 | 58.1 | 4.2 | -53.9 | 0.07 | PAG | Uncertain (PAG) | 1.97/2.59 | 16,200/1,530 |

Notes: BLM Classification is modified to include PAG for NNP <+ -20 t/Kt and this is shown in ( ).
BLM Uncertain classification applies to NNP less than +20 t/Kt. Above 20 t/Kt rock is classified as NAG.
Column pH and Column EC have initial and final pore volume results displayed as initial/final.
SU = Standard Units; t/Kt = Tons/Kiloton $CaCO_3$; EC = Electrical Conductivity (specific conductance).

Source: Schafer 2008b.

**Table 3.3-5 2002 Column Test Charge Samples**

| Number | Rock Type | Source | pH (SU) | ANP (t/Kt) | AGP (t/Kt) | NNP (t/Kt) | ANP:AGP | BGMI Class | BLM Class |
|---|---|---|---|---|---|---|---|---|---|
| 3 | Popovich | Highwall | 8.08 | 217 | 42.5 | 174.5 | 5.11 | NAG | NAG |
| 7 | Carlin | Highwall | 8.25 | 45 | 3.4 | 41.6 | 13.24 | NAG | NAG |
| 8 | Diorite | Highwall | 8.03 | 158 | 25.9 | 132.1 | 6.10 | NAG | NAG |
| 10 | Roberts Mtn Fm | Highwall | 7.82 | 42 | 31.3 | 10.7 | 1.34 | NAG | Uncertain |
| 15 | Vinini Fm | Highwall | 7.79 | 20 | 1.9 | 18.1 | 10.53 | NAG | Uncertain |
| 16 | Calc-silicates | Waste Rock | 6.8 | 265 | 5.6 | 259.4 | 47.32 | NAG | NAG |
| 17 | Calc-silicates | Waste Rock | 8.61 | 206 | 26.6 | 179.4 | 7.74 | NAG | NAG |
| 18 | Calc-silicates | Waste Rock | 8.55 | 633 | 20.3 | 612.7 | 31.18 | NAG | NAG |
| 19 | Diorite | Waste Rock | 2.44 | 13 | 75 | -62 | 0.17 | PAG | Uncertain (PAG) |
| 20 | Diorite | Waste Rock | 3.21 | 16 | 174.7 | -158.7 | 0.09 | PAG | Uncertain (PAG) |
| 21 | Diorite | Waste Rock | 5.56 | 65 | 4.7 | 60.3 | 13.83 | NAG | NAG |
| 23 | Rodeo Ck Fm | Waste Rock | 3.85 | 4 | 52.5 | -48.5 | 0.08 | PAG | Uncertain (PAG) |
| 24 | Rodeo Ck Fm | Waste Rock | 4.02 | 7 | 53.4 | -46.4 | 0.13 | PAG | Uncertain (PAG) |
| 28 | Popovich | Waste Rock | 3.55 | 29 | 58.1 | -29.1 | 0.50 | PAG | Uncertain (PAG) |
| 3 | Popovich | Highwall | 8.08 | 217 | 42.5 | 174.5 | 5.11 | NAG | NAG |
| 7 | Carlin | Highwall | 8.25 | 45 | 3.4 | 41.6 | 13.24 | NAG | NAG |
| 8 | Diorite | Highwall | 8.03 | 158 | 25.9 | 132.1 | 6.10 | NAG | NAG |
| 10 | Roberts Mtn Fm | Highwall | 7.82 | 42 | 31.3 | 10.7 | 1.34 | NAG | Uncertain |
| 15 | Vinini Fm | Highwall | 7.79 | 20 | 1.9 | 18.1 | 10.53 | NAG | Uncertain |
| 16 | Calc-silicates | Waste Rock | 6.8 | 265 | 5.6 | 259.4 | 47.32 | NAG | NAG |
| 17 | Calc-silicates | Waste Rock | 8.61 | 206 | 26.6 | 179.4 | 7.74 | NAG | NAG |
| 18 | Calc-silicates | Waste Rock | 8.55 | 633 | 20.3 | 612.7 | 31.18 | NAG | NAG |

Notes: BLM Classification is modified to include PAG for NNP <+ -20 t/Kt and this is shown in ( ).
BLM Uncertain classification applies to NNP less than 20 t/Kt.
BLM Classification has NAG for all rocks with NNP at >= +20 t/Kt.
SU = Standard Units; t/Kt = tons/kiloton $CaCO_3$

Source: Schafer 2008b.

**Table 3.3-6 BGMI Humidity Cell Test Summary with BGMI and BLM Waste Rock Classifications**

| Humidity Cell | Lithology | pH (SU) | Sulfate (mg/L) | AGP (T/Kt) | ANP (T/Kt) | NNP T/Kt) | BGMI Acid Risk Class | BGMI Waste Rock Class | BLM Waste Rock Class |
|---|---|---|---|---|---|---|---|---|---|
| B-10 | Drc-ox | 7.09 | 22 | 115.6 | 48.3 | -67.3 | Acid-generating | PAG | Uncertain (PAG) |
| WR-2P | Dp-Unox | 6.65 | 332.4 | 19.4 | 3.8 | -15.6 | Acid-generating | PAG | Uncertain |
| B-3 | Dp-Unox | 6.51 | 13.2 | 21.6 | 7.2 | -14.4 | Non-acid generating | PAG | Uncertain |
| B-5 | Dp-Unox | 6.35 | 12 | 7.5 | .1 | -7.4 | Non-acid generating | PAG | Uncertain |
| B-1 | Drc-ox | 5.7 | 129 | 1.9 | 1.8 | -0.1 | Non-acid generating | PAG | Uncertain |
| WR-3P | Jd | 7.09 | 11.2 | .6 | 40 | 39.4 | Non-acid generating | NAG | NAG |
| WR-1P | CZR | 6.69 | 187.2 | 1.6 | 46.4 | 44.8 | Non-acid generating | NAG | NAG |
| WR-7P | Jd | 6.39 | 194 | 51.9 | 122.0 | 70.1 | Non-acid generating | NAG | NAG |
| B-12 | Dp-Unox | 7.14 | 10 | 15.3 | 125.0 | 109.7 | Non-acid generating | NAG | NAG |
| WR-5P | Jd | 6.35 | 493.2 | 30 | 171 | 141 | Non-acid generating | NAG | NAG |
| WR-12P | | 6.5 | 10 | 14.7 | 191 | 176.3 | Non-acid generating | NAG | NAG |
| B-9 | Dp-Unox | 6.8 | 101.4 | 14.4 | 7.2 | -7.2 | Potentially acid generating | PAG | Uncertain |
| WR-13P | | 5.16 | 25 | 15.3 | 15 | -0.3 | Potentially acid generating | PAG | Uncertain |
| B-2 | Dp-Unox | 7.04 | 50.8 | 0.6 | 2.0 | 1.4 | Potentially acid generating | NAG | Uncertain |
| B-14 | Dp-Unox | 6.68 | 21.6 | 25.9 | 42.7 | 16.5 | Potentially acid generating | NAG | Uncertain |
| WR-6P | Jd | 6.05 | 53.8 | 41.3 | 224 | 182.8 | Potentially acid generating | NAG | NAG |
| WR-8P | Dp-Unox | 3.33 | 487.6 | 59.4 | 4.8 | -54.6 | Strongly acid generating | PAG | Uncertain (PAG) |
| B-6 | Dp-Unox | 3.38 | 737.6 | 62.2 | 8 | -54.2 | Strongly acid generating | PAG | Uncertain (PAG) |
| B-13 | Dp-Unox | 4.99 | 62 | 52.2 | 75.1 | 22.6 | Strongly acid generating | NAG | NAG |
| BP-16 | Jd | 6.58 | 10 | 1.5 | 5 | 3.5 | Non-acid generating | NAG | Uncertain |
| BP-2 | Jd | 7.0 | 13.4 | 6.3 | 10 | 3.7 | Non-acid generating | NAG | Uncertain |
| BP-72 | Dp-ox | 7.5 | 13 | 3.1 | 20 | 16.9 | Non-acid generating | NAG | Uncertain |
| BP-17 | Jd | 6.36 | 10 | .9 | 30 | 29.1 | Non-acid generating | NAG | NAG |
| BP-38 | Jd | 6.88 | 121.6 | 82.8 | 115.1 | 32.3 | Non-acid generating | NAG | NAG |
| BP-70 | *Jd* | *6.958* | *10* | *5.2* | *90.0* | 84.8 | Non acid-generating | NAG | NAG |
| BP20 | *CZR* | *7.5* | *10.6* | *2.3* | *110.0* | *107.8* | Non acid-generating | NAG | NAG |
| BP-21 | *CZR* | *3.92* | *275* | *103.4* | *20.0* | *-83.4* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-58 | *CZR* | *2.79* | *1049.6* | *119.1* | *65.1* | *-54.0* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-74 | *Jd* | *3.024* | *633.4* | *72.2* | *20.0* | *-52.2* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-67 | *Dp-Unox* | *4.62* | *200.2* | *56.9* | *10.0* | *-46.9* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-55 | *CZR* | *3.902* | *134.8* | *47.5* | *5.0* | *-42.5* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-28 | *CZR* | *3.164* | *466.4* | *41.6* | - | *-41.6* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-30 | *Drc-ox* | *2.996* | *720.8* | *45.9* | *10.0* | *-35.9* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-29 | *CZR* | *4.386* | *78.8* | *8.8* | - | *-8.8* | Strongly acid-generating | NAG | Uncertain |
| B-101 | *Drc-ox* | *7.216* | *12.8* | - | - | - | Strongly acid-generating | | |
| B-102 | *Drc-ox* | *8.348* | *11.8* | - | - | - | Non acid-generating | | |
| B-106 | *Drc-Unox* | *5.742* | *40.2* | - | - | - | | | |

**Table 3.3-6 BGMI Humidity Cell Test Summary with BGMI and BLM Waste Rock Classifications**

| Humidity Cell | Lithology | pH (SU) | Sulfate (mg/L) | AGP (T/Kt) | ANP (T/Kt) | NNP T/Kt) | BGMI Acid Risk Class | BGMI Waste Rock Class | BLM Waste Rock Class |
|---|---|---|---|---|---|---|---|---|---|
| B-110 | *Dp-Unox* | *5.304* | *190.8* | - | - | - | | | |
| B-111 | *Dp-Unox* | *3.554* | *375.6* | - | - | - | Strongly acid-generating | | |
| B-112 | *Dp-Unox* | *3.872* | *391.4* | - | - | - | Strongly acid-generating | | |
| BP-11 | *Dp-Unox* | *4.60* | 86 | *56.6* | *5.0* | *-51.6* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-7 | *Jd* | *5.15* | 129.5 | *150.9* | - | *-150.9* | Strongly acid-generating | PAG | Uncertain (PAG) |
| BP-1 | *Jd* | *6.808* | *10* | *20.1* | *5.0* | *-15.1* | Non acid-generating | PAG | Uncertain |
| BP-27 | *Drc-ox* | *6.758* | *10* | *14.1* | *5.0* | *-9.1* | Non acid-generating | PAG | Uncertain |
| BP-15 | *Jd* | *6.778* | *10* | *12.0* | *5.0* | *-7.0* | Non acid-generating | PAG | Uncertain |
| BP-53 | *CZR* | *6.65* | *10* | *16.1* | *10.0* | *-6.1* | Non acid-generating | PAG | Uncertain |
| BP-50 | *Drc-ox* | *6.488* | *10* | *4.5* | - | *-4.5* | Non acid-generating | NAG | Uncertain |
| BP-49 | *Drc-ox* | *6.62* | *11* | *17.7* | *15.0* | *-2.7* | Non acid-generating | PAG | Uncertain |
| BP-31 | *CZR* | *6.728* | *10* | *2.2* | - | *-2.2* | Non acid-generating | NAG | Uncertain |
| BP-54 | *CZR* | *6.984* | *10.4* | *9.9* | *10.0* | *0.1* | Non acid-generating | NAG | Uncertain |
| BP-26 | *Drc-ox* | *6.8* | 10 | *8.0* | *10.0* | *2.0* | Non acid-generating | NAG | Uncertain |
| BP-18 | *Jd* | *6.762* | *10* | *4.3* | *10.0* | *5.7* | Non acid-generating | NAG | Uncertain |
| BP-76 | *Drc-ox* | *6.484* | *10* | *4.0* | *10.0* | *6.0* | Non acid-generating | NAG | Uncertain |
| BP-91 | *Drc-ox* | *6.986* | *10* | *5.3* | *15.0* | *9.7* | Non acid-generating | NAG | Uncertain |
| BP-65 | *Drc-ox* | *6.256* | *10* | *9.8* | *25.0* | *15.2* | Non acid-generating | NAG | Uncertain |
| BP-98 | *Dp-Unox* | *6.824* | *10* | *2.8* | *20.0* | *17.2* | Non acid-generating | NAG | Uncertain |
| BP-14 | *Jd* | *6.78* | 10 | *15.3* | *55.0* | *39.7* | Non acid-generating | NAG | NAG |
| BP-94 | *Drc-unox* | *7.384* | *11* | *16.6* | *175.2* | *158.6* | Non acid-generating | NAG | NAG |
| BP-52 | *CZR* | *4.846* | *616.4* | *183.8* | *25.0* | *-158.8* | Strongly acid generating | PAG | Uncertain (PAG) |
| BP-86 | *Dp-Unox* | *3.012* | *532* | *74.7* | *15.0* | *-59.7* | Strongly acid generating | PAG | Uncertain (PAG) |
| BP-82 | *CZR* | *3.562* | *604* | *52.2* | - | *-52.2* | Strongly acid generating | PAG | Uncertain (PAG) |
| BP-81 | *Drc-unox* | *2.872* | *1277.2* | *60.3* | *20.0* | *-40.3* | Strongly acid generating | PAG | Uncertain (PAG) |
| BP-87 | *Drc-unox* | *2.896* | *610.8* | *51.9* | *15.0* | *-36.9* | Strongly acid generating | PAG | Uncertain (PAG) |
| *BP71* | *CZR* | *3.846* | *543.2* | *73.8* | *40.0* | *-33.8* | Strongly acid generating | PAG | Uncertain (PAG) |
| *BP100* | *Jd* | *3.444* | *182* | *43.1* | *25.0* | *-18.1* | Strongly acid generating | PAG | Uncertain |
| *BP77* | *Drcunox* | *4.263* | *119.4* | *15.7* | *5.0* | *-10.7* | Strongly acid generating | PAG | Uncertain |
| *BP89* | *Dp-Unox* | *3.88* | *75.6* | *55.0* | *190.2* | *135.2* | Strongly acid generating | NAG | NAG |
| *B105* | *Jd* | *7.888* | *10.8* | - | - | - | Non acid-generating | | |
| *B103* | *Drc-ox* | *7.57* | *12* | - | - | - | Non acid-generating | | |
| *BP56* | *CZR* | *5.83* | *22* | *34.7* | - | *-34.7* | Acid generating | PAG | Uncertain (PAG) |
| *BP5* | *Drc-ox* | *5.97* | *59.8* | *57.8* | *25.0* | *-32.8* | Acid generating | PAG | Uncertain (PAG) |
| *BP3* | *CZR* | *5.972* | *83* | *30.3* | *20.0* | *-10.3* | Acid generating | PAG | Uncertain |
| *BP40* | *Drc-ox* | *6.034* | *14.6* | *13.6* | - | *-13.6* | Non acid-generating | PAG | Uncertain |
| *BP51* | *Drc-ox* | *6.248* | *10* | *13.3* | *5.0* | *-8.3* | Non acid-generating | PAG | Uncertain |

**Table 3.3-6 BGMI Humidity Cell Test Summary with BGMI and BLM Waste Rock Classifications**

| Humidity Cell | Lithology | pH (SU) | Sulfate (mg/L) | AGP (T/Kt) | ANP (T/Kt) | NNP T/Kt) | BGMI Acid Risk Class | BGMI Waste Rock Class | BLM Waste Rock Class |
|---|---|---|---|---|---|---|---|---|---|
| *BP80* | *CZR* | *6.336* | *601* | *43.8* | *40.0* | *-3.8* | Non acid-generating | PAG | Uncertain |
| *BP13* | *Jd* | *6.554* | *10* | *6.4* | *20.0* | *13.6* | Non acid-generating | NAG | Uncertain |
| *BP73* | *CZR* | *6.59* | *106* | *54.7* | *75.1* | *20.4* | Non acid-generating | NAG | NAG |
| *BP19* | *Jd* | *6.966* | *10* | *1.8* | *25.0* | *23.2* | Non acid-generating | NAG | NAG |
| *BP84* | *Dp-Unox* | *6.774* | *27.4* | *19.8* | *55.0* | *35.2* | Non acid-generating | NAG | NAG |
| *BP34* | *Jd* | *7.336* | *24.8* | *46.6* | *100.1* | *53.5* | Non acid-generating | NAG | NAG |
| *BP41* | *Dp-ox* | *6.762* | *25* | *4.4* | *65.1* | *60.7* | Non acid-generating | NAG | NAG |
| *BP64* | *Jd* | *6.76* | *25* | *46.6* | *110.1* | *63.5* | Non acid-generating | NAG | NAG |
| *BP79* | *CZR* | *6.666* | *30* | *26.4* | *90.1* | *63.7* | Non acid-generating | NAG | NAG |
| *BP23* | *CZR* | *6.448* | *33.4* | *26.3* | *90.1* | *63.8* | Non acid-generating | NAG | NAG |
| *BP24* | *CZR* | *5.11* | *165.4* | *24.7* | *90.1* | *65.4* | Non acid-generating | NAG | NAG |
| *BP25* | *CZR* | *6.376* | *181.4* | *49.4* | *115.1* | *65.7* | Non acid-generating | NAG | NAG |
| *BP42* | *CZR* | *7.372* | *27.2* | *67.5* | *135.1* | *67.6* | Non acid-generating | NAG | NAG |
| *BP45* | *Dp-Unox* | *7.14* | *142.2* | *56.3* | *125.1* | *68.9* | Non acid-generating | NAG | NAG |
| *BP47* | *CZR* | *7.346* | *36.4* | *42.8* | *120.1* | *77.3* | Non acid-generating | NAG | NAG |
| *BP39* | *Jd* | *7.226* | *44.2* | *57.2* | *135.1* | *77.9* | Non acid-generating | NAG | NAG |
| *BP22* | *CZR* | *6.59* | *256.8* | *16.2* | *95.0* | *78.8* | Non acid-generating | NAG | NAG |
| *BP75* | *CZR* | *6.766* | *153* | *50.0* | *145.1* | *95.1* | Non acid-generating | NAG | NAG |
| *BP60* | *Jd* | *6.95* | *48.4* | *45.6* | *145.1* | *99.5* | Non acid-generating | NAG | NAG |
| *BP32* | *Jd* | *7.146* | *41.6* | *40.3* | *145.1* | *104.8* | Non acid-generating | NAG | NAG |
| *BP61* | *CZR* | *6.544* | *218* | *88.8* | *200.2* | *111.5* | Non acid-generating | NAG | NAG |
| *BP43* | *Jd* | *7.558* | *15.6* | *43.4* | *170.1* | *126.7* | Non acid-generating | NAG | NAG |
| *BP62* | *CZR* | *6.768* | *153* | *80.3* | *225.2* | *144.9* | Non acid-generating | NAG | NAG |
| *BP9* | *Dp-Unox* | *7.262* | *14.4* | *24.0* | *185.2* | *161.2* | Non acid-generating | NAG | NAG |
| *BP44* | *Jd* | *7.17* | *44.8* | *27.7* | *200.2* | *172.5* | Non acid-generating | NAG | NAG |
| *BP48* | *Jd* | *7.34* | *81.6* | *48.8* | *235.2* | *186.5* | Non acid-generating | NAG | NAG |
| *BP63* | *CZR* | *7.01* | *74.6* | *67.5* | *320.3* | *252.8* | Non acid-generating | NAG | NAG |
| *BP97* | *Dp-Unox* | *6.244* | *341.6* | *54.4* | *335.3* | *280.9* | Non acid-generating | NAG | NAG |
| *BP35* | *Jd* | *6.734* | *327.6* | *119.4* | *25.0* | *-94.4* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP96* | *Dp-Unox* | *6.85* | *49.8* | *90.0* | *5.0* | *-85.0* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP66* | *Dp-Unox* | *6.128* | *327* | *107.8* | *40.0* | *-67.8* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP6* | *Jd* | *6.758* | *103.6* | *81.3* | *40.0* | *-41.3* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP68* | *Dp-Unox* | *6.352* | *373* | *72.8* | *35.0* | *-37.8* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP88* | *Drc-unox* | *6.60* | *228* | *45.9* | *10.0* | *-35.9* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP8* | *CZR* | *6.666* | *44.8* | *150.9* | *120.1* | *-30.8* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP33* | *Jd* | *6.966* | *273.2* | *85.6* | *60.0* | *-25.6* | Potentially acid generating | PAG | Uncertain (PAG) |
| *BP69* | *Jd* | *6.402* | *132.8* | *53.4* | *30.0* | *-23.4* | Potentially acid generating | PAG | Uncertain (PAG) |

**Table 3.3-6 BGMI Humidity Cell Test Summary with BGMI and BLM Waste Rock Classifications**

| Humidity Cell | Lithology | pH (SU) | Sulfate (mg/L) | AGP (T/Kt) | ANP (T/Kt) | NNP T/Kt) | BGMI Acid Risk Class | BGMI Waste Rock Class | BLM Waste Rock Class |
|---|---|---|---|---|---|---|---|---|---|
| *BP78* | *Drc-unox* | *5.174* | *148* | *42.5* | *25.0* | *-17.5* | Potentially acid generating | PAG | Uncertain |
| *BP46* | *CZR* | *6.922* | *194* | *65.9* | *50.0* | *-15.9* | Potentially acid generating | PAG | Uncertain |
| *BP36* | *Jd* | *7.144* | *42.2* | *51.9* | *40.0* | *-11.9* | Potentially acid generating | PAG | Uncertain |
| *BP12* | *Jd* | *5.894* | *36* | *4.3* | *20.0* | *15.8* | Potentially acid generating | NAG | Uncertain |
| *BP83* | *Ov* | *5.36* | *93.6* | *31.6* | *60.0* | *28.4* | Potentially acid generating | NAG | NAG |
| *BP99* | *Dp-Unox* | *5.932* | *35.2* | *13.2* | *50.0* | *36.8* | Potentially acid generating | NAG | NAG |
| *BP59* | *Jd* | *7.082* | *38* | *105.3* | *150.1* | *44.8* | Potentially acid generating | NAG | NAG |
| *BP10* | *Jd* | *7.132* | *32.2* | *51.3* | *120.1* | *68.9* | Potentially acid generating | NAG | NAG |
| *BP4* | *Jd* | *5.958* | *33.4* | *47.8* | *270.2* | *222.4* | Potentially acid generating | NAG | NAG |
| *BP90* | *Dp-Unox* | *4.974* | *439.6* | *81.9* | *35.0* | *-46.9* | Strongly acid generating | PAG | Uncertain (PAG) |
| *BP57* | *CZR* | *4.26* | *43.4* | *37.5* | *5.0* | *-32.5* | Strongly acid generating | PAG | Uncertain (PAG) |
| *BP85* | *CZR* | *4.834* | *22.2* | *18.8* | | *-18.8* | Strongly acid generating | PAG | Uncertain |
| *BP95* | *Drc-unox* | *4.62* | *58.8* | *29.2* | *20.0* | *-9.2* | Strongly acid generating | PAG | Uncertain |
| *BP92* | *Drc-ox* | *4.274* | *212.2* | *18.9* | *15.0* | *-3.9* | Strongly acid generating | PAG | Uncertain |
| *BP93* | *Drc-ox* | *4.45* | *152.2* | *37.8* | *85.0* | *47.2* | Strongly acid generating | NAG | NAG |
| BP93 | Drc-ox | 4.45 | 152.2 | 43.1 | 95.1 | 52.0 | Strongly acid generating | NAG | NAG |

Notes: BGMI Lithologic Classifications: ARG = Argillaceous; GD = Granodiorite; LS = Limestone; CZR = Contact Zone Rocks; Drc-ox = Oxidized Rodeo Creek Fm; Drc-unox = Unoxidized Rodeo Creek Fm; Dp-ox = Oxidized Popovich; Dp-Unox = Unoxidized Popovich; Ov = Vinini Fm; Jd = Jurassic intrusive.
BGMI Acid Risk Classification Scheme (Based on Humidity Cell test results last 5 weeks): NAG: pH>5.0; sulfate < 20 mg/kg; Potentially Acid Generating: pH>5.0; sulfate > 20 mg/kg. Acid Generating: pH>5.0; sulfate > 20 mg/kg; NNP < -5.0 Strongly Acid Generating: pH< 5.0.
Units Sulfate: mg/L; ANP, AGP, and NNP: t/Kt $CaCO_3$; SU = Standard Units
Blank cell indicates no data.

Source: Schafer 2008b.

BGMI has a two-phase approach for classifying the potential for acid generation in rocks mined at Goldstrike. The first phase is the classification of the rocks from the static ABA test results, which has been discussed at length in the preceding paragraphs. The second phase is the kinetic testing. All rock types mined are subjected to kinetic tests, regardless of whether they are classified as PAG or NAG, as shown in **Table 3.3-6**. The kinetic test results are then used as the basis for the final classification of the potential for acid generation by the rock type.

This second phase of the BGMI method conforms to BLM guidelines (BLM 1996) and allows BGMI to accurately assess the acid generation potential of all waste rock and place waste rock in waste rock facilities such as the Bazza Waste Rock Facility and the proposed Clydesdale Waste Rock Facility in a manner that would prevent the generation of acid seepage from the waste rock facilities. Because BGMI conducts kinetic tests on all rock types mined as part of its two-phase approach, the BGMI method is more conservative than the BLM guidelines and allows for the management of waste rock in a manner that would prevent acidic seepage. Also, field observations and monitoring of the existing waste rock facilities at the Goldstrike Mine over the past 15 years have shown no evidence of acid rock seepage. These data show that BGMI's two-phase method of waste rock classification and its management of PAG waste rock in waste rock facilities is working and prevents the generation of acid rock drainage (ARD).

Geochemistry of the Proposed Expansion Area and Characteristics of Rocks Routed to the Clydesdale Waste Rock Facility

The proposed pit expansion consists of two laybacks containing approximately 315 million tons of waste rock. Over 28,000 lithologic logs were taken for sampled intervals in boreholes drilled in the 2NW and 3NW laybacks. Additionally, 2,368 static ABA tests were conducted on selected samples, mostly within the ore-bearing zones in the Popovich Formation. A small portion of the Popovich samples were PAG, while the majority of the clastic Rodeo Creek samples were PAG (Schafer 2008b).

Rodeo Creek and Vinini rock units comprise the majority of waste rock in the laybacks. Approximately 19 percent of the mined rock in the proposed laybacks is expected to be PAG, which is similar to the historic amount of PAG material for the life of the mine (Schafer 2008b).

The proposed Clydesdale Waste Rock Facility would receive up to 350 million tons of waste rock from the proposed laybacks and from other permitted portions of the mine. Overall, about 10 percent of the rock to be mined from all sources (current authorized mining and the proposed laybacks) from early 2007 through 2015 is classified as PAG. Historically, approximately 25 percent of the mined rock at the Goldstrike Mine has been PAG. The majority of PAG material would be placed as pit backfill; consequently, PAG rock would constitute approximately 7 percent of the tonnage placed collectively in the Bazza and Clydesdale Waste Rock facilities (Schafer 2008b).

### 3.3.2 Environmental Consequences

The primary issues related to groundwater resources include:

- Reduction in groundwater quantity from mine dewatering through 2015 under existing permits and authorizations from the State of Nevada (No Action Alternative);
- Impacts to groundwater quality from the construction, operation, and closure of mine facilities; and
- Impacts related to the water quality of the post-mining pit lake.

Groundwater modeling for estimation of environmental consequences was conducted with an updated version of the groundwater model used in BLM (2000a). The minor changes to this model are discussed in **Appendix B**, Groundwater Resources and Geochemistry.

#### 3.3.2.1 No Action Alternative

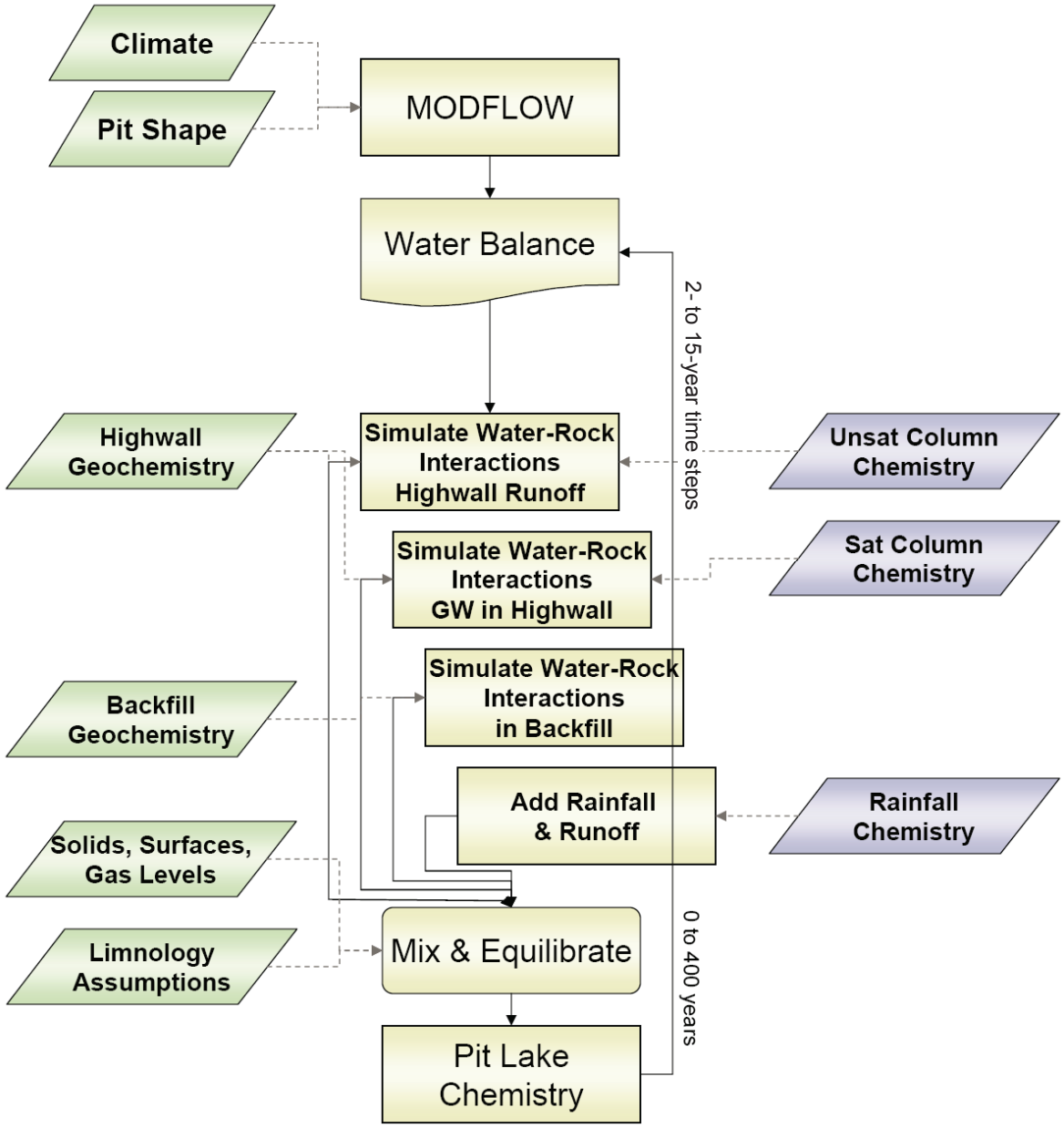
Under the No Action Alternative, the Betze Pit would not be expanded beyond current authorizations. Groundwater pumping and dewatering of the pit prior to cessation of mining would continue as discussed in the Betze Project SEIS (BLM 2000a, 2003a) and in Chapter 2.0; dewatering would continue for an additional 4 years beyond 2011, as analyzed in the Betze Project SEIS (BLM 2000a, 2003a).

Post-mining Pit Lake

The chemistry of the post-mining pit lake would be controlled by the composition of the various types of water flowing into the pit and the reaction of these waters with the pit highwall rocks and the waste rock left in the pit. Groundwater flowing into the pit through the highwalls and the pit floor would come mostly from carbonate rock and from the Carlin Formation along the east highwall. Rain would fall into the pit directly and also would produce pit wall runoff. It was estimated that approximately 14.9 percent of rainfall would enter the pit as pit wall runoff (Schafer 2007). The composition of the principal waters expected to contribute to the post-mining pit are given in **Table B-7**, in **Appendix B**. These waters would react with rocks in the pit highwalls and the waste rock left in the pit after mining to produce the final pit lake water quality. **Figure 3.3-4** shows the sequence of reactions used in modeling the pit lake water quality over time. Groundwater inflow to the pit was modeled using the BGMI Groundwater Flow Model (McDonald Morrissey Associates 1998); chemical reactions were modeled with the USGS chemical reaction modeling code PHREEQC (Parkhurst and Appelo 1999). The details of the pit lake water quality modeling can be found in Schafer (2007) and are summarized in this section.

**Figure 3.3-5** shows the cumulative water elevation of the post-mining pit lake over time; **Figure 3.3-6** shows the proportions of different water types over time as the pit lake forms. The pit lake would be a terminal pit lake, meaning that groundwater and surface water would flow into the pit, and no groundwater would flow out of the pit. Evaporation from the enlarging pit lake would eventually balance the water flowing into the pit at steady state, which would occur approximately 400 years after cessation of pumping (**Figure 3.3-6**). In the Betze Project Draft SEIS (BLM 2000a), the pit lake was modeled out to 230 years, which is approximately 95 percent of full recovery. Modeling out to 400 years more closely approaches the final steady state water level in the pit lake and allows chemical trends in the pit lake water quality that will be influenced by evaporation to be more evident. During the first 14 years of pit lake formation, runoff from the pit highwalls would constitute the main source of inflow to the pit (Schafer 2007). The groundwater level would be below the pit bottom, so water flowing into the pit would evaporate and infiltrate to some degree. Groundwater inflow through the pit highwalls and pit bottom would begin around Year 14 and would be expected to be the dominant form of inflow by Year 20. As shown in **Figure 3.3-6**, there is a major change in the percentage contribution of inflowing water types starting around Year 20. By Year 50, the percentage contribution of inflowing water types would have stabilized with groundwater flow through the pit highwalls becoming the dominant contribution to the pit lake. This pattern of water inflow to the pit lake would continue to a near steady state condition at Year 400 with evaporation becoming important after about Year 50 due to the enlarging pit lake. This change in inflowing water contributions is reflected in a change in pit lake water quality.

Rodeo Creek may be diverted into the post-mining pit as an option at mine closure. BGMI is not seeking approval for the diversion of Rodeo Creek from the Nevada State Engineer and the NDEP at this time. The BLM has no decision-making authority relative to the diversion of Rodeo Creek. The expected average flow rate of Rodeo Creek into the pit would be approximately 225 gpm (Schafer 2007). The Rodeo Creek water quality used in the pit lake water quality modeling is given in **Table B-7**. The diversion of Rodeo Creek into the Betze Pit upon completion of mining would be a permanent diversion and would not substantially affect the overall water balance for the pit lake once the pit lake reaches steady state. The final pit lake elevation under the No Action Alternative at steady state (Year 400) would be an estimated 5,144 feet amsl. The Betze Pit Lake associated with the No Action Alternative is approximately 803 acres. Approvals and modifications not requiring NEPA action have modified the No Action Betze Pit Lake surface area acreage in the interim since the 2000 SEIS.




**Betze Pit Expansion Project**

Figure 3.3-4

Structure of Betze Pit Lake Model

Source: Schafer 2007.

04/23/08

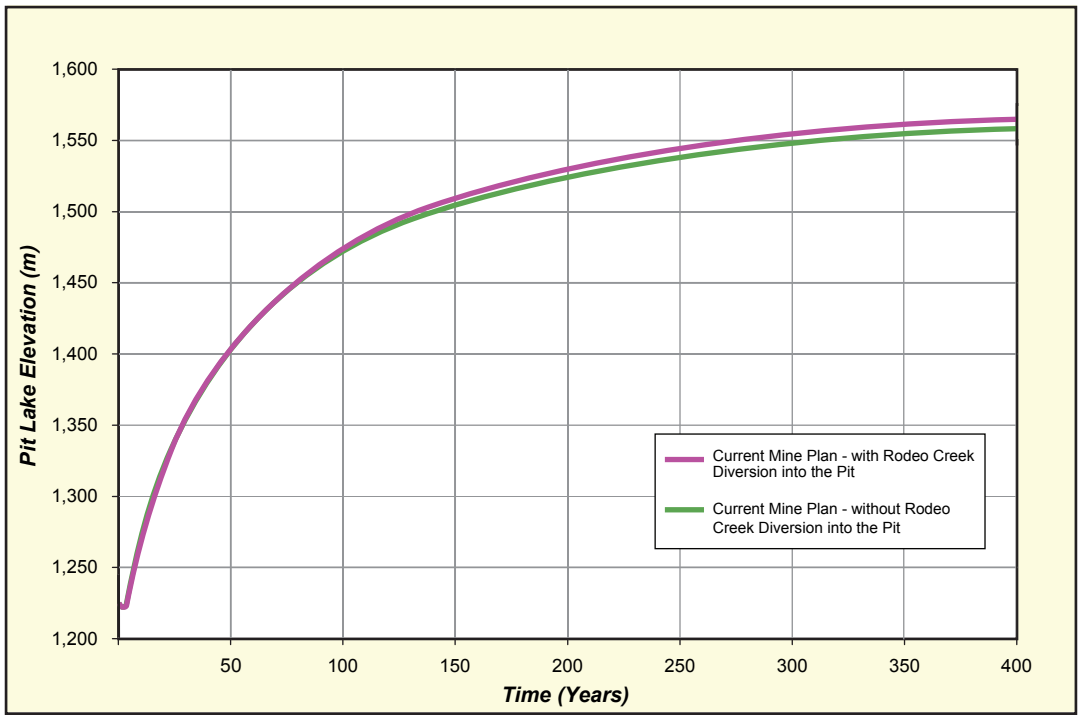



**Figure 3.3-5 Comparison of Betze Pit Lake Water Elevation for the Current Mine Plan with and without Diversion of Rodeo Creek**

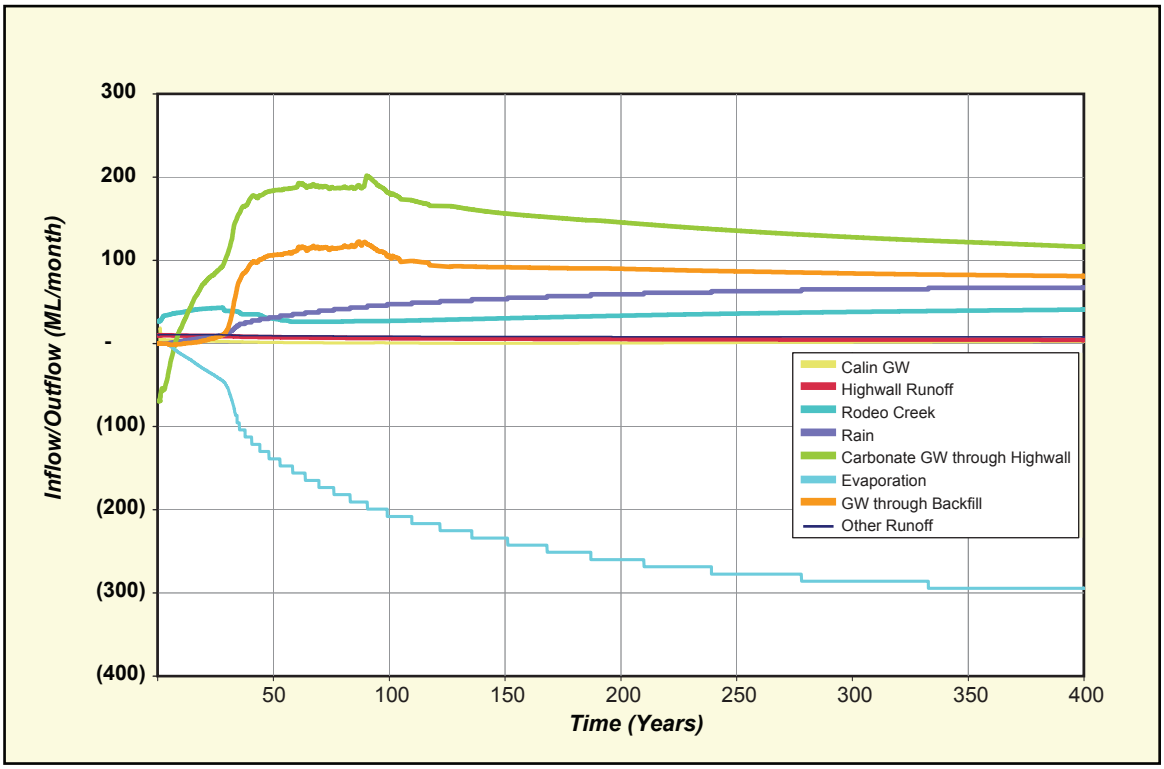



**Figure 3.3-6 Rate of Inflow (+) or Outflow (-) for Various Hydrologic Components of Current Mine Plan Pit Lake with Rodeo Creek Diversion**

Chemical changes in the pit lake with time under the Current Mine Plan are shown in **Figures 3.3-7** through **3.3-25.** These figures compare the predicted water quality in the pit lake with time under two potential mine closure options: 1) diversion of Rodeo Creek into the pit at the end of mining, and 2) no diversion of Rodeo Creek into the pit at the end of mining. These chemical changes reflect the differing proportions of water types entering the pit lake at various times, the reaction between inflowing waters and the pit walls and waste rock left in the pit, and chemical reactions within the pit water leading to precipitation of some minerals, most notably ferrihydrite (iron oxyhydroxide), and the sorption of metals, such as arsenic, on the precipitating phases.

*Water Quality Without Rodeo Creek Diversion*

Pit lake water is not intended for use as drinking water or agricultural water, nor has it been designated by NDEP for such uses. Comparison of predicted pit lake water to water quality standards based on use is provided below for informational purposes only. Water quality in the pit lake at Year 50 under the No Action Alternative (Current Mine Plan without diversion of Rodeo Creek into the pit at mine closure) would exceed Nevada drinking water standards (**Table B-1**) for TDS, sulfate, antimony, arsenic, cadmium, and nickel (**Table 3.3-7**). Irrigation water standards would be exceeded for arsenic, manganese, nickel, and fluoride. Stock water standards would be exceeded for arsenic, cadmium, and fluoride. Wildlife propagation standards would not be exceeded.

At Year 400, the No Action Alternative Betze pit lake water quality without Rodeo Creek Diversion at mine closure would exceed drinking water standards for TDS, sulfate, fluoride, antimony, arsenic, cadmium, and nickel (**Table 3.3-8**). Irrigation water standards would be exceeded for boron, cadmium, manganese, fluoride, and nickel. Stock water standards would be exceeded for only fluoride. Wildlife propagation standards would not be exceeded at Year 400 in the pit lake water. Thus, the pit lake water under the No Action Alternative would not be suitable for drinking water, irrigation water, or stock water. An ecological risk assessment for wildlife use is presented in Section 3.8, Wildlife Resources. Bedrock groundwater in the vicinity of the Betze Pit currently is elevated in TDS, arsenic, boron, iron, manganese, antimony, and fluoride due to mineralization in the Carlin Trend area.

*Water Quality with Rodeo Creek Diversion*

Under the Current Mine Plan with Rodeo Creek Diversion into the pit at the end of mining, the water quality in the pit lake would be similar to the water quality under the Current Mine Plan without diversion of Rodeo Creek. Chloride would be slightly higher with the diversion of Rodeo Creek (**Figure 3.3-14**) because Rodeo Creek contains more chloride than the groundwater in the Betze pit area. At 50 years after cessation of mining, the pH of the water would be approximately 7.56 and the TDS would be around 1,800 mg/L, which is somewhat less than the TDS of 2,000 mg/L under the Current Mine Plan without the Rodeo Creek Diversion (**Figure 3.3-7**). Sulfate would be about 999 mg/L compared to 1,230 mg/L without Rodeo Creek (**Table 3.3-7**). The pit lake would exceed drinking water, stock water, and irrigation water standards for arsenic (0.276 mg/L), drinking water standards for antimony (0.019 mg/L), stock water standards for boron (0.7 mg/L), drinking water and irrigation water standards for nickel (1.58 mg/L),and drinking water, stock water and irrigation water standards for cadmium (0.054 mg/L). Manganese (1.65 mg/L) and fluoride (2.0 mg/L) would exceed irrigation water standards (**Table B-1**). Drinking water standards would be exceeded for sulfate and TDS. The pit lake water would be a calcium-sodium sulfate dominated water. The pit lake water is not intended for drinking water use.

At Year 400, which is approximately steady state for the pit lake water level, the pit lake water quality with Rodeo Creek Diversion would have a pH of about 7.72 and a TDS of approximately 2,000 mg/L, similar to the water quality without the Rodeo Creek Diversion. Boron (2.7 mg/L) would exceed irrigation water standards, fluoride (4.7 mg/L) would exceed drinking water, stock water, and irrigation water standards, cadmium (0.034 mg/L) would exceed irrigation water standards, and nickel (1.12 mg/L) would exceed drinking water and

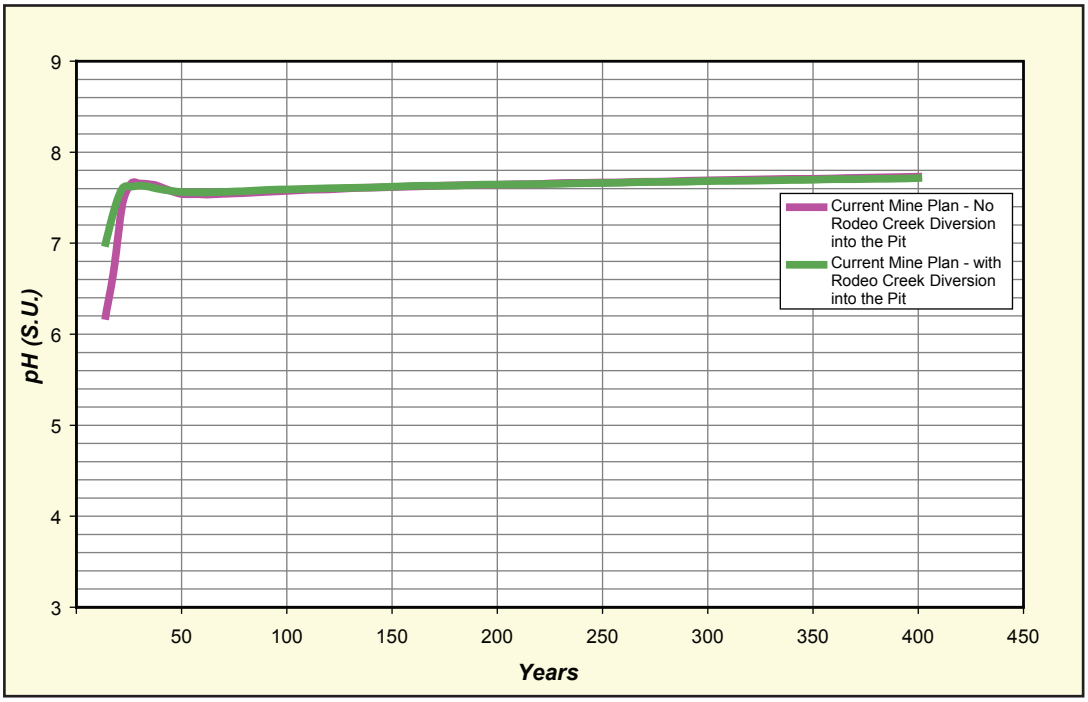



**Figure 3.3-7 Betze Pit Lake pH, Current Mine Plan**

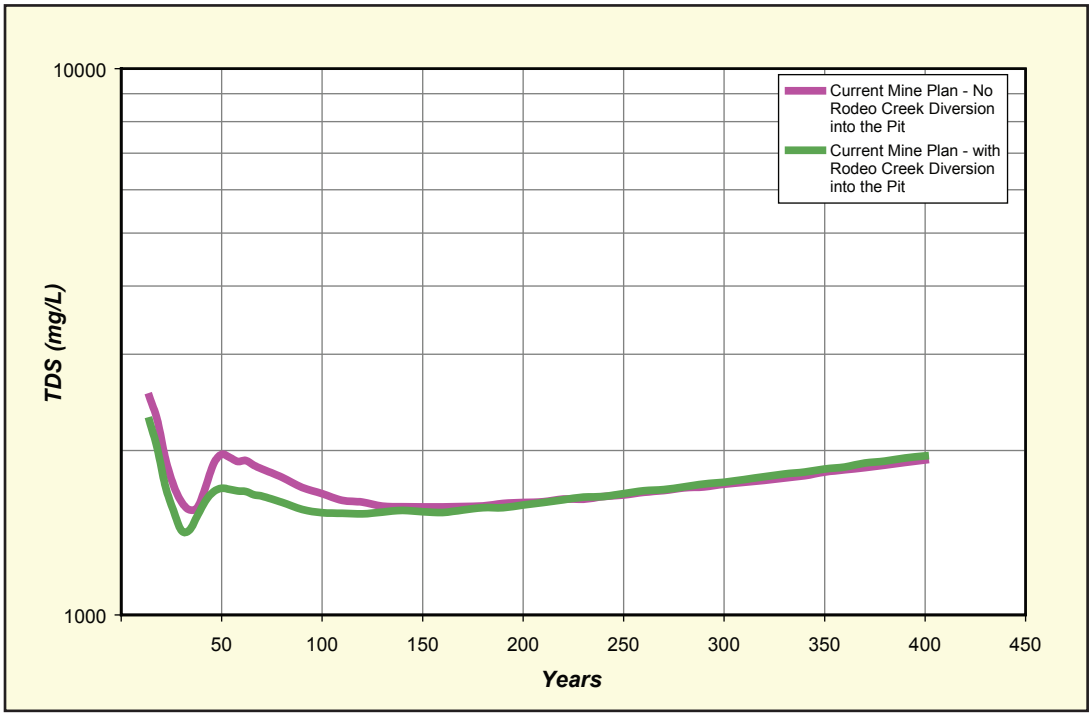



**Figure 3.3-8 Betze Pit Lake Total Dissolved Solids, Current Mine Plan**

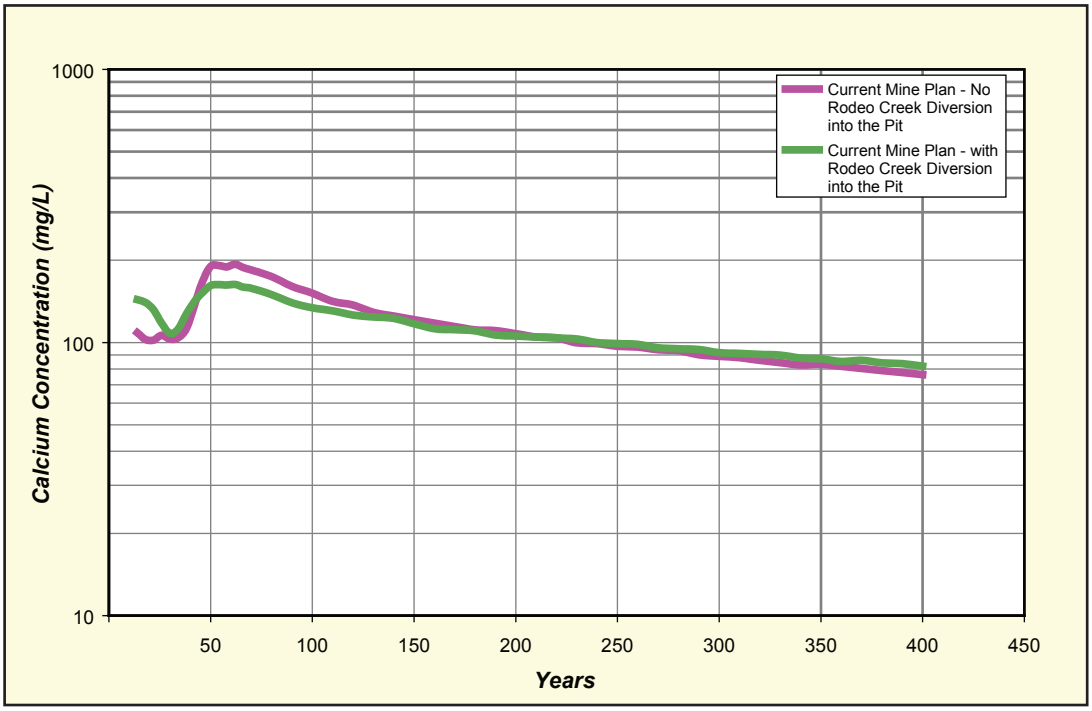



**Figure 3.3-9 Betze Pit Lake Calcium Chemistry, Current Mine Plan**

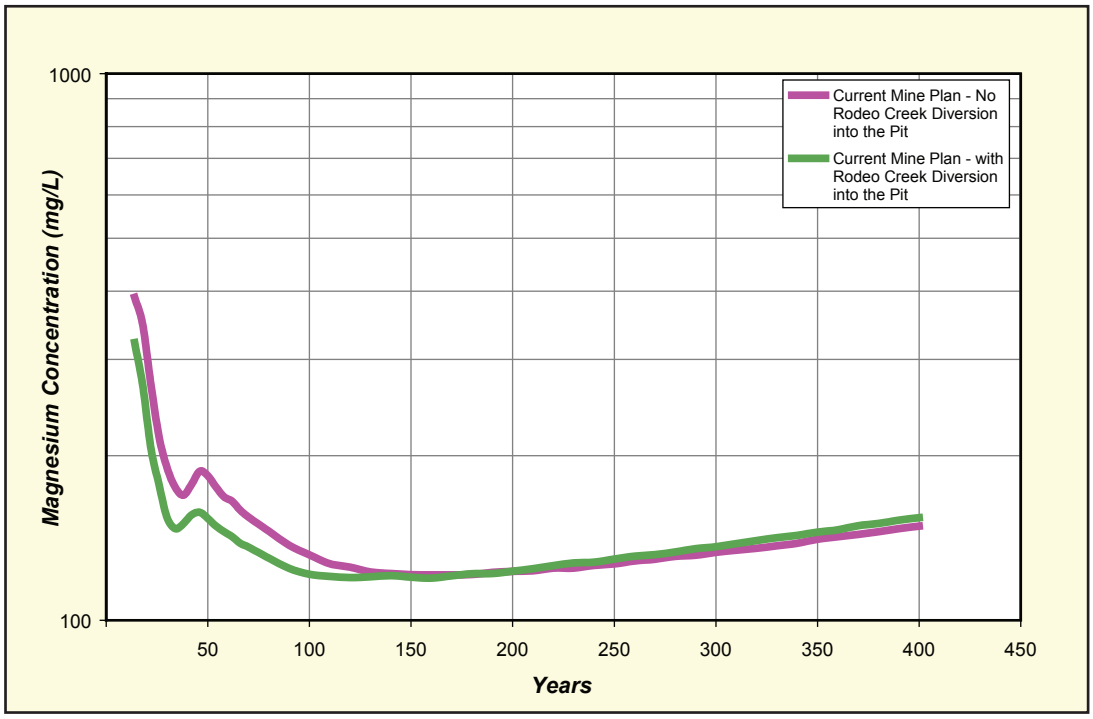



**Figure 3.3-10 Betze Pit Lake Magnesium Chemistry, Current Mine Plan**

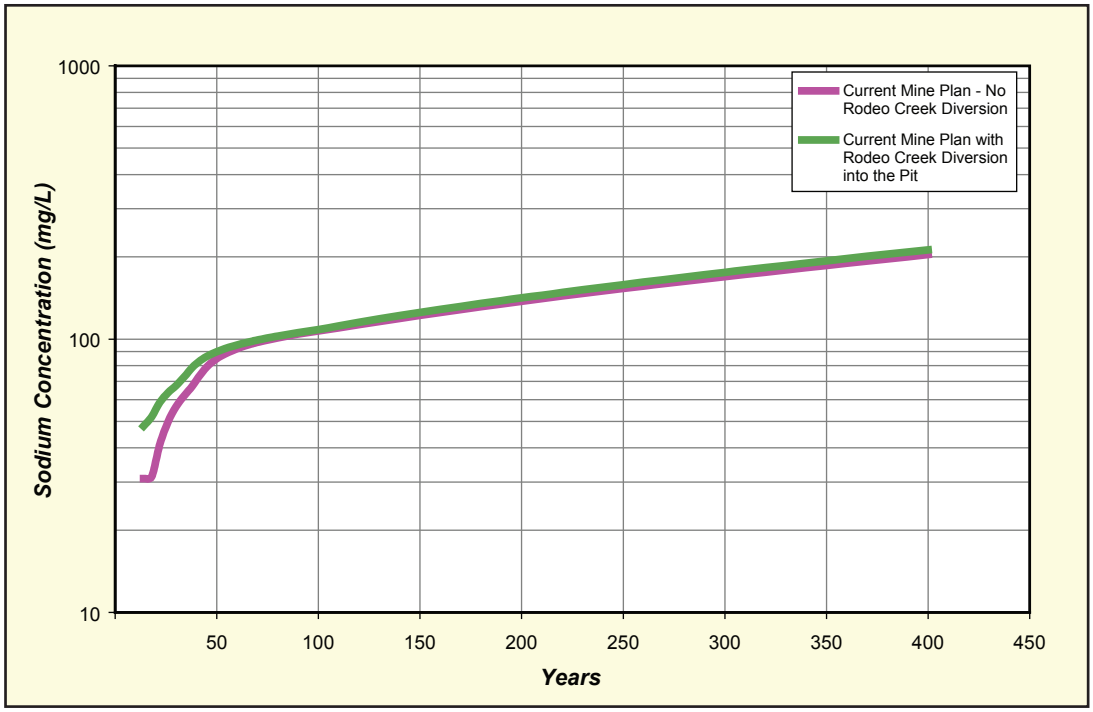



**Figure 3.3-11 Betze Pit Lake Sodium Chemistry, Current Mine Plan**

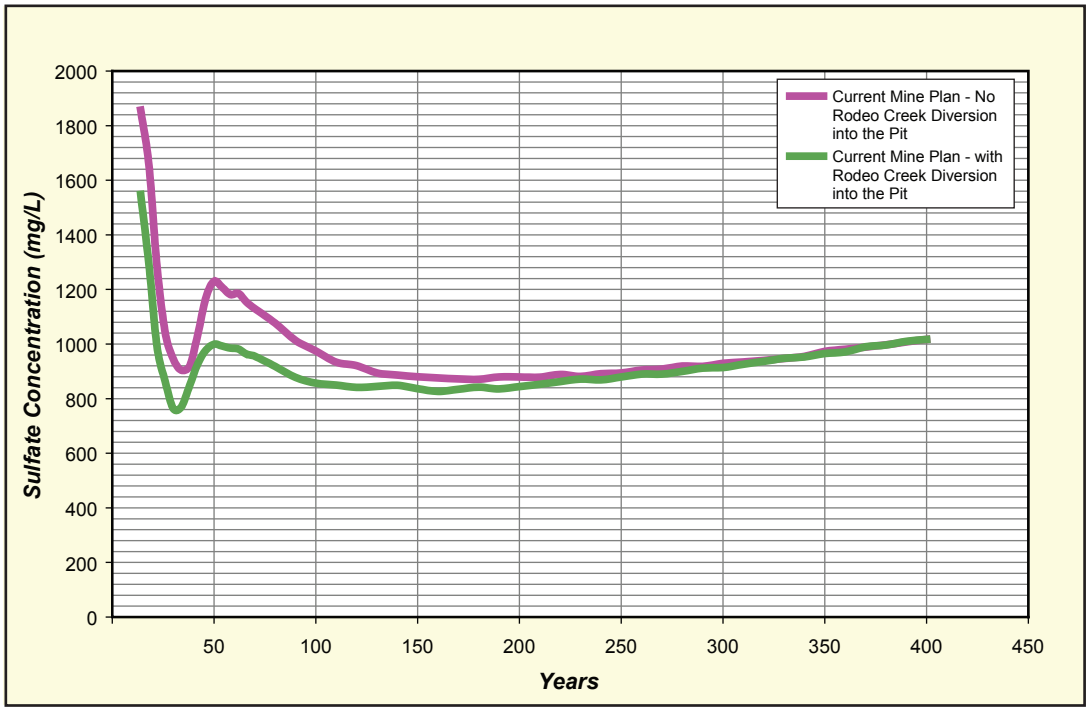



**Figure 3.3-12 Betze Pit Lake Sulfate Chemistry, Current Mine Plan**

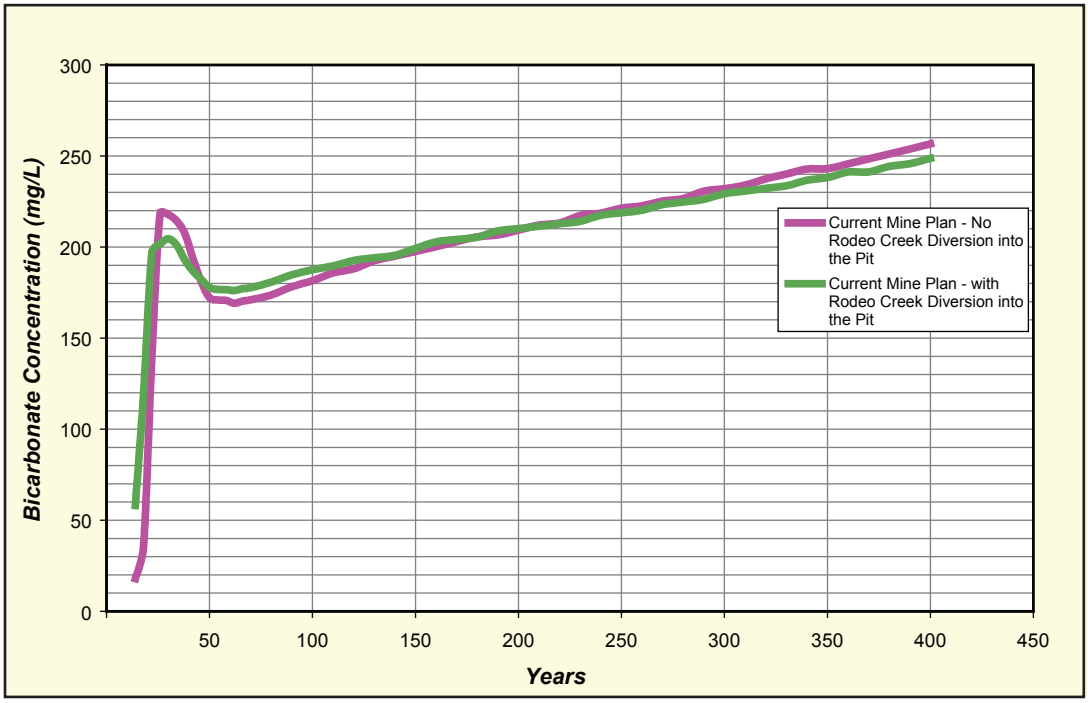



**Figure 3.3-13 Betze Pit Lake Bicarbonate Chemistry, Current Mine Plan**

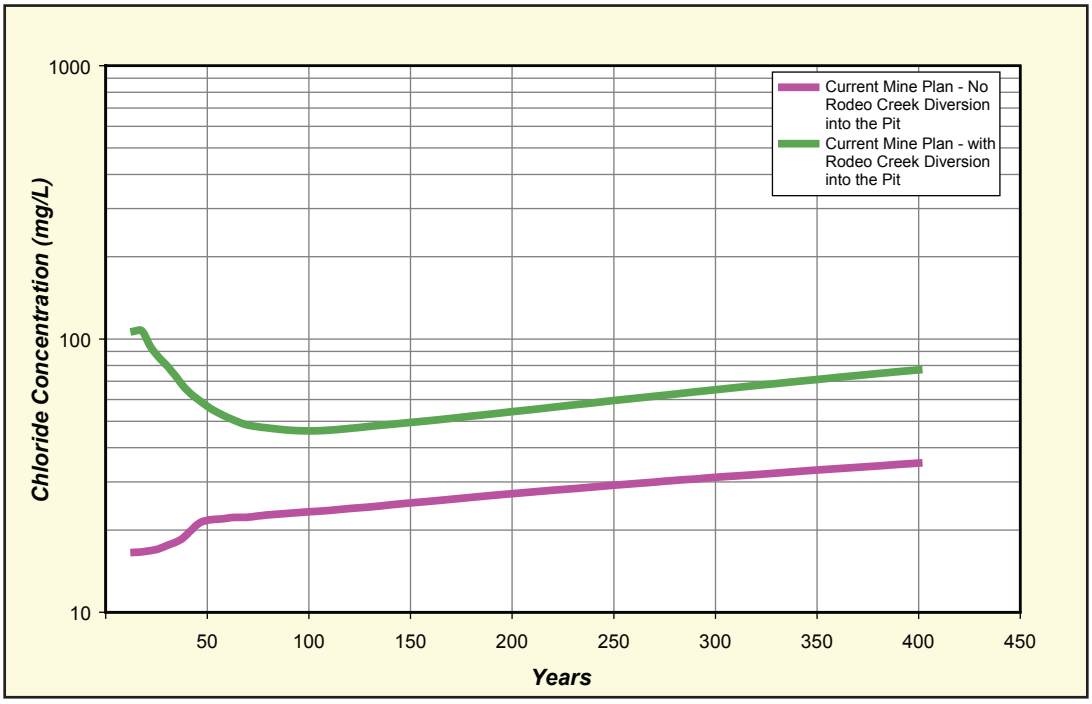



**Figure 3.3-14 Betze Pit Lake Chloride Chemistry, Current Mine Plan**

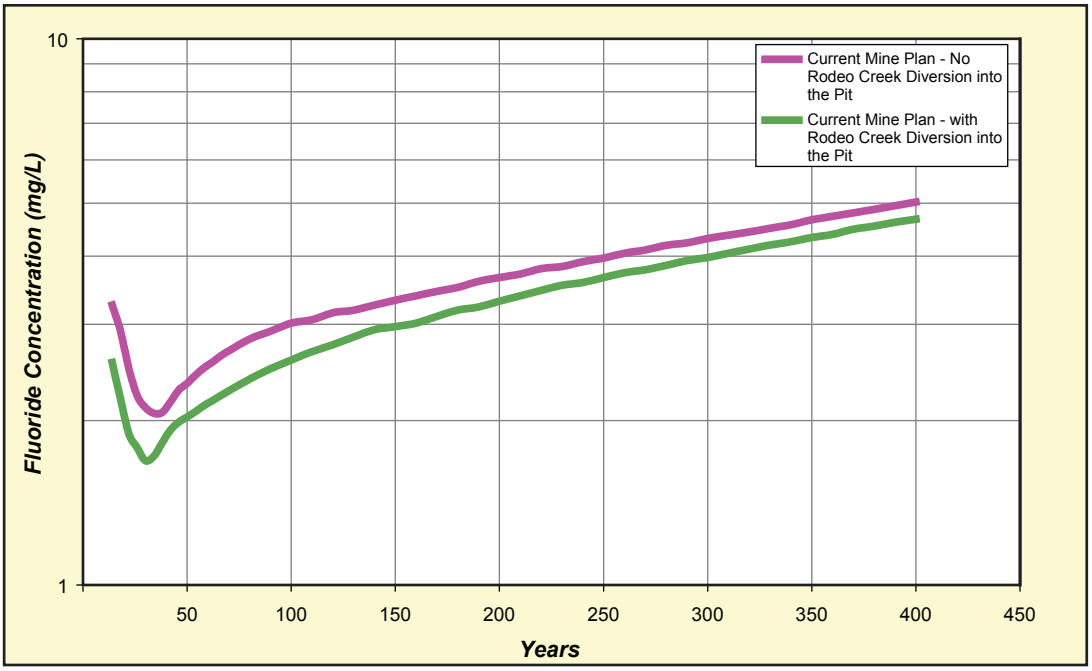



**Figure 3.3-15 Betze Pit Lake Fluoride Chemistry, Current Mine Plan**

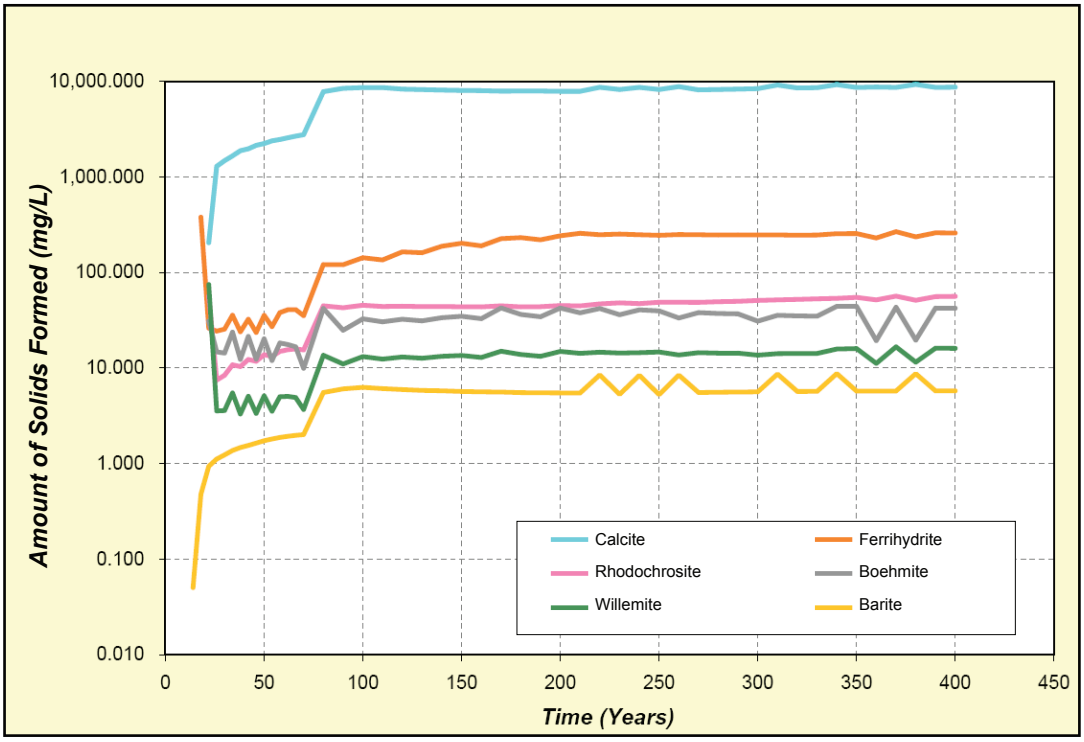



**Figure 3.3-16 Predicted Quantity of Mineral Solids for Expanded Pit and Currrent Mine Plan**

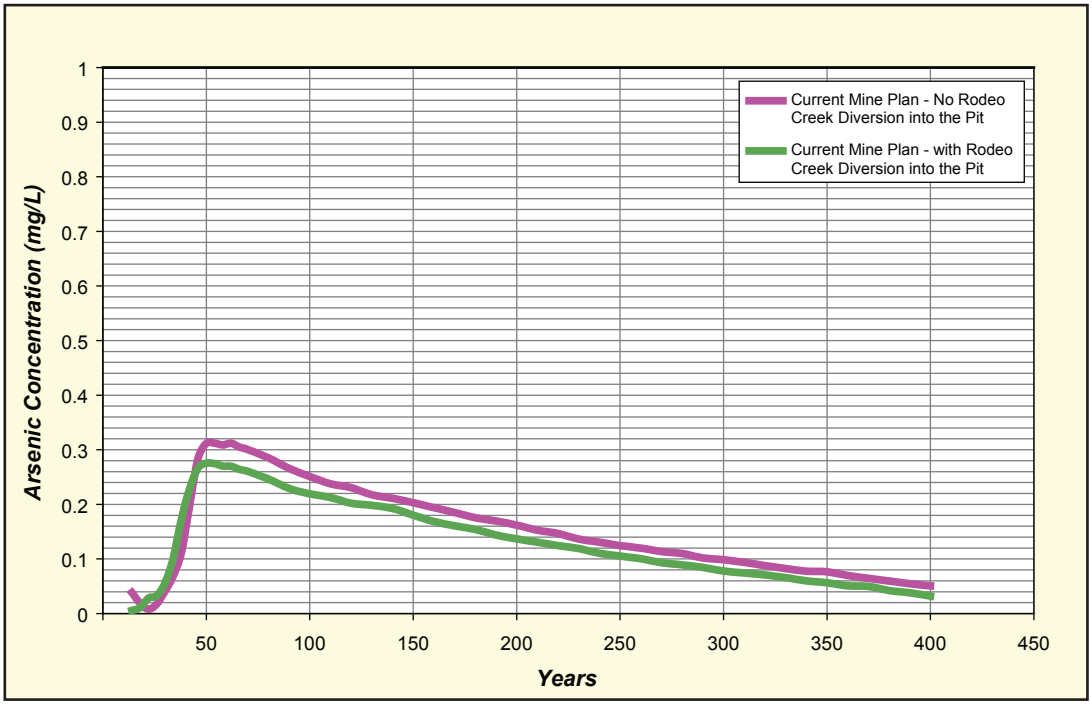



**Figure 3.3-17 Betze Pit Lake Arsenic Chemistry, Current Mine Plan**

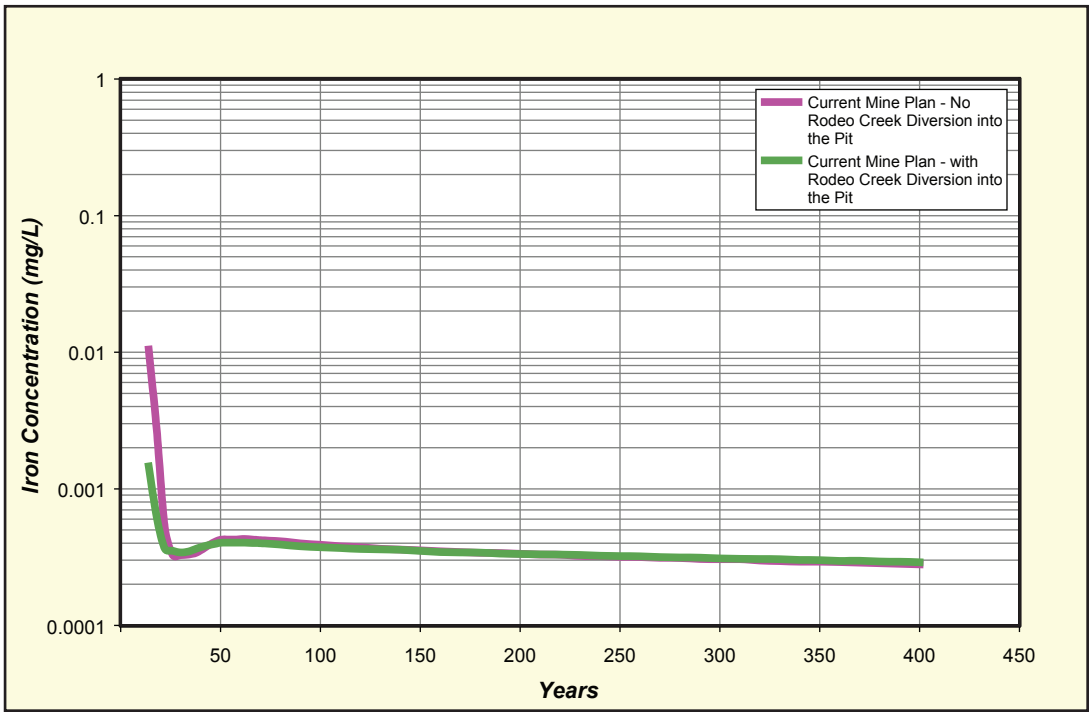



**Figure 3.3-18 Betze Pit Lake Iron Chemistry, Current Mine Plan**

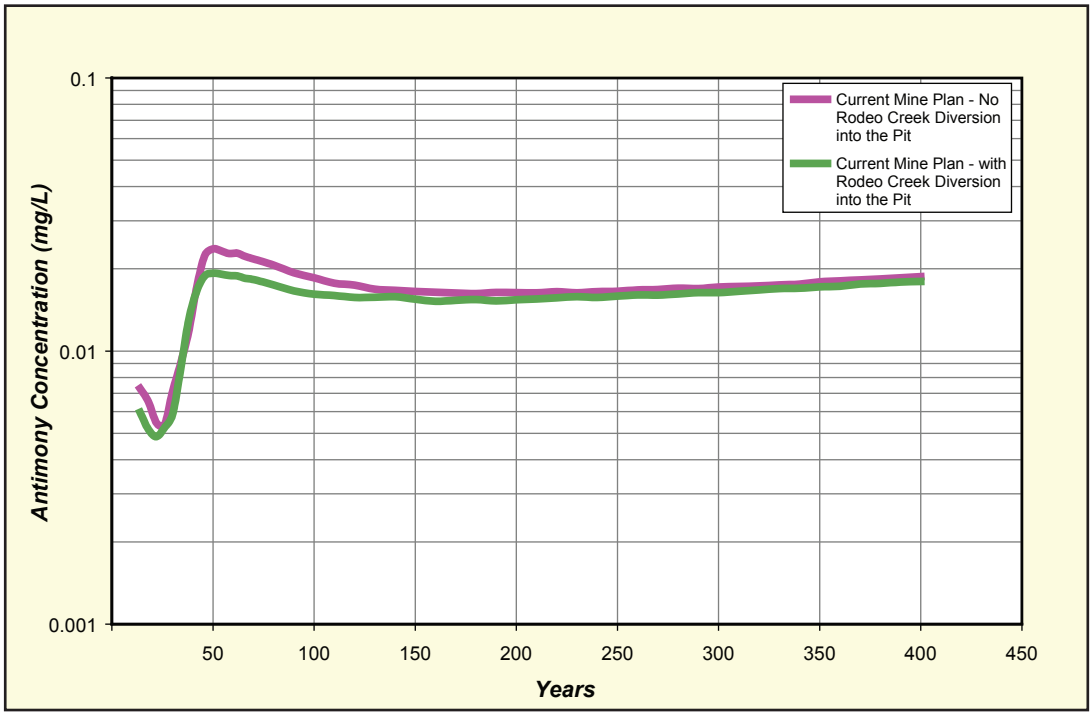



**Figure 3.3-19 Betze Pit Lake Antimony Chemistry, Current Mine Plan**

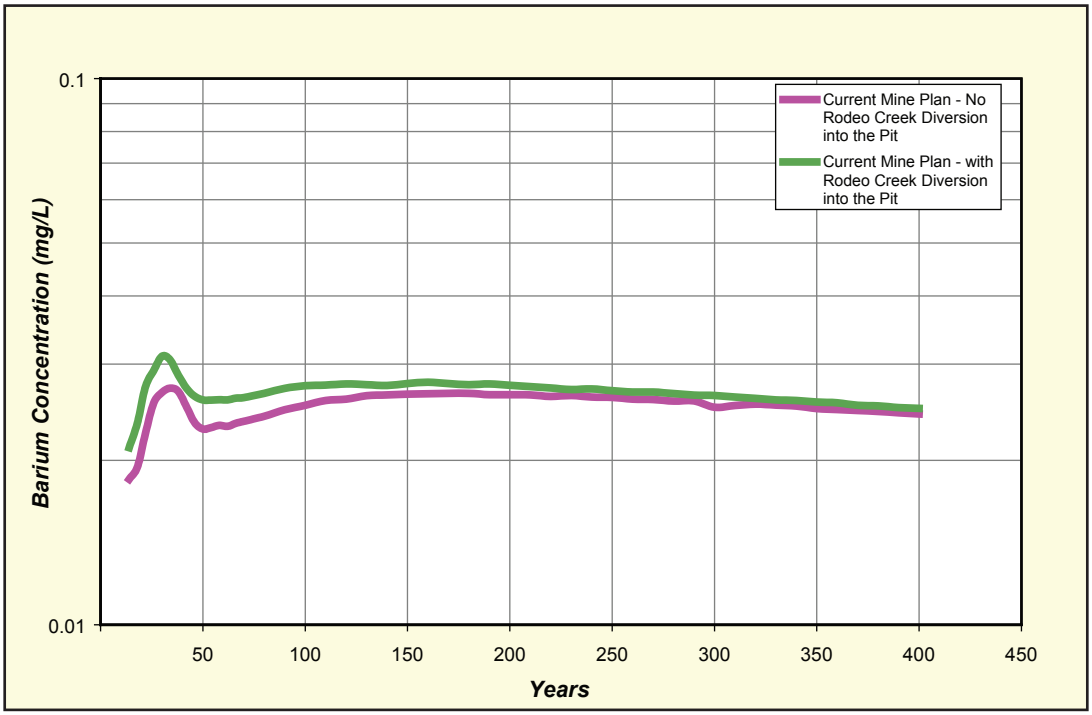



**Figure 3.3-20 Betze Pit Lake Barium Chemistry, Current Mine Plan**

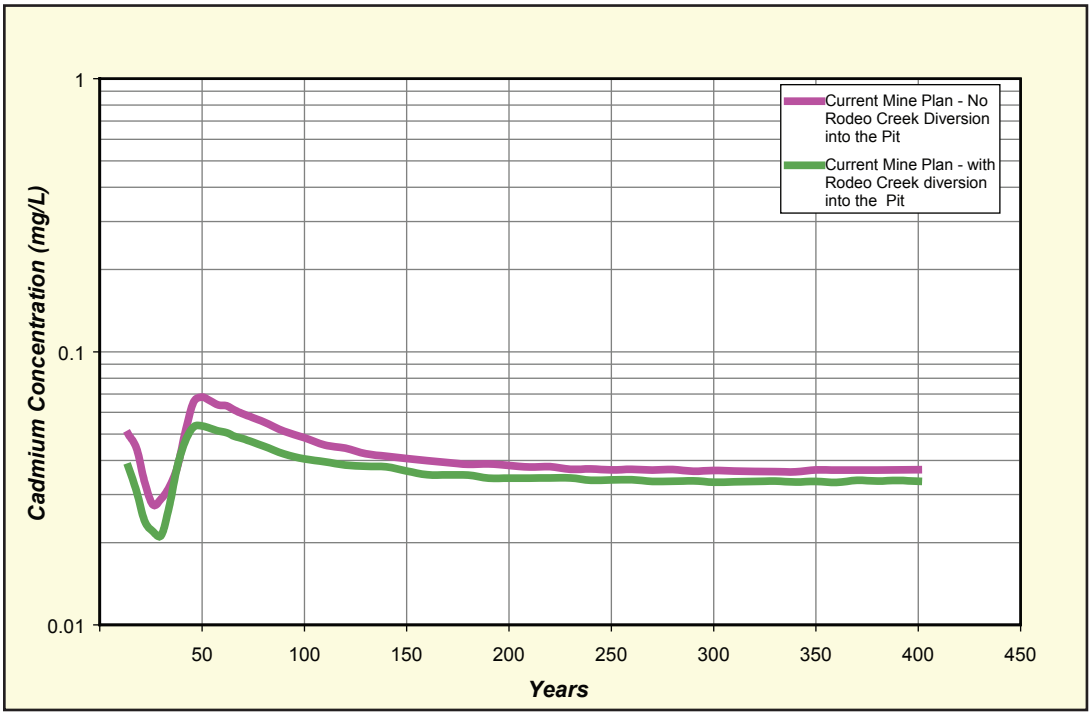



**Figure 3.3-21 Betze Pit Lake Cadmium Chemistry, Current Mine Plan**

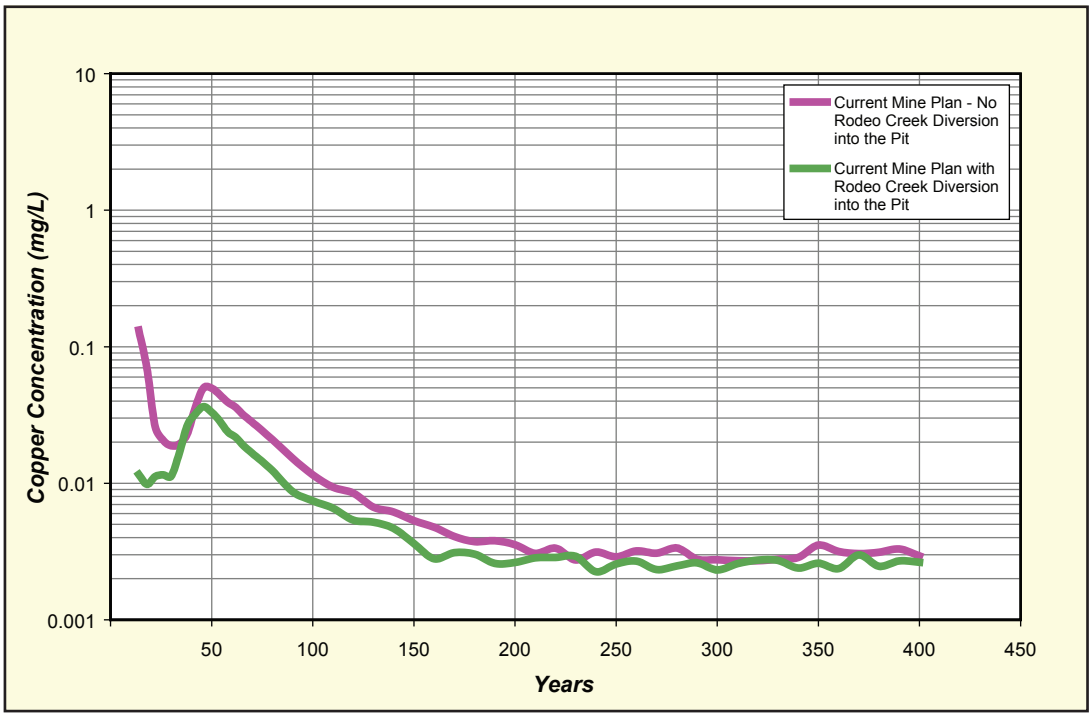



**Figure 3.3-22 Betze Pit Lake Copper Chemistry, Current Mine Plan**

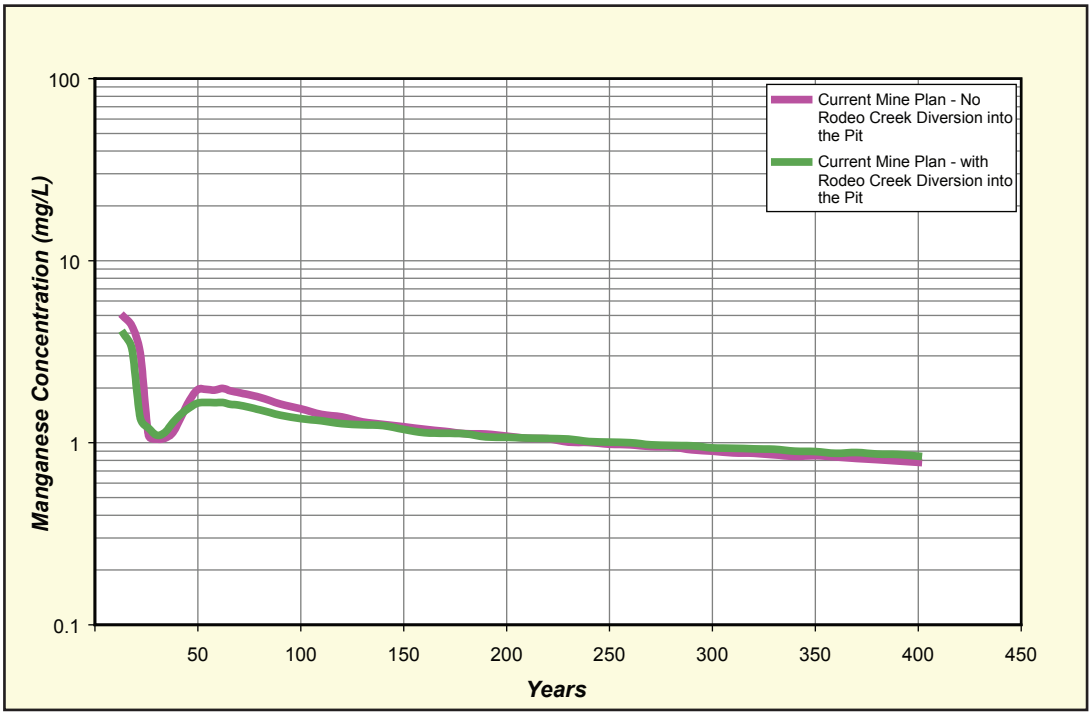



**Figure 3.3-23 Betze Pit Lake Manganese Chemistry, Current Mine Plan**

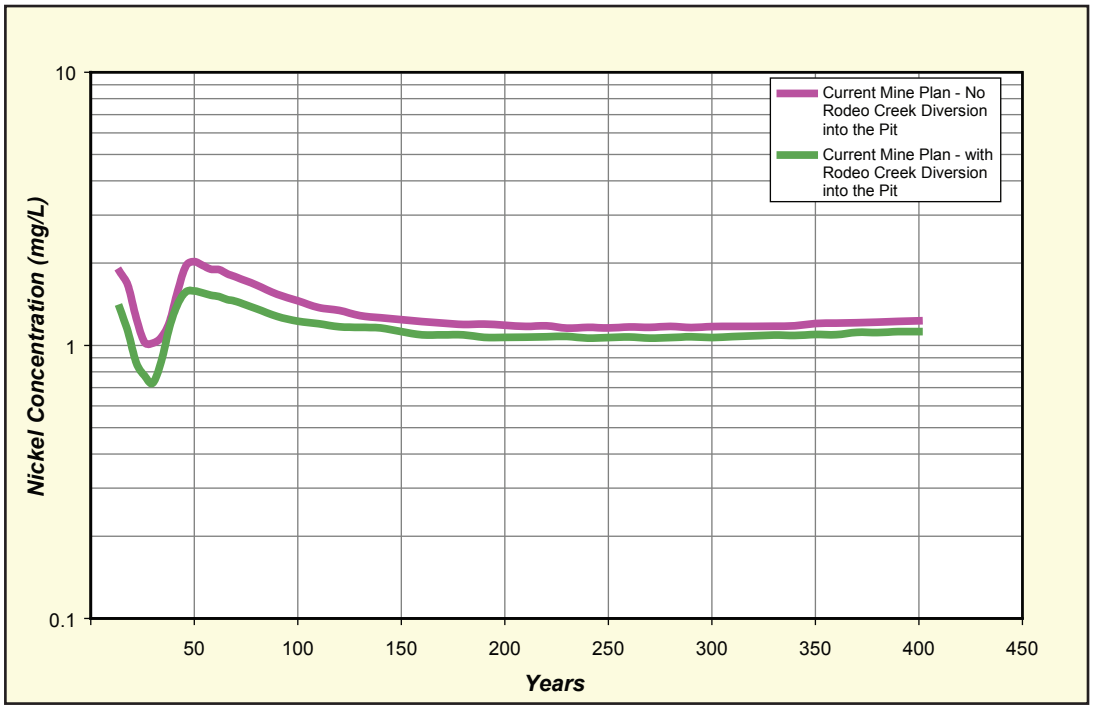



**Figure 3.3-24 Betze Pit Lake Nickel Chemistry, Current Mine Plan**

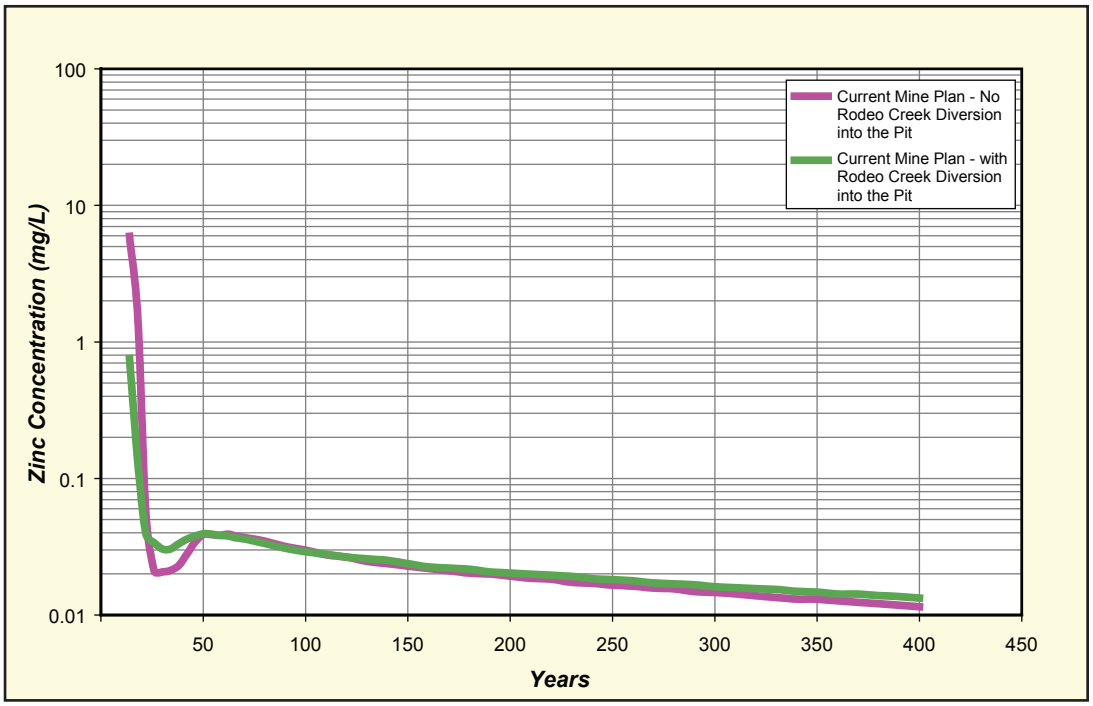



**Figure 3.3-25 Betze Pit Lake Zinc Chemistry, Current Mine Plan**

**Table 3.3-7 Predicted Betze Pit Lake Chemistry in Year 50 under the Current Mine Plan**

| Constituent | Current Mine Plan without Rodeo Creek Diversion into the Pit | Current Mine Plan with Rodeo Creek Diversion into the Pit |
|---|---|---|
| pH (SU) | 7.54 | 7.56 |
| ORP (V) | 0.33 | 0.33 |
| Calcium | 190 | 162 |
| Magnesium | 184 | 154 |
| Sodium | 85 | 90 |
| Potassium | 22 | 21 |
| Sulfate | 1,230 | 999 |
| Bicarbonate | 172 | 178 |
| Chloride | 22 | 57 |
| Silica | 55 | 39 |
| Nitrate | 0.5 | 0.6 |
| Boron | 0.7 | 0.7 |
| Fluoride | 2.3 | 2.0 |
| Aluminum | 0.005 | 0.005 |
| Antimony | 0.024 | 0.019 |
| Arsenic[1] | 0.312 | 0.276 |
| Barium | 0.023 | 0.026 |
| Cadmium | 0.068 | 0.054 |
| Chromium[2] | <0.01 | 0.0073 |
| Copper | 0.050 | 0.033 |
| Iron | 0.0004 | 0.0004 |
| Lead[2] | <0.003 | 0.00211 |
| Manganese | 1.96 | 1.65 |
| Nickel | 2.02 | 1.58 |
| Selenium | 0.009 | 0.007 |
| Silver[2] | <0.004 | 0.004 |
| Thallium | 0.006 | 0.005 |
| Zinc | 0.039 | 0.039 |
| Volume (ML) | 58,411 | 82,077 |
| Stage (m) | 1,400 | 1,407 |

[1]Based on comparison to analogous pit lakes and 2002 batch tests, model overpredicts arsenic levels.

[2]Constituents were below detection level in most source waters.

Notes: Units = mg/L unless otherwise indicated; SU = Standard Units; V = Volts; ML = million liters; M = meters.

Source: Schafer 2007.

**Table 3.3-8 Predicted Betze Pit Lake Chemistry in Year 400 Under the Current Mine Plan**

| Constituent | Current Mine Plan without Rodeo Creek Diversion into the Pit | Current Mine Plan with Rodeo Creek Diversion into the Pit |
|---|---|---|
| pH (SU) | 7.73 | 7.72 |
| ORP (V) | 0.32 | 5.48 |
| Calcium | 76 | 82 |
| Magnesium | 149 | 154 |
| Sodium | 204 | 212 |
| Potassium | 57 | 55 |
| Sulfate | 1,017 | 1,017 |
| Bicarbonate | 257 | 249 |
| Chloride | 35 | 77 |
| Silica | 115 | 98 |
| Nitrate | 1.6 | 1.8 |
| Boron | 2.7 | 2.7 |
| Fluoride | 5.0 | 4.7 |
| Aluminum | 0.007 | 0.007 |
| Antimony | 0.019 | 0.018 |
| Arsenic[1] | 0.051 | 0.032 |
| Barium | 0.024 | 0.025 |
| Cadmium | 0.037 | 0.034 |
| Chromium[2] | <0.00009 | 0.0001 |
| Copper | 0.003 | 0.003 |
| Iron | 0.0003 | 0.0003 |
| Lead[2] | <0.00008 | 0.00006 |
| Manganese | 0.78 | 0.84 |
| Nickel | 1.23 | 1.12 |
| Selenium | 0.007 | 0.007 |
| Silver[2] | <0.008 | 0.008 |
| Thallium | <0.004 | 0.004 |
| Zinc | 0.012 | 0.013 |
| Volume (ML) | 460,830 | 453,410 |
| Stage (m) | 1,560 | 1,566 |

[1]Based on comparison to analogous pit lakes and 2002 batch tests, model overpredicts arsenic levels.

[2]Constituents were below detection level in most source waters.

Notes: Units = mg/L unless otherwise indicated; SU = Standard Units; V = Volts; ML = million liters; M = meters.

Source: Schafer 2007.

irrigation water standards. The water would be a sodium-calcium sulfate dominated water. The pit lake water would not be used for drinking water. The pit lake water quality as a function of time for the Current Mine Plan with Rodeo Creek Diversion is shown in **Figures 3.3-7** through **3.3-25.**

Comparison of 2000 and 2007 Groundwater Models

Groundwater levels, and especially estimated groundwater drawdown contours prepared by BGMI for this SEIS, differ slightly from those in the SEIS prepared for the Goldstrike Mine in 2000 (BLM 2000a;2003a) (**Figure 3.3-26**). This is most apparent for the predicted 10-foot maximum drawdown contour. This contour refers to the maximum extent of the 10-foot drawdown and is not specific to any time period. The most notable difference is northwest of the Betze Pit in the area of Rock Creek where the 10-foot maximum drawdown contour from the 2007 model extends about 2 miles farther to the west and northwest than the 10-foot maximum drawdown contour from the 2000 model (BLM 2000a). This results in additional springs being included within the projected 10-foot maximum drawdown contour for 2007 that were not included in the 2000 projection. These springs that fall outside the 2000 projection of the maximum 10-foot drawdown but within the 2007 projection of that same contour are located within the 2000 maximum cumulative 10-foot drawdown contour (**Figure 3.3-27**). The mitigation specified in Appendix A of the Betze Project SEIS (BLM 2003a) addressed all direct, indirect, and cumulative impacts within the projected maximum cumulative 10-foot drawdown contour (**Figure 3.3-27**). Therefore, the revised groundwater modeling for 2007 has not resulted in any new impacts to water resources beyond those that were discussed and covered by mitigation in the Betze Project SEIS (BLM 2000a, 2003a; Appendix A).

*Cause of Slight Difference in 10-foot Drawdown Contour*

Dewatering of the Betze Pit has been at a relatively constant rate for the past 3 to 5 years (Zhan 2007). Thus, the pumping rate of the dewatering wells near the pit has not changed significantly. BGMI frequently updates the groundwater model used to estimate impacts of pit dewatering based on the quarterly and annual monitoring well water level data. The groundwater model calibration is adjusted slightly to better match these new data each year. Thus, the BGMI groundwater model for the Betze Pit and the Boulder Valley area has been adjusted and recalibrated a number of times since the Year 2000. Recalibration of the model causes the drawdown contours to change shape and move somewhat either closer to or farther away from the Betze Pit.

Under the No Action Alternative, BGMI will continue the current dewatering of the Betze Pit for 4 additional years beyond 2011 holding water levels at or near their current elevation. Dewatering at the Betze Pit is now at or near steady state because groundwater levels have not changed in the past few years, so an additional 4 years of pumping is not anticipated to substantially change the nature or magnitude of drawdown around the pit or in the Boulder Valley area. **Figure 3.3-28** compares the maximum extent of 10-foot drawdown for groundwater pumping to Year 2011 vs. groundwater pumping for an additional 4 years to 2015 using BGMI's model from the Betze SEIS (BLM 2000a). This figure shows that the additional 4 years of pumping would not result in an expansion of groundwater drawdown. Recalibration of the groundwater model to changes in monitoring well water levels is a standard procedure for ensuring the accuracy of model predictions. This annual recalibration can lead to variations in the projected areal extent of groundwater drawdown, especially near the farthest extent of model predictions. Because the additional 4 years of pumping under the No Action Alternative for the Betze Pit is not expected to substantially change the nature of drawdown around the pit (Zhan 2007), the variation in the location of the 10-foot maximum drawdown contour between 2000 and 2007 is due to recalibration of the model between 2000 and 2007.

#### 3.3.2.2 Proposed Action

Under the Proposed Action, the Betze Pit would be expanded to the northwest with two laybacks, as discussed in Chapter 2.0. This would result in 315 million tons of waste rock, and the proposed pit backfill would increase from 570 million tons (No Action Alternative) to 940 million tons under the Proposed Action. The pit backfill would be placed in three elevations or zones: 1) Lower Backfill for elevations below

5,116 feet amsl; 2) Middle Backfill for elevations between 5,116 feet and 5,246 feet amsl; and 3) Upper Backfill for elevations above 5,246 feet amsl (Schafer 2007). The pit backfill would be inundated during pit lake formation and below the final pit lake elevation after Year 100. The sequence of pit filling is shown in **Appendix C** (**Figures C-1** through **C-3**). The Lower Backfill zone would contain about 24 percent PAG waste rock (Schafer 2008b). The Middle Backfill zone would contain no PAG waste rock and would have an overall NNP of about 130 kg/t (Schafer 2007). The Upper Backfill zone would contain about 13 percent PAG (Schafer 2008b).

Post-mining Pit Lake

Under the Proposed Action, the area of the post-mining pit lake in the Betze Pit would be increased by 15 percent compared to the current Mine Plan (No Action Alternative), and the resulting pit lake would have a lower final elevation and about 90 percent of the volume of the pit lake under the existing mine plan. The Pit Lake surface area would be approximately 927 acres. The geochemical character of the pit walls would be different than Goldstrike's existing mine plan; the proposed expansion is at the northwest end of the Betze Pit and would involve mostly carbonate rock. The increase in backfill material to be left in the pit after mining compared to the existing mine plan would result in more PAG waste rock being left in the pit. However, the amount of PAG material in the remaining high walls of the post-mining pit would decrease from 15 percent under the existing mine plan to 12.5 percent under the Proposed Action (Schafer 2007). The average NNP for the pit highwall rocks would increase from 141 to 160-kg/t under the Proposed Action. The procedure for chemical modeling of the Proposed Action pit lake was the same as used for the No Action Alternative.

The Proposed Action pit lake water quality was analyzed for the two mine closure options: 1) without diversion of Rodeo Creek into the pit, and 2) with diversion of Rodeo Creek into the pit (**Figures 3.3-29** through **3.3-47**). The final pit lake elevation under the Proposed Action at steady state (Year 400) would be an estimated 5,111 feet amsl.

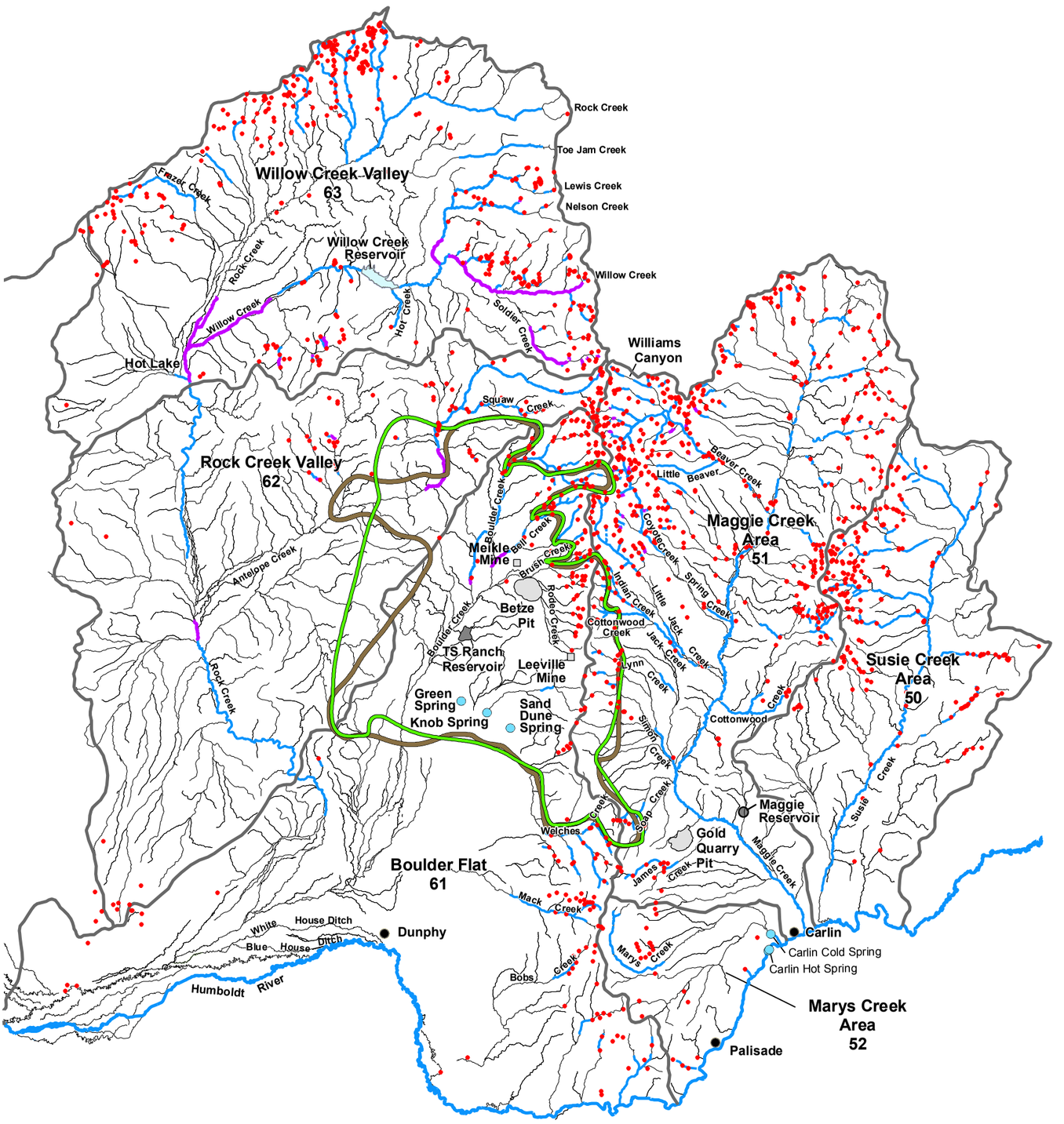
Without the diversion of Rodeo Creek, the first 14 years have pit wall runoff and precipitation as the main sources of water coming into the pit. Starting around Year 14, groundwater begins to enter the pit. By Year 20, groundwater becomes a dominant source of water flowing into the pit. Thus, the pit lake water quality begins to change between Years 14 and 20, and by Year 50 the pit lake water quality is dominated by inflowing groundwater and reactions between the inflowing groundwater and the pit walls. Also, precipitation of various phases controls the concentration of constituents such as arsenic, barium, iron, and calcium in the evolving pit lake water.

*Water Quality with Rodeo Creek Diversion*

**Figures 3.3-29** through **3.3-47** show the changes in pit lake water quality with time for the Proposed Action with diversion of Rodeo Creek. With the closure option of the Rodeo Creek Diversion into the pit, the influx of Rodeo Creek controls the pit lake water quality during the first 20 years of pit filling. By Year 50, the pit lake water quality would begin to resemble the water quality under the Proposed Action without the Rodeo Creek Diversion, and the continued evolution of the pit water quality would follow a trend similar to that for the Proposed Action without the Rodeo Creek Diversion.

Modeling results show the pH of the pit lake would not be acidic, even during the early years of lake formation (**Figure 3.3-30**). Although not anticipated to be necessary, BGMI commits to adding 100-tons of limestone to the pit as a precautionary measure to ensure that the pit lake does not become acidic during these early years.

Pit lake water is not intended for use as drinking water nor agricultural water, nor has it been designated by NDEP for such uses. Comparison of predicted pit lake water to water quality standards based on use is provided below for informational purposes only. **Table 3.3-9** presents the concentration of major and minor constituents in the pit lake at Year 50. **Table 3.3-10** presents the same constituents at Year 400 in the pit lake. For the Expanded Pit with the Rodeo Creek Diversion, the pit lake water quality at Year 50 would exceed




**LEGEND**

- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinous Flowing Stream Reach
- Seeps and Springs
- Maximum Extent of 10-foot Drawdown Contour (2000 Model)
- Maximum Extent of 10-foot Drawdown Contour (2007 Model)

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: BLM 2000a; BGMI 2007a.

N

0 5 10 Miles

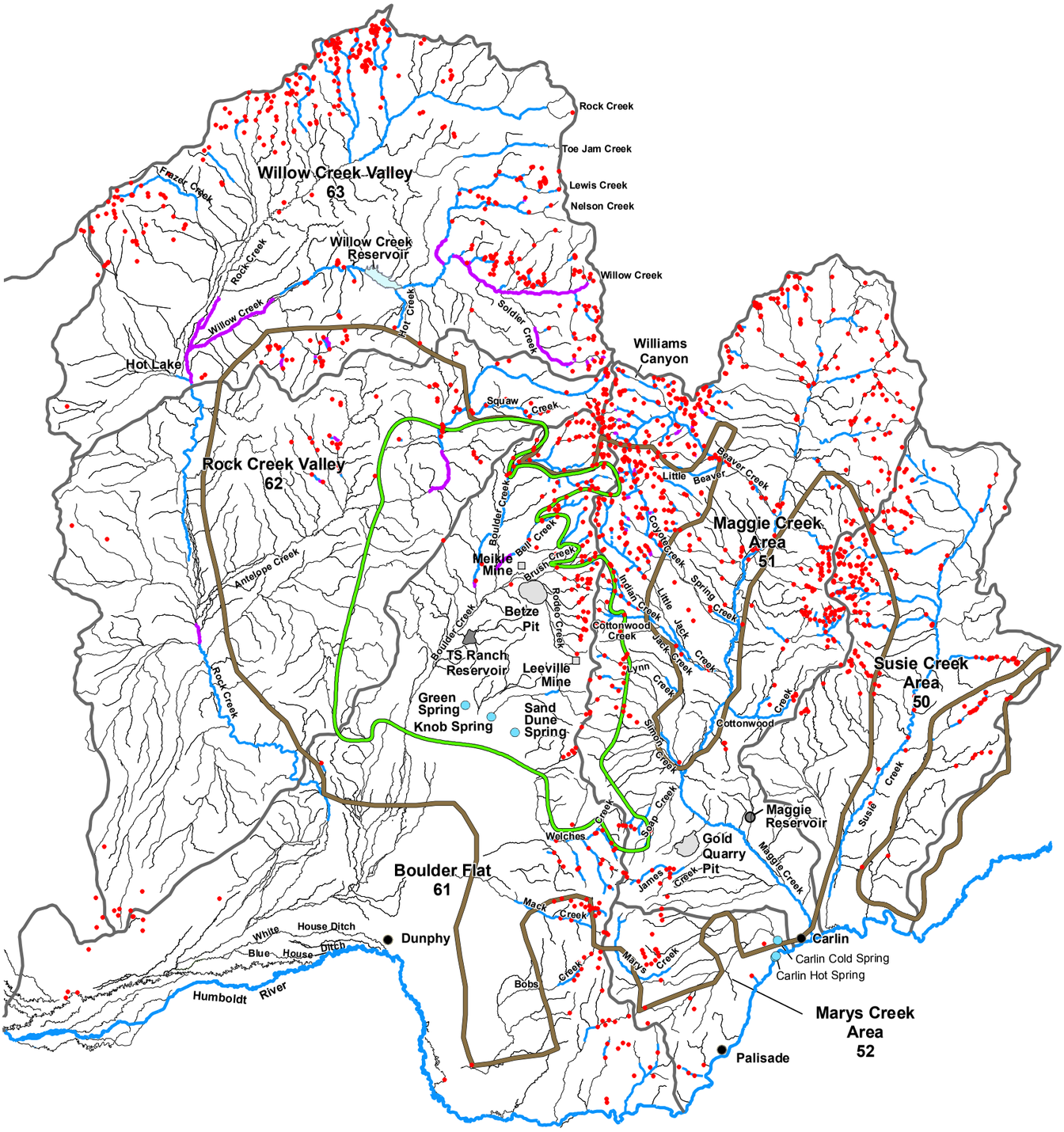
**Betze Pit Expansion Project**

Figure 3.3-26

Areas of Perennial Stream Reaches, Seeps, and Springs in the Hydrologic Study Area and Comparison of 2000 and 2007 Maximum 10-foot Drawdown Extent



06/17/2008




## LEGEND

- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinous Flowing Stream Reach
- Maximum Extent of Cumulative 10-foot Drawdown Contour (2000 Model)
- Maximum Extent of 10-foot Drawdown Contour (2007 Model)
- Seeps and Springs

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: BLM 2000a; BGMI 2007a.

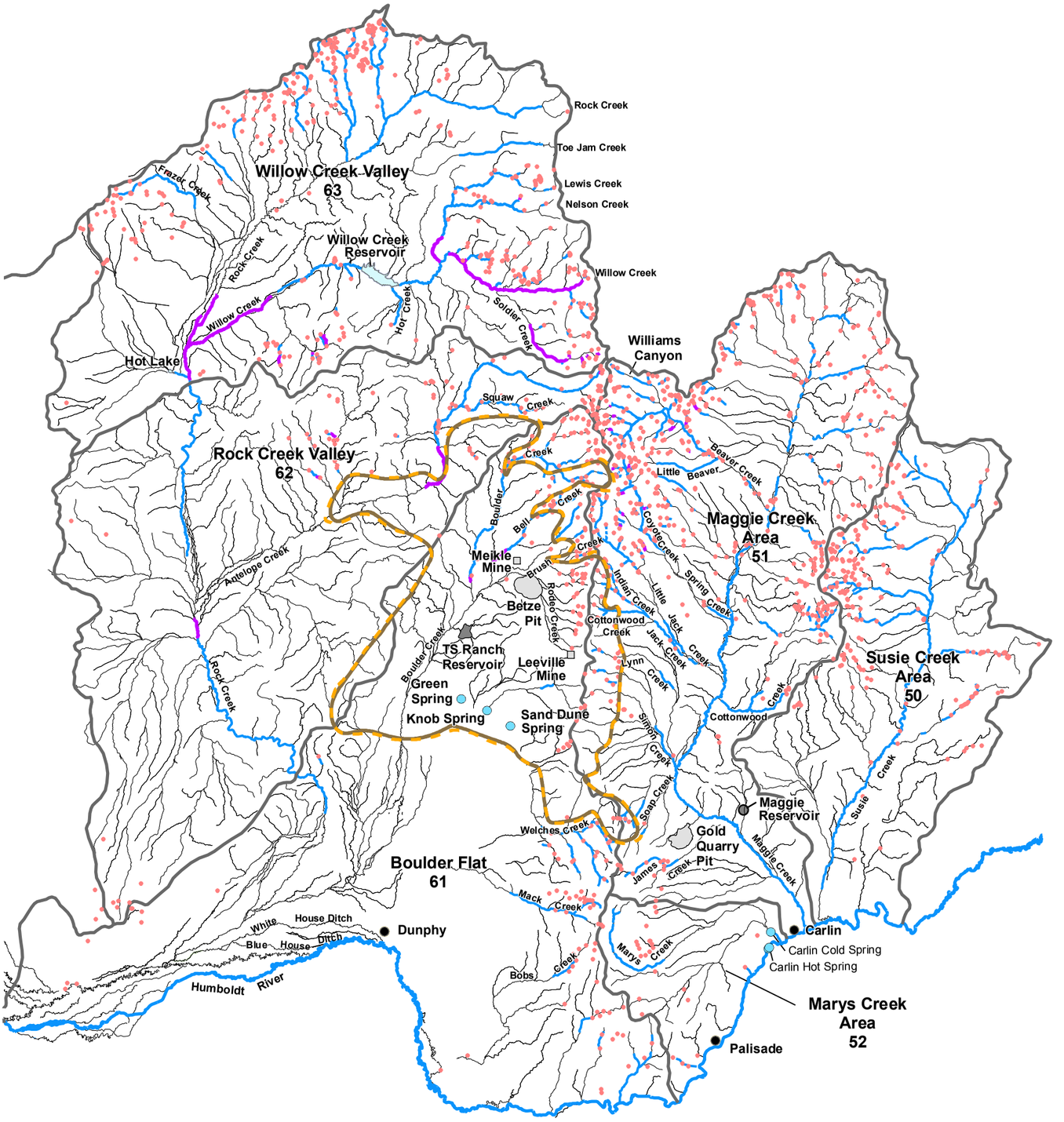
N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.3-27

Comparison of the 2007 10-foot Drawdown Contour (BGMI Pumping Only) and 2000 Cumulative Pumping 10-foot Drawdown Contour




## LEGEND

- Maximum Extent of 10-foot Drawdown Contour, Pumping Case 2015 (2000 Model)
- Maximum Extent of 10-foot Drawdown Contour, Pumping Case 2011 (2000 Model)
- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream
- Discontinous Flowing Stream Reach
- Seeps and Springs

Note: The 2011 and 2015 10-foot drawdown contours are based on the Betze Project SEIS 2000 groundwater model. Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: BLM 2000b; BGMI 2007a.

N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.3-28

Maximum Extent of 10-foot Drawdown Contours (Barrick Pumping Only) Pumping Case 2011 vs. 2015



06/17/2008

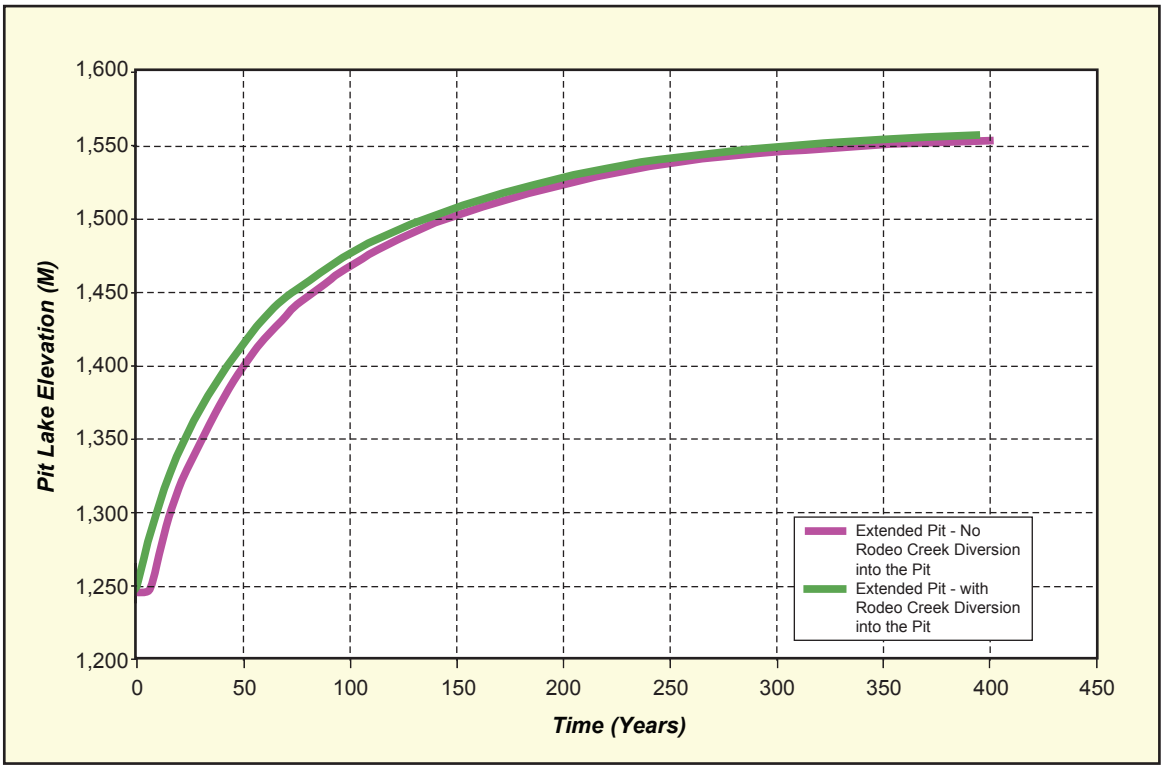



**Figure 3.3-29 Comparison of Betze Pit Lake Elevation for the Expanded Pit with and without Diversion of Rodeo Creek**

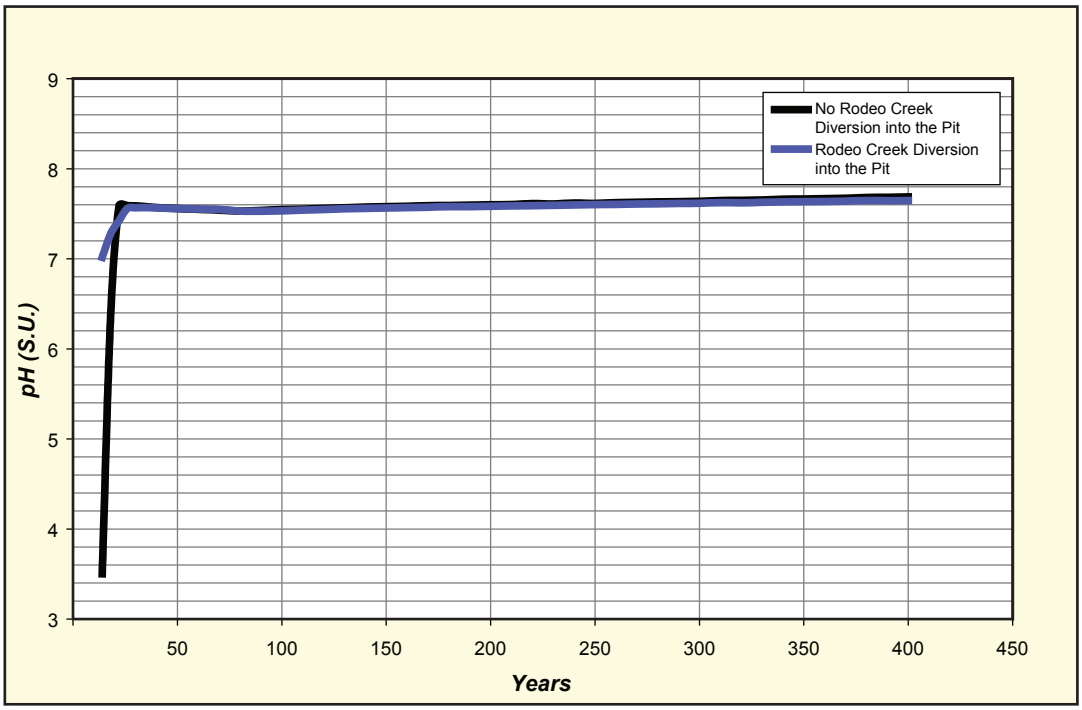



**Figure 3.3-30 Betze Pit Lake pH, Expanded Pit without Addition of Limestone in the Early Years**

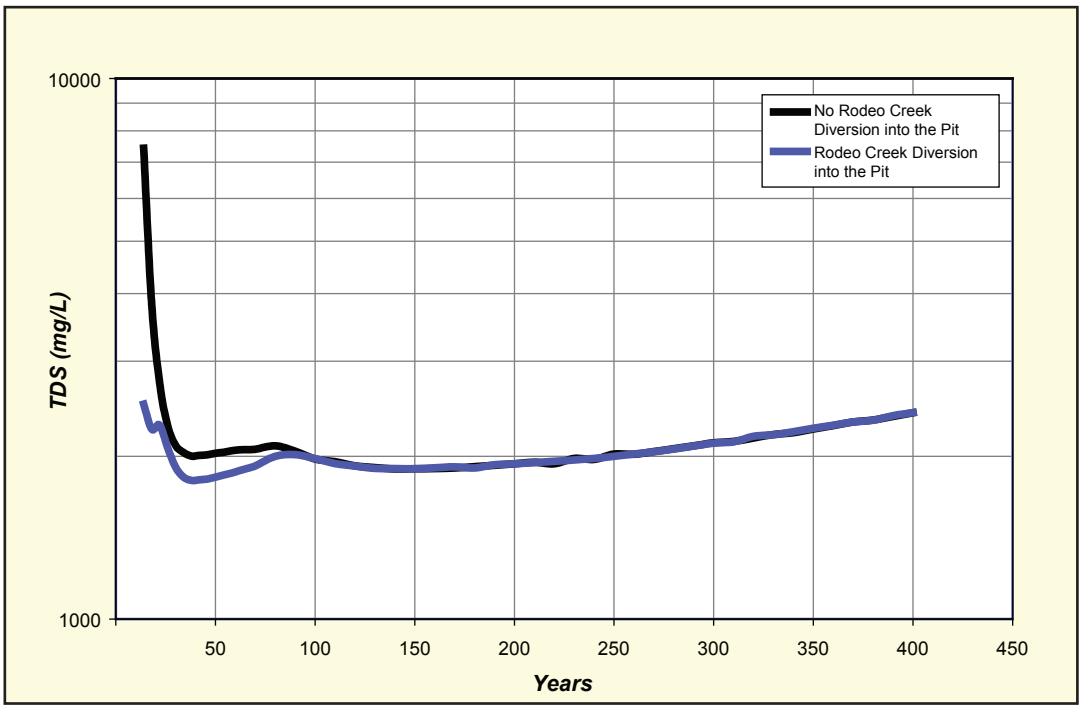



**Figure 3.3-31 Betze Pit Lake Total Dissolved Solids, Expanded Pit without Addition of Limestone in the Early Years**

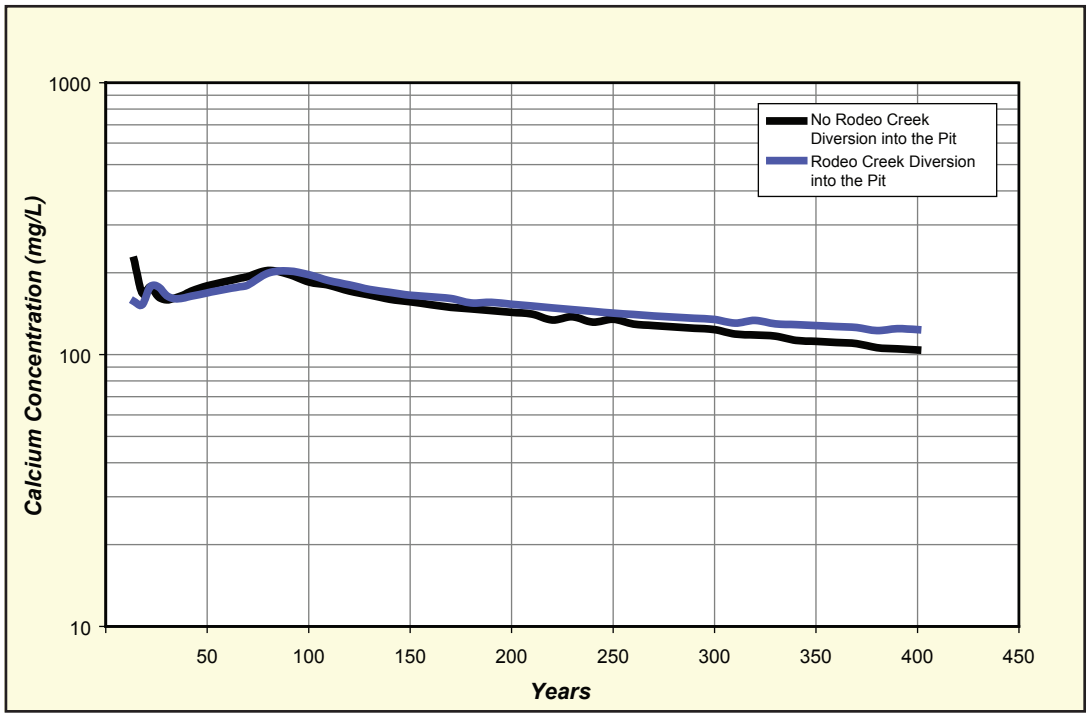



**Figure 3.3-32 Betze Pit Lake Calcium Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

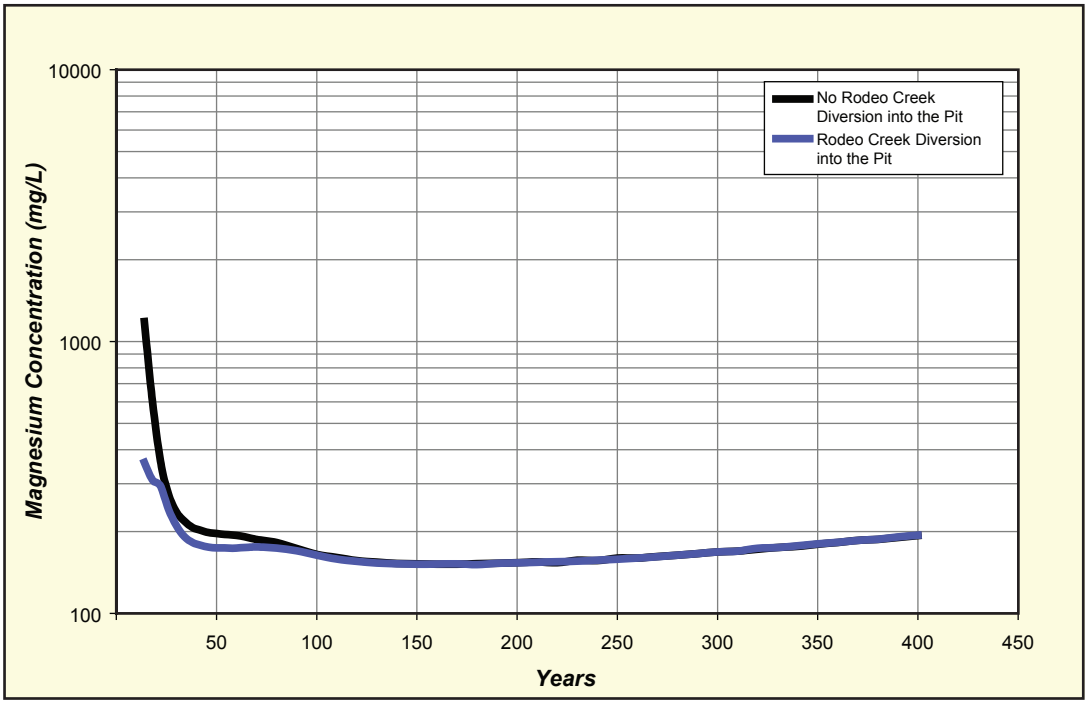



**Figure 3.3-33 Betze Pit Lake Magnesium Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

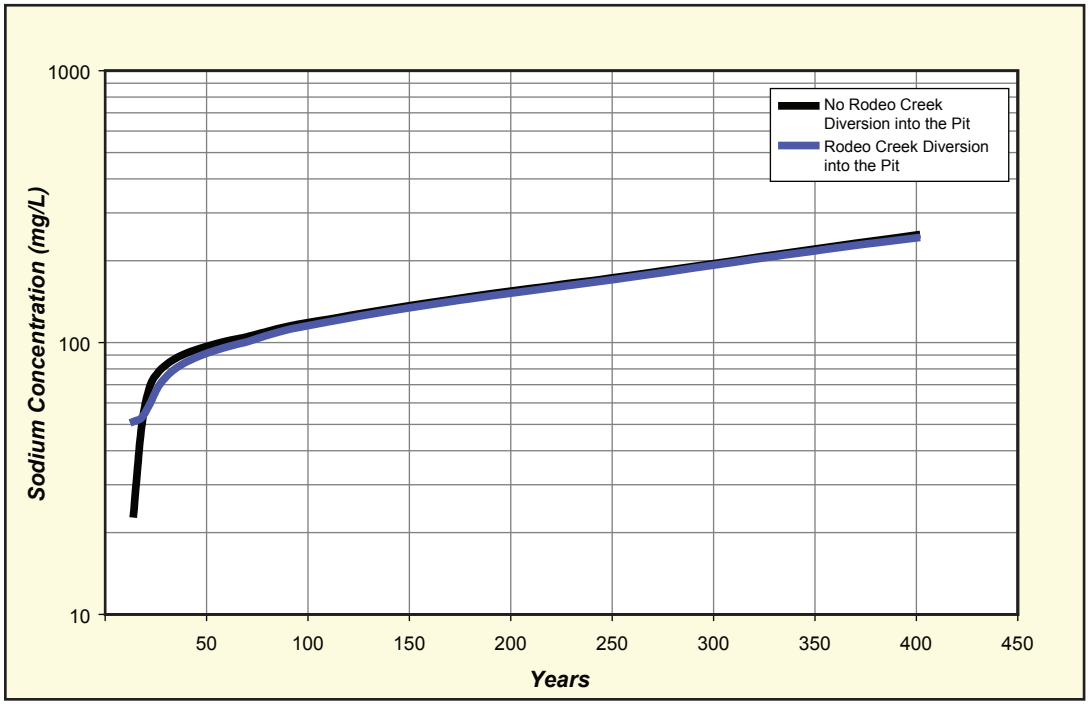



**Figure 3.3-34 Betze Pit Lake Sodium Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

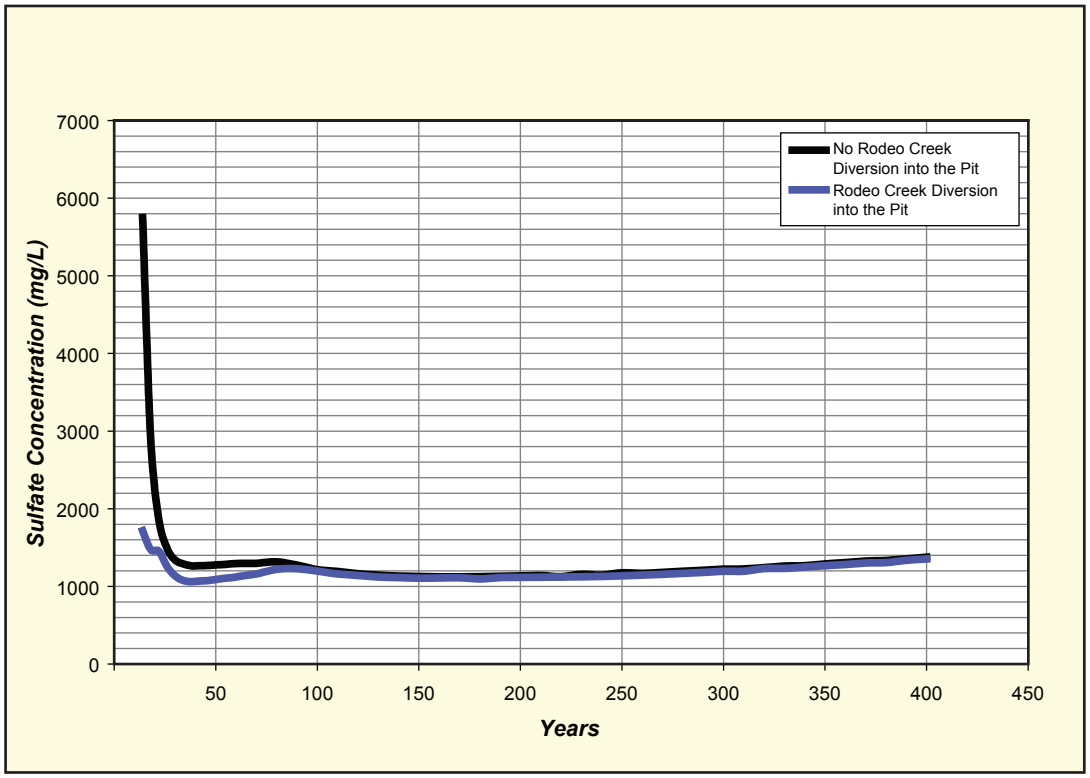



**Figure 3.3-35 Betze Pit Lake Sulfate Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

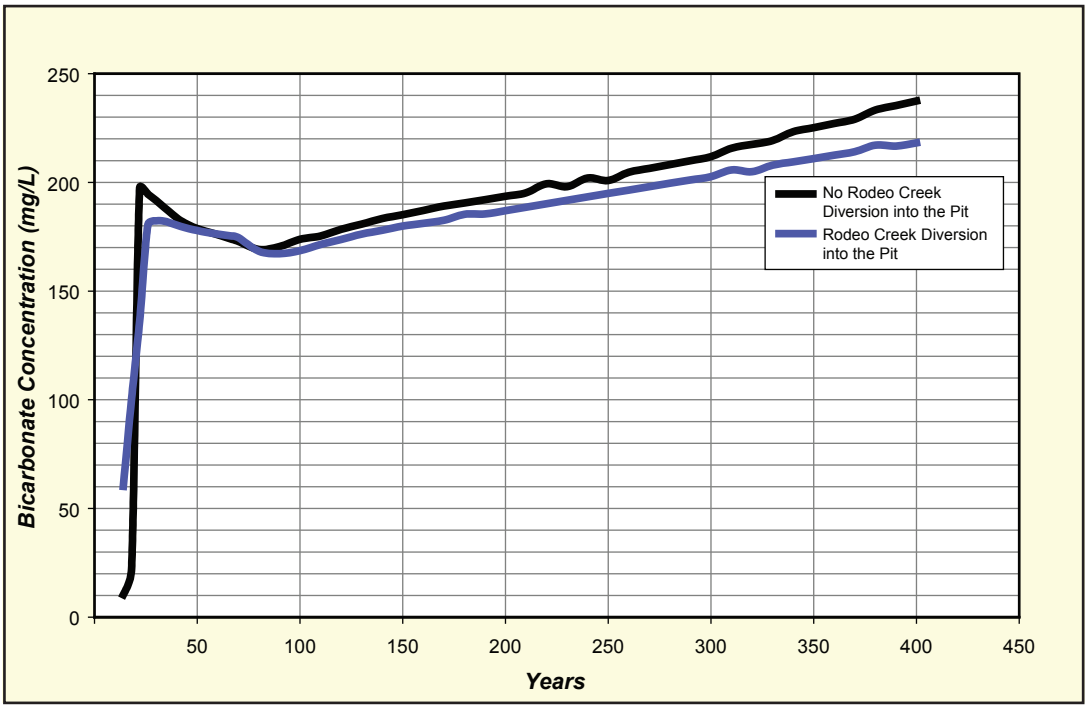



**Figure 3.3-36 Betze Pit Lake Bicarbonate Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

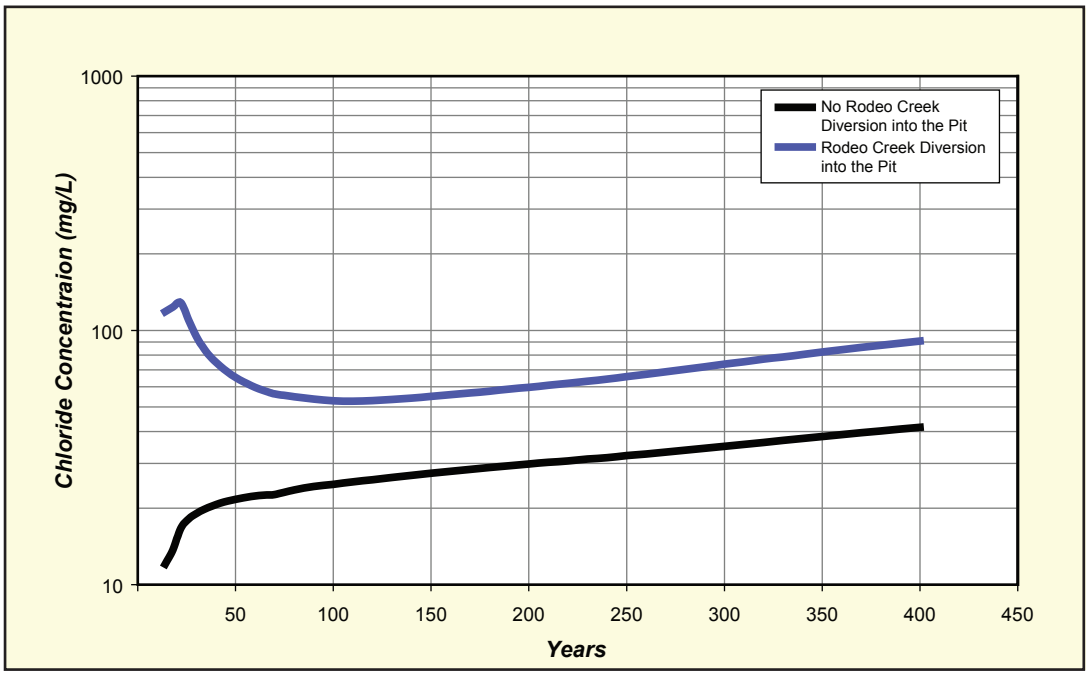



**Figure 3.3-37 Betze Pit Lake Chloride Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

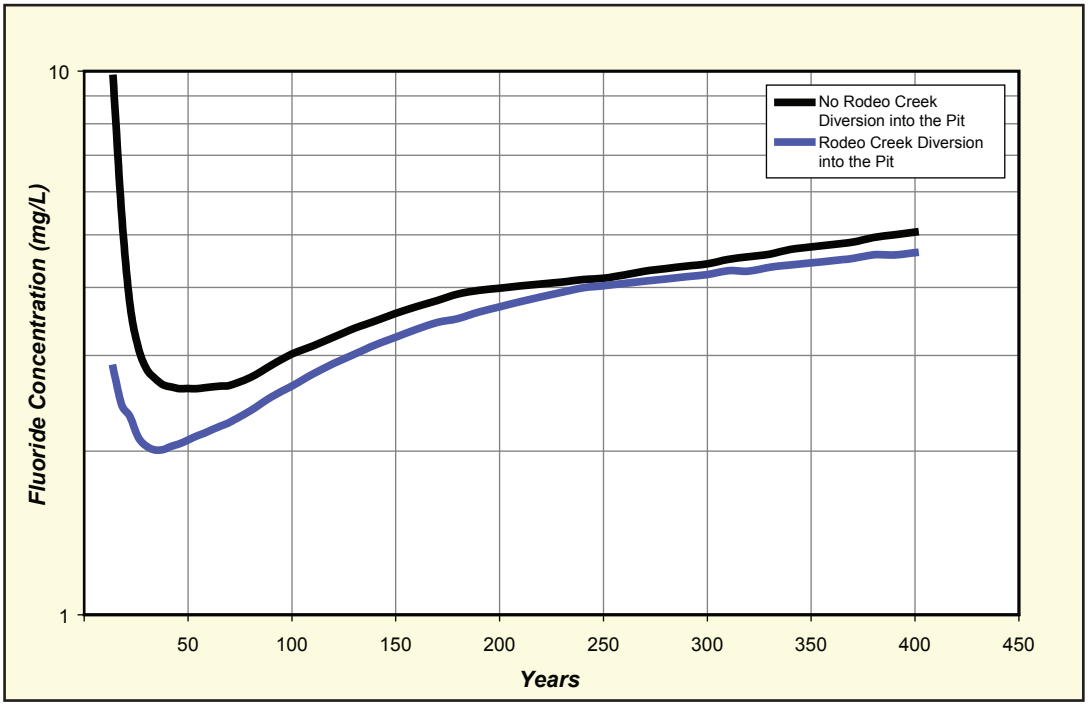



**Figure 3.3-38 Betze Pit Lake Fluoride Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

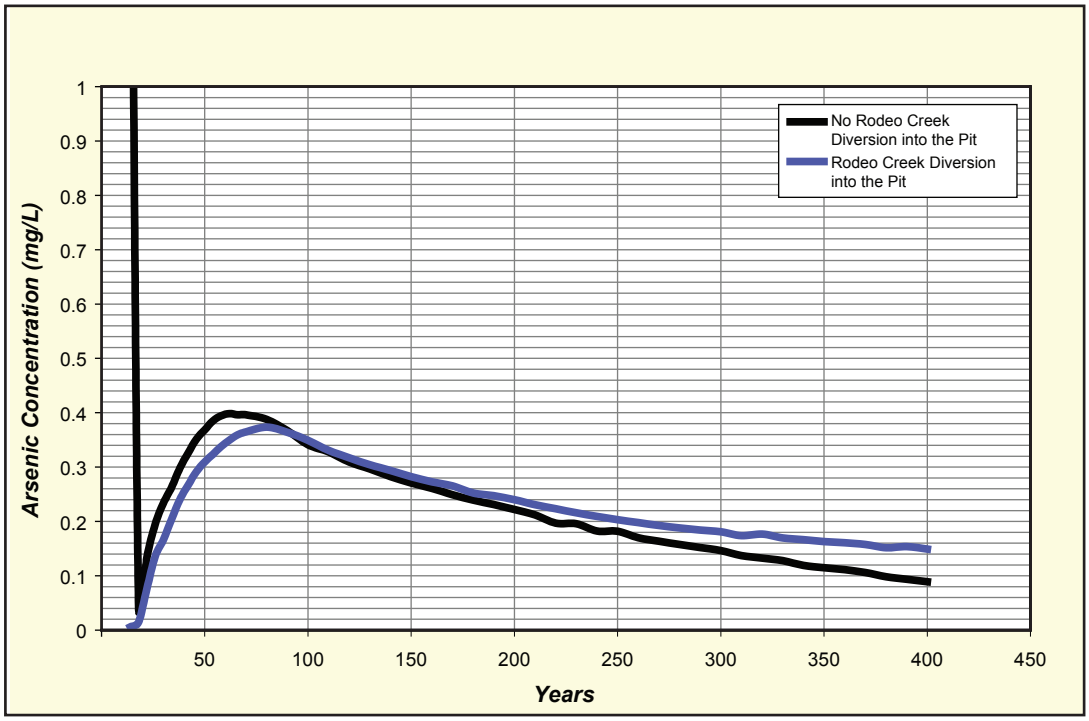



**Figure 3.3-39 Betze Pit Lake Arsenic Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

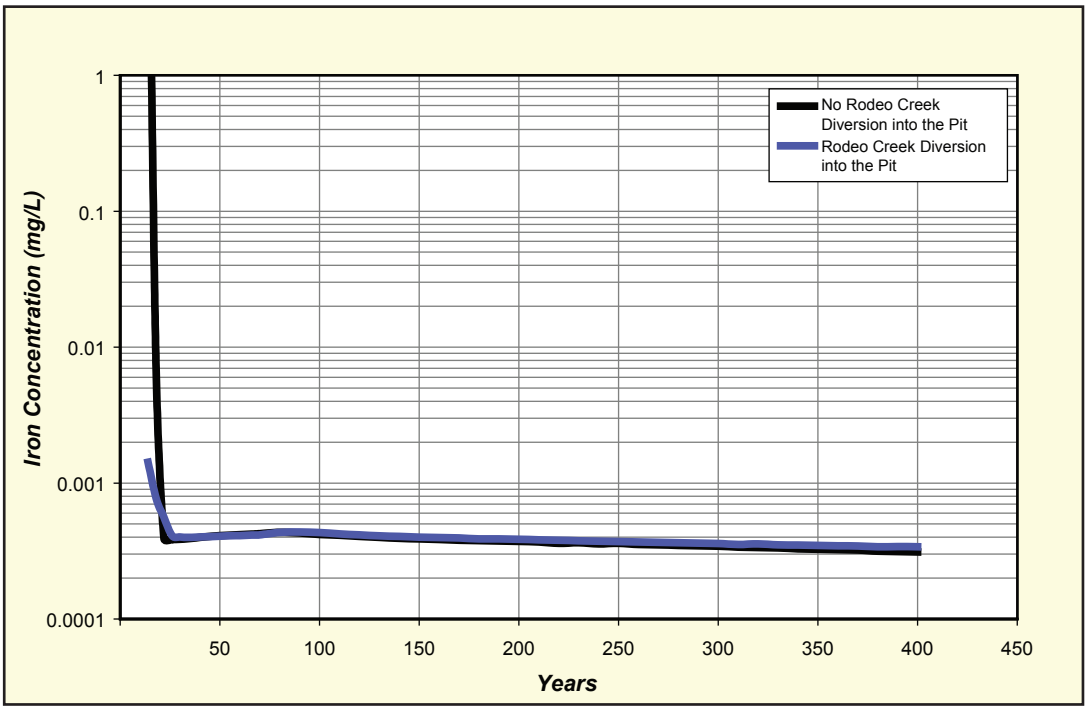



**Figure 3.3-40 Betze Pit Lake Iron Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

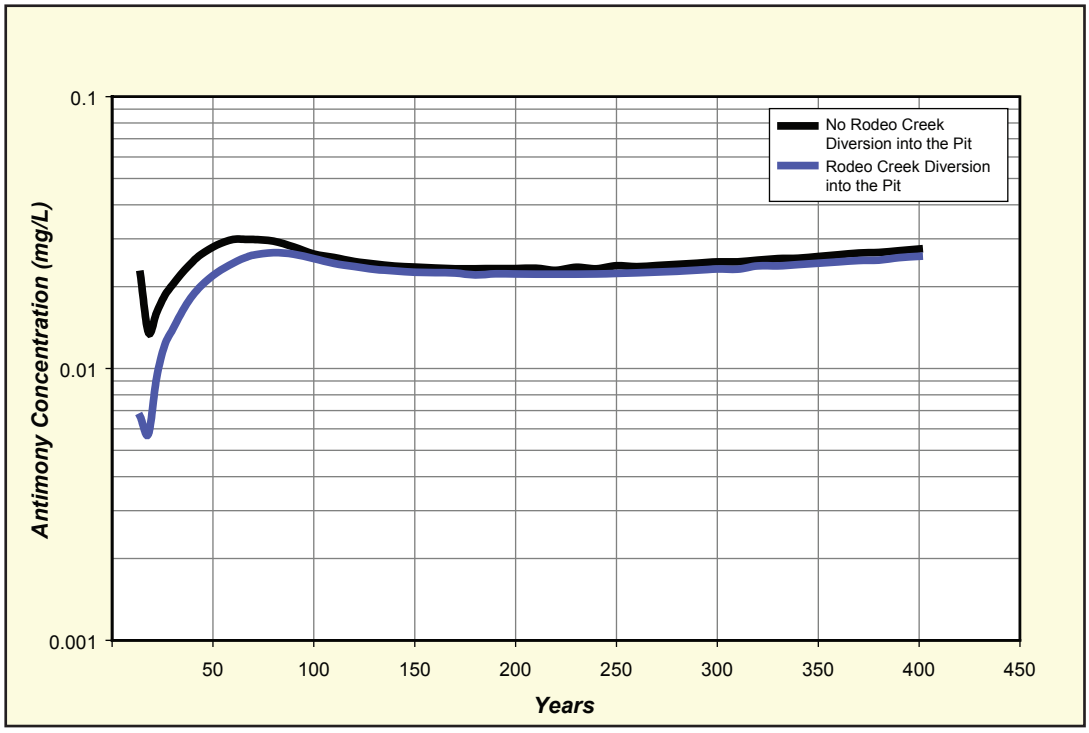



**Figure 3.3-41 Betze Pit Lake Antimony Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

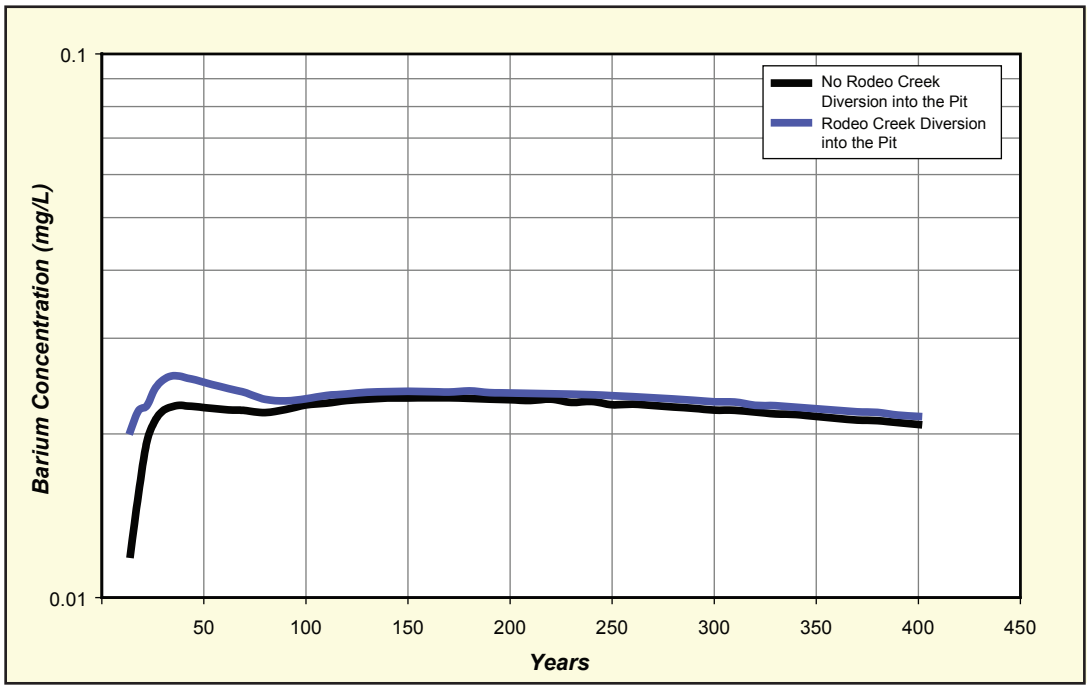



**Figure 3.3-42 Betze Pit Lake Barium Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

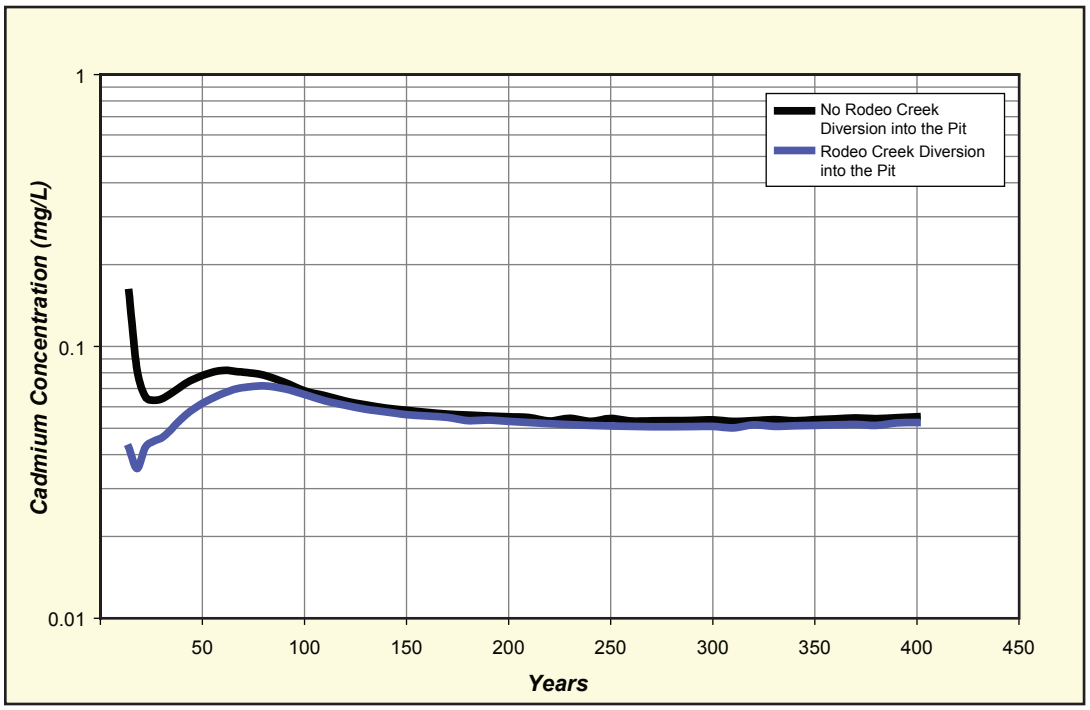



**Figure 3.3-43 Betze Pit Lake Cadmium Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

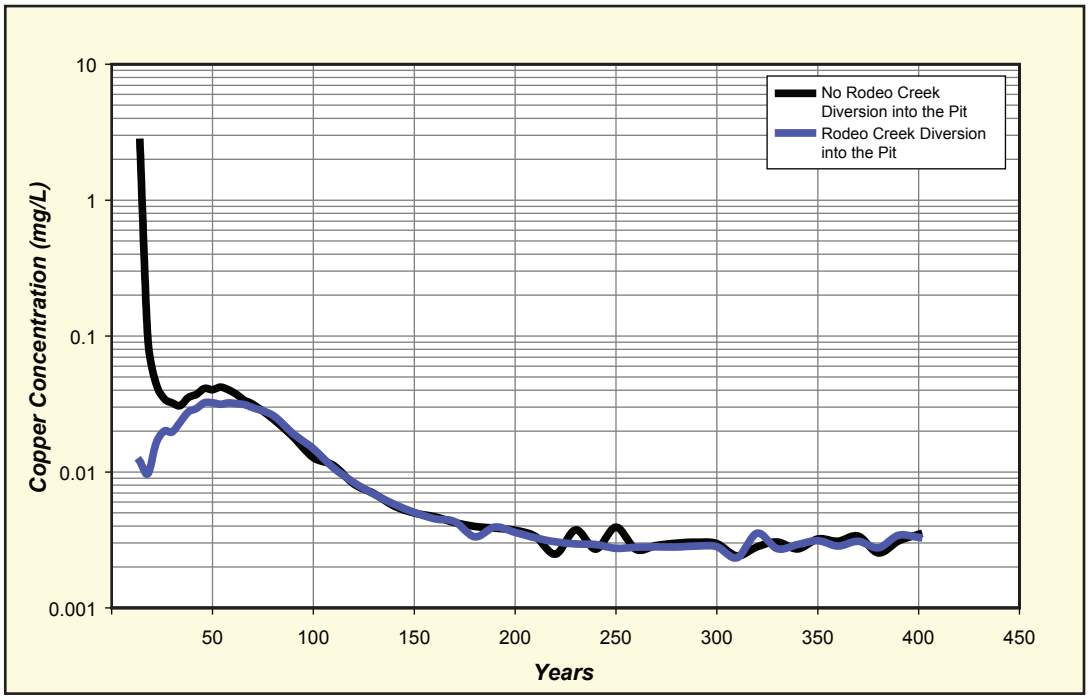



**Figure 3.3-44 Betze Pit Lake Copper Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

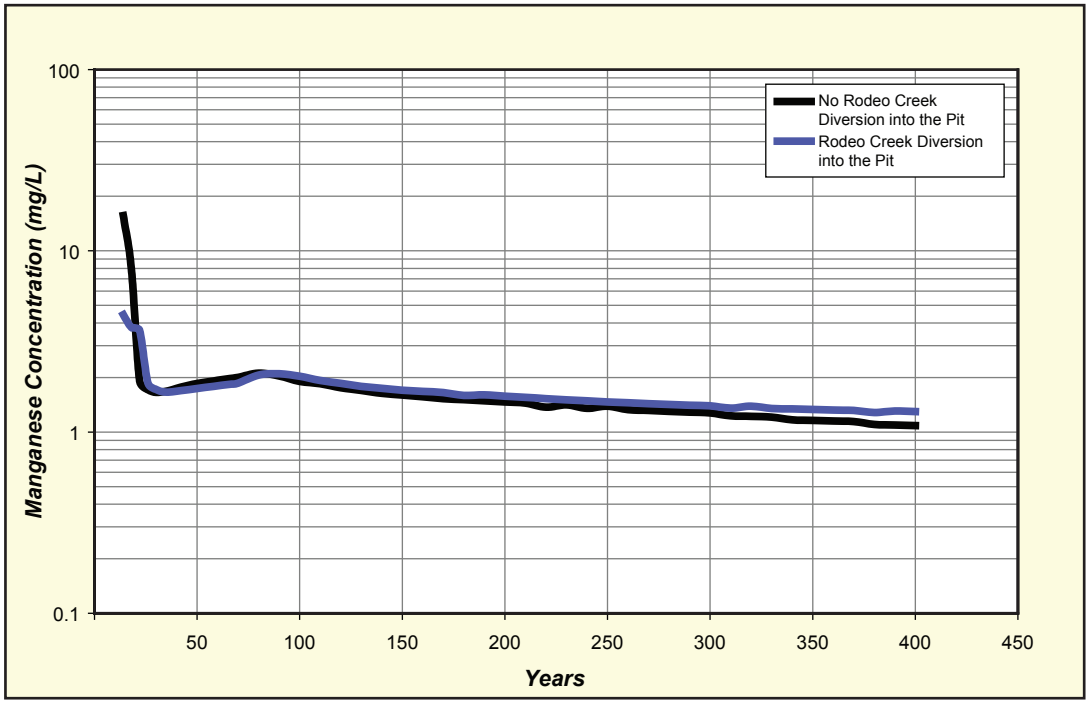



**Figure 3.3-45 Betze Pit Lake Manganese Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

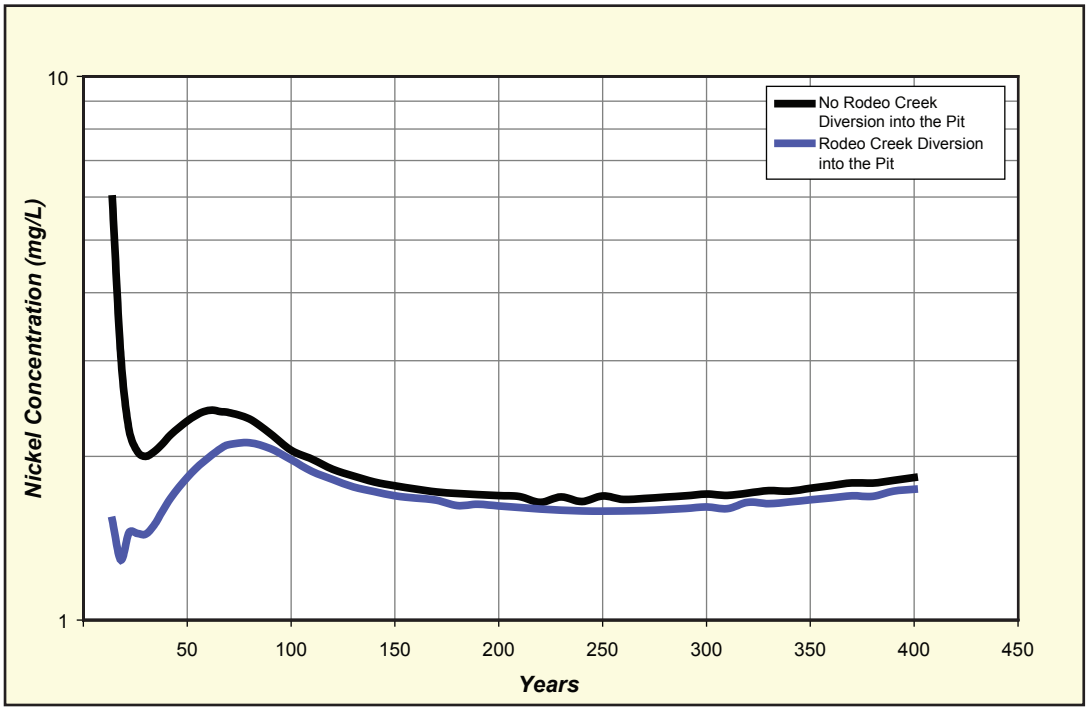



**Figure 3.3-46 Betze Pit Lake Nickel Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

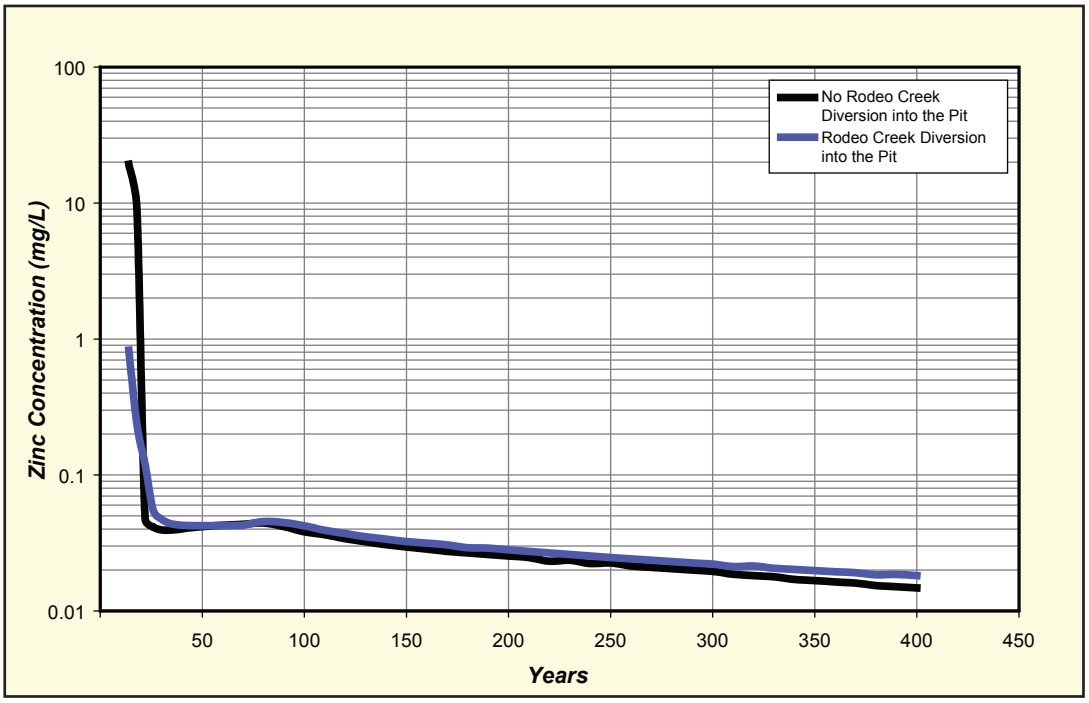



**Figure 3.3-47 Betze Pit Lake Zinc Chemistry, Expanded Pit without Addition of Limestone in the Early Years**

**Table 3.3-9 Predicted Betze Pit Lake Chemistry in Year 50, Expanded Pit**

| Constituent | Expanded Pit without Rodeo Creek Diversion into the Pit | Expanded Pit with Rodeo Creek Diversion into the Pit |
|---|---|---|
| pH (SU) | 7.56 | 7.56 |
| ORP (V) | 0.33 | 0.33 |
| Calcium | 179 | 169 |
| Magnesium | 197 | 174 |
| Sodium | 97 | 91 |
| Potassium | 25 | 21 |
| Sulfate | 1,277 | 1,088 |
| Bicarbonate | 179 | 178 |
| Chloride | 22 | 65 |
| Silica | 42 | 36 |
| Nitrate | 0.5 | 0.5 |
| Boron | 0.9 | 0.7 |
| Fluoride | 2.6 | 2.1 |
| Aluminum | 0.006 | 0.005 |
| Antimony | 0.028 | 0.022 |
| Arsenic[1] | 0.368 | 0.309 |
| Barium | 0.022 | 0.025 |
| Cadmium | 0.078 | 0.062 |
| Chromium[2] | <0.01 | <0.01 |
| Copper | 0.040 | 0.032 |
| Iron | 0.0004 | 0.0004 |
| Lead[2] | <0.002 | <0.002 |
| Manganese | 1.85 | 1.74 |
| Nickel | 2.32 | 1.83 |
| Selenium | 0.008 | 0.008 |
| Silver[2] | <0.004 | <0.004 |
| Thallium | 0.006 | 0.005 |
| Zinc | 0.042 | 0.042 |
| Volume (ML) | 59,572 | 62,336 |
| Stage (m) | 1,401 | 1,404 |

[1] Based on comparison to analogous pit lakes and 2002 batch tests, model overpredicts arsenic levels.

[2] Constituents were below detection level in most source waters.

Notes: Units = mg/L unless otherwise indicated; SU = Standard Units; V = Volts; ML = million liters; M = meters.

Source: Schafer 2007.

**Table 3.3-10 Predicted Betze Pit Lake Chemistry in Year 400, Expanded Pit**

| Constituent | Expanded Pit without Rodeo Creek Diversion into the Pit | Expanded Pit with Rodeo Creek Diversion into the Pit |
|---|---|---|
| pH (SU) | 7.69 | 7.65 |
| ORP (V) | 0.32 | 0.33 |
| Calcium | 104 | 124 |
| Magnesium | 193 | 194 |
| Sodium | 249 | 243 |
| Potassium | 68 | 62 |
| Sulfate | 1,376 | 1,354 |
| Bicarbonate | 237 | 218 |
| Chloride | 42 | 91 |
| Silica | 125 | 112 |
| Nitrate | 2.0 | 1.9 |
| Boron | 3.3 | 3.0 |
| Fluoride | 5.1 | 4.6 |
| Aluminum | 0.007 | 0.006 |
| Antimony | 0.028 | 0.026 |
| Arsenic[1] | 0.089 | 0.149 |
| Barium | 0.021 | 0.022 |
| Cadmium | 0.055 | 0.052 |
| Chromium[2] | <0.00013 | <0.00014 |
| Copper | 0.003 | 0.003 |
| Iron | 0.0003 | 0.0003 |
| Lead[2] | <0.00011 | <0.00012 |
| Manganese | 1.08 | 1.30 |
| Nickel | 1.83 | 1.74 |
| Selenium | 0.008 | 0.008 |
| Silver[2] | <0.009 | <0.009 |
| Thallium | <0.006 | <0.006 |
| Zinc | 0.015 | 0.018 |
| Volume (ML) | 420,170 | 435,330 |
| Stage (m) | 1,554 | 1,558 |

[1] Based on comparison to analogous pit lakes and 2002 batch tests, model overpredicts arsenic levels.

[2] Constituents were below detection level in most source waters.

Notes: Units = mg/L unless otherwise indicated; SU = Standard Units; V = Volts; ML = million liters; M = meters.

Source: Schafer 2007.

Nevada drinking water standards for TDS (1,850 mg/L); sulfate (1,088 mg/L); fluoride (2.1 mg/L); antimony (0.022 mg/L); arsenic (0.309 mg/L); cadmium (0.062 mg/L); manganese (1.74 mg/L); and selenium (1.80 mg/L). The pit lake would exceed Nevada irrigation and stock water standards (**Table B-1**) for arsenic, cadmium, nickel, fluoride, and selenium, and irrigation standards for manganese. Wildlife propagation standards would not be exceeded. At Year 400, the pit lake with the Rodeo Creek Diversion would exceed Nevada drinking water standards for TDS (2,500 mg/L); sulfate (1,354 mg/L); boron (3.0 mg/L); fluoride (4.6 mg/L); antimony (0.026 mg/L); arsenic (0.149 mg/L); cadmium (0.052 mg/L); manganese (1.3 mg/L); and nickel (1.74 mg/L). The pit lake would exceed Nevada irrigation and stock water standards for arsenic, boron (irrigation only), cadmium, manganese (irrigation only), nickel (irrigation only), and fluoride. The water would not exceed wildlife propagation standards. An ecological risk assessment summary on the pit lake water is presented in Section 3.8, Wildlife Resources.

*Water Quality without Rodeo Creek Diversion*

**Figures 3.3-29** to **3.3-47** show changes in pit lake water quality for the Betze pit lake without diversion of Rodeo Creek into the pit. **Table 3.3-9** shows the expected composition of the pit lake at 50 years for the Proposed Action without the diversion of Rodeo Creek. Sulfate in the pit lake would be around 1,277 mg/L; antimony would be at 0.028 mg/L; fluoride would be 2.6 mg/L; arsenic would be at 0.368 mg/L; cadmium 0.078 mg/L; copper at 0.04 mg/L; and nickel at 2.32 mg/L. The pit lake would exceed current Nevada drinking water standards for TDS, sulfate, antimony, arsenic, nickel, and cadmium. The pit lake would exceed irrigation standards for arsenic, boron, cadmium, manganese, nickel, and fluoride. The pit lake would exceed stock water standards for arsenic, cadmium, and fluoride. The pit lake would not exceed wildlife propagation standards. **Table 3.3-10** gives the composition of the pit lake under the Proposed Action without the Rodeo Creek Diversion at 400 years. In this case, the pit lake would exceed current Nevada drinking water standards for TDS (2,500 mg/L); antimony (0.028 mg/L); arsenic (0.089 mg/L); cadmium (0.055 mg/L); nickel (1.83 mg/L); fluoride (5.1 mg/L); and sulfate (1,376 mg/L). The pit lake also would exceed irrigation standards for arsenic, boron, cadmium, manganese, nickel, and fluoride. Stock water standards would be exceeded for arsenic, cadmium, and fluoride. Wildlife propagation standards would not be exceeded. Without the Rodeo Creek Diversion, the pit lake would be acidic and metal-laden during the first 20 years of pit lake formation. Once groundwater enters the pit after Year 20, the pit lake would gradually reflect the dominance of the groundwater chemistry and by Year 50 the pit lake would be comparable to the pit lake under the Proposed Action with the Rodeo Creek Diversion.

The pit lake modeling conducted by BGMI (Schafer 2007) evaluated empirical test results on mine water from Goldstrike and concluded that the geochemical modeling may over-predict the concentrations of some elements in the future pit lake. The constituents that may be over-predicted were arsenic, antimony, and cadmium (Schafer 2007). Predicting the future water quality of a pit lake requires assumptions about reaction mechanisms between solids and water flowing into a pit through the pit walls, the pit floor, or down the pit walls as pit wall runoff. The pit lake modeling completed for BGMI by Schafer (2007) made every effort to calibrate the geochemical model to the results of laboratory column tests and batch mixing tests. The conclusion in the pit lake report of Schafer (2007) that some constituents may be over-predicted is reasonable. Thus, concentrations given for arsenic, antimony, and cadmium in the text and tables of this report should be considered as very conservative estimates.

To offset the expected acidity of the pit lake water during the first 14 years of pit lake formation under the Proposed Action without the diversion of Rodeo Creek, BGMI proposes to add approximately 100 tons of crushed limestone to the pit. This would neutralize the acidity, and the initial pit lake water quality would have a pH around 7.0 to 7.5 standard units and stay in that range for the remainder of the future of the pit lake (Schafer 2007). Sulfate, however, would follow a pattern similar to the Proposed Action without the diversion of Rodeo Creek and start around 9,000 mg/L. **Table 3.3-11** shows the expected pit lake water quality from Year 5 to Year 13 for the pit lake without the diversion of Rodeo Creek and without the addition of limestone. **Table 3.3-12** shows the benefit of adding limestone.

**Table 3.3-11 Predicted Betze Pit Lake Chemistry During Early Stage Filling (Years 5 to 13) without Limestone Addition**

| Constituent | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| pH (SU) | 3.39 | 3.56 | 3.66 | 3.88 | 4.37 | 4.86 | 7.01 | 7.41 | 7.57 |
| ORP (V) | 0.46 | 0.43 | 0.42 | 0.40 | 0.38 | 0.38 | 0.23 | 0.25 | 0.25 |
| Calcium | 385 | 184 | 137 | 82 | 98 | 99 | 100 | 101 | 102 |
| Magnesium | 2,052 | 982 | 730 | 436 | 436 | 373 | 319 | 277 | 245 |
| Sodium | 37 | 18 | 13 | 8 | 19 | 28 | 36 | 42 | 47 |
| Potassium | 3.9 | 0.7 | 0.3 | 0.03 | 0.0002 | 0.001 | 4.9 | 8.1 | 10.3 |
| Sulfate | 10,075 | 4,815 | 3,579 | 2,138 | 2,129 | 1,801 | 1,551 | 1,349 | 1,197 |
| Bicarbonate | 5.6 | 4.9 | 4.7 | 4.7 | 5.0 | 5.8 | 38.0 | 101.4 | 148.3 |
| Chloride | 20.1 | 9.7 | 7.2 | 4.4 | 6.7 | 8.2 | 9.2 | 10.1 | 10.8 |
| Silica | 39.2 | 18.8 | 14.0 | 8.3 | 13.6 | 17.9 | 19.0 | 21.8 | 24.1 |
| Nitrate | 0.8 | 1.7 | 2.0 | 2.4 | 2.2 | 1.9 | 1.7 | 1.6 | 1.4 |
| Boron | 0.12 | 0.06 | 0.04 | 0.03 | 0.13 | 0.23 | 0.32 | 0.38 | 0.44 |
| Fluoride | 16.57 | 7.93 | 5.89 | 3.52 | 3.67 | 3.33 | 3.03 | 2.78 | 2.60 |
| Aluminum | 108.4 | 49.4 | 36.2 | 21.4 | 15.2 | 3.6 | 0.0 | 0.0 | 0.0 |
| Antimony | 0.038 | 0.018 | 0.013 | 0.008 | 0.009 | 0.008 | 0.007 | 0.006 | 0.006 |
| Arsenic | 3.043 | 1.456 | 1.083 | 0.647 | 0.465 | 0.235 | 0.018 | 0.002 | 0.001 |
| Barium | 0.022 | 0.019 | 0.014 | 0.008 | 0.028 | 0.041 | 0.051 | 0.040 | 0.039 |
| Cadmium | 0.270 | 0.129 | 0.096 | 0.057 | 0.057 | 0.048 | 0.041 | 0.034 | 0.030 |
| Chromium | 0.215 | 0.103 | 0.077 | 0.046 | 0.025 | 0.002 | 0.0003 | 0.0001 | 0.0001 |
| Copper | 4.561 | 2.182 | 1.623 | 0.971 | 0.966 | 0.802 | 0.097 | 0.024 | 0.019 |
| Iron | 152.2 | 72.8 | 54.2 | 32.4 | 20.7 | 1.7 | 0.0002 | 0.0001 | 0.0001 |
| Lead | 0.005 | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.0001 | 0.00003 | 0.00003 |
| Manganese | 27.0 | 12.9 | 9.6 | 5.7 | 5.7 | 4.9 | 4.2 | 3.3 | 1.5 |
| Nickel | 10.2 | 4.9 | 3.6 | 2.2 | 2.2 | 1.9 | 1.6 | 1.3 | 1.1 |
| Selenium | 0.324 | 0.155 | 0.115 | 0.069 | 0.067 | 0.053 | 0.040 | 0.028 | 0.021 |
| Silver | 0.008 | 0.004 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| Thallium | 0.006 | 0.003 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Zinc | 33.1 | 15.8 | 11.8 | 7.0 | 7.0 | 5.9 | 0.45 | 0.078 | 0.037 |
| Volume (Millions of liters) | 0.9 | 2.4 | 28 | 131 | 317 | 565 | 865 | 1,227 | 1,635 |
| Stage (m) | 1,247 | 1,248 | 1,253 | 1,258 | 1,265 | 1,271 | 1,277 | 1,282 | 1,288 |

Notes: SU = Standard Units; V = Volts; m = meters; All metals in mg/L.

Source: Schafer 2007.

**Table 3.3-12 Predicted Betze Pit Lake Chemistry During Early Stage Filling (Years 5 to 13) with Limestone Addition**

| Constituent | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| pH (SU) | 7.46 | 7.40 | 7.43 | 7.19 | 7.37 | 7.30 | 7.49 | 7.59 | 7.61 |
| ORP (V) | 0.22 | 0.20 | 0.19 | 0.21 | 0.20 | 0.23 | 0.20 | 0.24 | 0.25 |
| Calcium | 458 | 419 | 321 | 186 | 190 | 152 | 134 | 125 | 111 |
| Magnesium | 2,049 | 980 | 729 | 436 | 435 | 372 | 319 | 277 | 245 |
| Sodium | 37 | 18 | 13 | 8 | 19 | 28 | 36 | 42 | 47 |
| Potassium | 14.1 | 6.8 | 5.0 | 3.02 | 5.8716 | 8.478 | 10.4 | 12.0 | 13.3 |
| Sulfate | 9,165 | 4,837 | 3,601 | 2,152 | 2,158 | 1,845 | 1,580 | 1,369 | 1,213 |
| Bicarbonate | 130.6 | 99.6 | 100.3 | 55.7 | 83.9 | 75.6 | 105.7 | 148.5 | 161.1 |
| Chloride | 20.1 | 9.7 | 7.2 | 4.4 | 6.7 | 8.2 | 9.2 | 10.1 | 10.8 |
| Silica | 24.1 | 11.6 | 8.6 | 5.3 | 10.5 | 15.3 | 18.8 | 21.8 | 24.1 |
| Nitrate | 0.8 | 1.7 | 2.0 | 2.4 | 2.2 | 1.9 | 1.7 | 1.6 | 1.4 |
| Boron | 0.12 | 0.06 | 0.04 | 0.03 | 0.13 | 0.23 | 0.32 | 0.38 | 0.44 |
| Fluoride | 10.12 | 7.31 | 5.89 | 3.52 | 3.67 | 3.33 | 3.03 | 2.78 | 2.60 |
| Aluminum | 0.013 | 0.016 | 0.019 | 0.011 | 0.014 | 0.008 | 0.017 | 0.011 | 0.009 |
| Antimony | 0.038 | 0.018 | 0.013 | 0.008 | 0.009 | 0.008 | 0.007 | 0.006 | 0.006 |
| Arsenic | 0.005 | 0.002 | 0.002 | 0.002 | 0.001 | 0.002 | 0.001 | 0.001 | 0.001 |
| Barium | 0.022 | 0.019 | 0.014 | 0.008 | 0.028 | 0.042 | 0.052 | 0.040 | 0.039 |
| Cadmium | 0.254 | 0.120 | 0.089 | 0.054 | 0.053 | 0.045 | 0.038 | 0.033 | 0.029 |
| Chromium | 0.0004 | 0.0002 | 0.0002 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Copper | 0.048 | 0.029 | 0.026 | 0.015 | 0.018 | 0.014 | 0.018 | 0.020 | 0.020 |
| Iron | 0.0001 | 0.001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Lead | 0.00003 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00001 | 0.00002 | 0.00003 | 0.00003 |
| Manganese | 8.5 | 6.6 | 4.8 | 5.0 | 4.8 | 4.4 | 2.4 | 1.5 | 1.3 |
| Nickel | 8.2 | 4.0 | 3.0 | 1.9 | 1.9 | 1.6 | 1.4 | 1.2 | 1.0 |
| Selenium | 0.061 | 0.035 | 0.027 | 0.022 | 0.020 | 0.018 | 0.015 | 0.013 | 0.012 |
| Silver | 0.008 | 0.004 | 0.003 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 | 0.002 |
| Thallium | 0.006 | 0.003 | 0.002 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Zinc | 0.2 | 0.2 | 0.1 | 0.4 | 0.1 | 0.2 | 0.05 | 0.037 | 0.032 |
| Volume (Millions of liters) | 0.9 | 2.4 | 28 | 131 | 317 | 565 | 865 | 1,227 | 1,635 |
| Stage (m) | 1,247 | 1,248 | 1,253 | 1,258 | 1,265 | 1,271 | 1,277 | 1,282 | 1,288 |

Notes: SU = Standard Units; V = Volts; M = meters; All metals in mg/L.

Source: Schafer 2007.

Without the addition of limestone, the pit lake at Year 5 would exceed current Nevada drinking water standards for pH, TDS, sulfate, fluoride, antimony, arsenic, cadmium, and other metals. For irrigation standards, the pit lake water would exceed arsenic, cadmium chromium copper, iron, manganese, nickel, selenium, zinc, and fluoride standards at Year 5. For stock water, only arsenic, cadmium, chromium, copper, selenium, zinc, and fluoride standards would be exceeded. Wildlife propagation standards would not be exceeded. As previously indicated, pit lake water is not intended for drinking water or agricultural water uses, nor has it been designated for such use by NDEP. By Year 13, the pit lake would approach the composition of pit lake water with the addition of limestone under the Proposed Action without the diversion of Rodeo Creek.

With the addition of limestone, only antimony, cadmium, nickel, selenium, sulfate, TDS, and fluoride standards would be exceeded at Year 5 for current Nevada drinking water standards. Irrigation standards for cadmium, manganese, nickel, selenium, and fluoride would be exceeded at Year 5. For stock water, only cadmium, selenium, and fluoride standards would be exceeded at Year 5 with the addition of limestone. The wildlife propagation standards would not be exceeded. By Year 13, the pit lake would exceed current Nevada drinking water standards for TDS, sulfate, fluoride (secondary standard), arsenic, cadmium, manganese (secondary standard), and nickel. The pit lake would exceed irrigation water standards for fluoride, arsenic, manganese, and nickel. The stock water standards would be exceeded for only fluoride and arsenic. Wildlife propagation standards would not be exceeded.

The addition of limestone to the pit under the Proposed Action in the event the diversion of Rodeo Creek is not permitted by the Nevada State Engineer or the NDEP would prevent the formation of an acid pit lake during the first 14 years of pit lake history. After Year 14, groundwater would enter the pit and control the pit lake chemistry. Sulfate would not be affected by the addition of limestone, but most other constituents of concern would be lowered in concentration in the initial pit lake (**Tables 3.3-11** and **3.3-12**). The pit lake would, however, still exceed irrigation and stock water standards for many key constituents. Section 3.8, Wildlife Resources, discusses the environmental risks posed by the pit lake for wildlife and stock use of the water.

At full recovery, which would be approximately 400 years after cessation of pumping at the Goldstrike Mine, the drawdown created by evaporation from the Betze Pit lake under the Proposed Action would be somewhat different than under the No Action Alternative. Under the Proposed Action with the expanded Betze Pit, the pit lake would be about 15 percent larger in surface area than under the No Action Alternative. This would result in a maximum 10-foot drawdown pattern at recovery as shown in **Figure B-3**. Compared to the No Action Alternative, the expanded pit under the Proposed Action would create a 10-foot maximum drawdown at recovery that would extend farther to the northwest and somewhat farther to the southeast. The 10-foot drawdown would extend less to the southwest along Antelope Creek. Part of this change in configuration of the 10-foot maximum drawdown at recovery is due to the expanded area of the pit lake, and part is due to recalibration of the groundwater model from 2000 to 2007.

Clydesdale Waste Rock Facility

According to the BGMI 2007 block model for the Betze Pit, PAG rocks would account for about 19 percent of the rocks mined in the proposed laybacks (Schafer 2008a). In the proposed Clydesdale Waste Rock Facility, PAG rocks would comprise about 7 percent of the total waste rock and would be encapsulated in the waste rock facility, as discussed in Chapter 2.0. This would prevent oxidation or leaching of the PAG material and prevent the generation of an acidic effluent from the proposed waste rock facility. The expected pore water volume in the proposed Clydesdale Waste Rock Facility would be around 2 to 3 percent (Schafer 2008a) and would remain below the amount needed to initiate seepage from the facility. In addition, the PAG cells in the proposed Clydesdale Waste Rock Facility would have a cover of 24 inches of topsoil and 48 inches of Carlin material, with a 50-foot setback from the base of the facility. Groundwater beneath the facility would be approximately 150 feet below ground surface after recovery of the groundwater table following cessation of mining. This design should prevent seepage from the facility under all expected precipitation scenarios for the life of the facility. No impacts to groundwater are expected from the proposed facility. Should seepage occur

from the Clydesdale Waste Rock Facility under prolonged adverse weather conditions, the water quality in the seepage is expected to be elevated in sulfate, fluoride, arsenic, cadmium, nickel, and manganese (Schafer 2008b).

The quality of the water that may seep from the proposed Clydesdale Waste Rock Facility under conditions of extreme precipitation would depend on the path of the infiltrating water through the waste rock and the chemical reactions that may ensue. If calcite is involved in the reactions between infiltrating water and waste rock, any fluid that may emanate from the base of the Clydesdale Waste Rock Facility would have a neutral pH; sulfate in the range of 2,600 mg/L; fluoride around 2 to 3 mg/L; manganese around 5 mg/L; nickel around 6 mg/L; and elevated arsenic (1.15 mg/L); cadmium (0.2 mg/L); copper (0.3 mg/L); and antimony (0.074 mg/L). It is unlikely that seepage would ever emanate from the proposed Clydesdale Waste Rock Facility because of the design of the infiltration barrier in the cover.

Goldstrike No. 3 Tailings Facility

The proposed Goldstrike No. 3 Tailings Facility is designed to be a zero-discharge facility, thus eliminating the potential for seepage of effluent that may be acidic or elevated in metals. The facility would contain approximately 115.4 million tons of tailings and have a composite liner along with a drain beneath the tailings liner to capture any seepage and an underdrain beneath the facility to allow for passage of stream waters. Thus, no impacts to groundwater are expected from this proposed facility.

The proposed Goldstrike No. 3 Tailings Facility would have thickened tailings with about 50 to 60 percent solids and an internal drain system above the double liner to allow for removal of water to reduce the hydraulic head on the liner. At closure, the tailings would be reclaimed with an infiltration cover to prevent entry of precipitation and would be drained to remove the readily drainable water using the drains installed above the double liner. Draindown time is estimated to take about 50 years for the draindown rate to decline to a steady value around 9 gpm (see **Figure 2-20**). During the first 10 years of draindown, the tailings would drain at a rapidly declining rate between about 100 to 200 gpm initially and 50 gpm at 10 years. Then the draindown rate would decline slowly to reach the rate of about 9 gpm at 50 years after closure (see **Figure 2-20**). The water quality in the draindown fluid is expected to be similar to that of the AA Tailings and the North Block Tailings and consist of sulfate, sodium, bicarbonate, calcium, and various metals. The water would be sodium sulfate dominated water with a TDS around 3,000 to 5,000 mg/L and may be elevated in arsenic, fluoride, boron, copper, iron, and molybdenum (Schafer 2008b). This water would be managed with evaporation ponds to capture the draindown water and to prevent interaction with surface water or groundwater.

If the proposed Goldstrike No. 3 Tailings Facility were to leak water to the surface due to some unforeseen failure of either the underdrain seepage capture system or the tailings dam, the expected water quality would be similar to what is observed for the North Block Tailings and the AA Tailings draindown waters (Schafer 2008b). These waters have a pH around 7 to 8 standard units; TDS in the range of 3,000 to 5,000 mg/L; sulfate in the range of 2,000 to 3,300 mg/L; and sodium in the range of 360 to 740 mg/L; making the waters sodium sulfate dominated. Elevated metals include arsenic (0.05 to 1.2 mg/L), boron (0.08 to 0.4 mg/L), antimony (up to 0.01 mg/L), iron (1.5 to 2.5 mg/L), copper (0.1 to 0.3 mg/L), manganese (1.7 to 7.3 mg/L), thiocyanate (up to 27 mg/L), and molybdenum (0.4 to 2.1 mg/L).

#### 3.3.2.3 Bazza Waste Rock Facility Alternative

Under this alternative, groundwater resource impacts would be the same as described for the Proposed Action. PAG and non-PAG waste rock would be encapsulated in the existing Bazza Waste Rock Facility according to the approved Bazza Waste Rock Management Plan. No impacts to groundwater are expected from continued use of the Bazza Waste Rock Facility.

### 3.3.3 Cumulative Groundwater Effects

#### 3.3.3.1 No Action Alternative

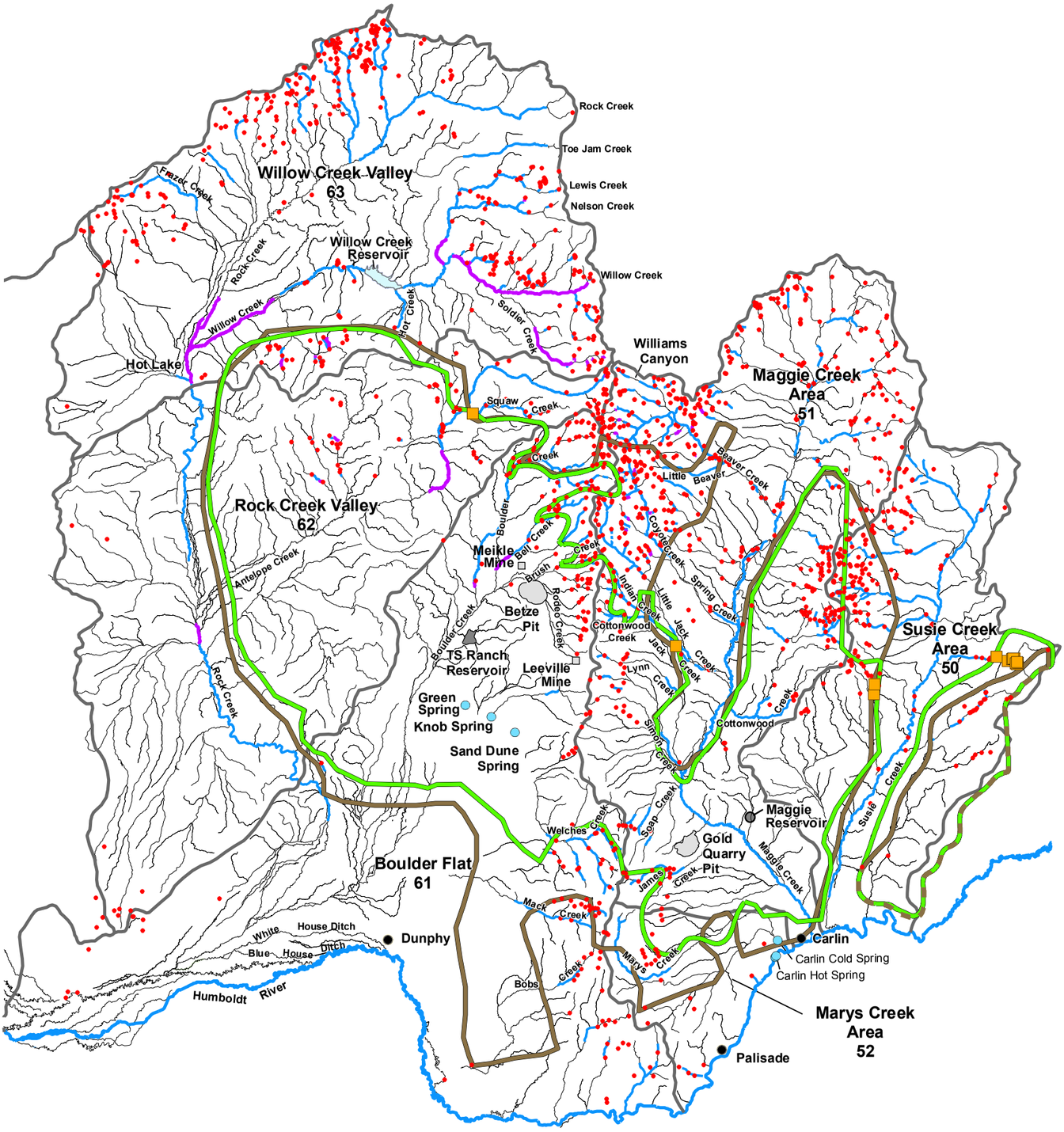
The CESA for groundwater resources encompasses six hydrographic basins along the Carlin Trend that lie north of the Humboldt River, as shown in **Figure 3.3-1**. These basins include Susie Creek (Hydrographic Basin 50), Maggie Creek (Hydrographic Basin 51), Marys Creek (Hydrographic Basin 52), Boulder Flat (Hydrographic Basin 61), Rock Creek (Hydrographic Basin 62), and Willow Creek (Hydrographic Basin 63).

The CESA for groundwater is the same as the area evaluated in the BLM's April 2000 CIA report (BLM 2000b). For that assessment, mine discharges were evaluated from the SOAPA, Betze/Post, Leeville, and Lone Tree mines. The Lone Tree Mine ceased dewatering activities in 2006. This cumulative effects analysis will consider only the Betze/Post, Leeville, and SOAPA dewatering and water management activities and will tier off the BLM (2000b) CIA report. The past and present actions and RFFAs in this area are identified in Section 3.1.

**Figure 3.3-48** compares the estimated maximum projected extent of the cumulative 10-foot drawdown from the 2000 SEIS (BLM 2000a, 2003a) and the current 2007 estimate of this same cumulative 10-foot drawdown using the current versions of the BGMI and Newmont groundwater models. Compared to the 2000 EIS maximum cumulative 10-foot drawdown, the 2007 drawdown is somewhat less in the southern Tuscarora Mountains and somewhat greater in the Susie Creek area (**Figure 3.3-48**). The figure shows that there are no new cumulative impacts that were not already considered in the 2003 SEIS for the Betze Project (BLM 2003a) with the following exception. Using the 2007 models, there are 14 springs that fall outside the original 2000 SEIS estimate of the maximum predicted cumulative 10-foot drawdown in the uppermost aquifer but fall within the 2007 estimate of this same maximum cumulative 10-foot drawdown in the uppermost aquifer. These 14 springs are shown on **Figure 3.3-48**. Two of these springs are within the predicted maximum 10-foot drawdown due to pumping from the Betze Pit. The others are in the Susie Creek area and are related to pumping at Gold Quarry. The two springs that fall within the predicted maximum cumulative 10-foot drawdown contour that may be related to pumping at Betze fall only slightly outside the original 2000 maximum cumulative 10-foot drawdown contour. One spring is in Jack Creek and is located above an elevation of 6,000 feet amsl, suggesting it may not be affected by groundwater pumping. The other spring is in Squaw Creek and is located very close to the original 2000 SEIS maximum cumulative 10-foot contour. Potential impacts to these two springs would be of unknown extent but would be of relatively short-term duration because the springs are at the maximum extent of the 10-foot drawdown contour. The Betze Project Final SEIS (BLM 2003a) has a contingency fund for unexpected impacts, and these two springs would be covered by that special fund (see Section 3.3.4.2, Mitigation Measures).

Impacts to groundwater quality are not expected from cumulative drawdown throughout the CESA. Bedrock water quality is elevated above Nevada drinking water standards for arsenic (BLM 2000a) in some areas due to naturally elevated arsenic in the bedrock. Water quality in bedrock is relatively similar throughout each hydrographic basin in the CESA, so that temporary changes in groundwater flow paths due to cumulative mine-induced drawdown are not expected to result in measurable changes in water quality.

Runoff and drainage from waste rock storage facilities, leach pads, tailings impoundments and other mine-related facilities could potentially impact water quality. To date, with the exception of the Hollister Development Block Project in the Antelope Creek drainage, there has been no indication of ARD or elevated metals in groundwater related to mining in the CESA (BLM 2007b). The South overburden stockpile at Hollister has generated acidic drainage in the past, but the conditions that caused the acidic drainage have been corrected (BLM 2007b). ARD has occurred at refractory ore piles at Newmont's South Operations Area; this drainage is captured and used in ore processing. These stockpiles will be removed prior to project closure and, therefore, would not present a long-term concern for water quality. Impacts to surface water quality and possibly groundwater quality also can be related to non-mining processes such as wildfires, flooding, and erosion.




**LEGEND**

- Maximum Extent of Cumulative 10-foot Drawdown Contour (2007 Model)
- Maximum Extent of Cumulative 10-foot Drawdown Contour (2000 Model)
- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinous Flowing Stream Reach
- Seeps and Springs
- Seeps and Springs that are within the 2007 Cumulative Drawdown Contour but not within the 2000 Cumulative Drawdown Contour

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: BLM 2000b; BGMI 2007a.

N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.3-48

Potentially Impacted Springs within the Cumulative Drawdown Area



07/22/2008

In 1994, a small seep was discovered west of the active mining area near Goldstrike. This seep had a low pH, and a collection pond was constructed to capture the seep water and transfer the water to the Goldstrike processing facility. The seep was the result of a pipeline leak, and the problem was repaired. The pipeline was in an area where the original ground surface contacted historical waste rock from previous operations. This waste rock was excavated during subsequent laybacks of the Betze Pit. In 2006, a seep was detected downgradient of the Goldbug Refractory Ore Stockpile. The stockpile was excavated, and a flaw was discovered in the soil liner due to settling of the foundation material below. The source of the low pH seep was removed and disposed of in a contained process facility. In 2007, a seep was detected on the BLLS-50 Stockpile. The stockpile was excavated, and all ore and impacted subsurface material were removed to a contained facility (BGMI 2008a). There was no impact from these events and no expectation that future activities will affect groundwater quality.

At the end of mining in the CESA, there would be pit lakes. The Betze Pit lake was discussed earlier in detail and is not expected to result in a long-term impact to water quality. This pit lake would be a terminal pit lake with elevated sulfate and TDS. Similarly, the Tara Pit north of Goldstrike would be a terminal pit lake and would have a near-neutral pH with an arsenic concentration below influent groundwater quality and an antimony concentration within Nevada drinking water standards (BLM 2007b). Water in these pit lakes would not be used for human consumption or recreation. The Gold Quarry Pit lake would be a flow-through pit lake starting at 70 percent recovery. Pit lake outflow would reach a maximum of about 1,440 gpm at 100 percent recovery. Pit outflow would be to the southeast following the groundwater gradients in the area of the pit and the water quality of the pit outflow would be similar to or better than background water quality (Geomega 2001).

**Figure 3.3-48** shows the cumulative drawdown area based on the BGMI modeling, which includes Newmont dewatering as well as the BGMI mine dewatering operations. Newmont also has modeled a cumulative drawdown area based on combined BGMI and Newmont mine dewatering operations. Their modeled area of drawdown is presented in Figure 3.2 of the Leeville and SOAPA Draft Supplemental Environmental Impact Statements (BLM 2007b,c). As expected, there are differences between the models. However, the Newmont-calculated cumulative drawdown area is entirely within the BGMI-calculated drawdown area. Thus, potential impacts represented in the cumulative drawdown area are addressed within the more conservative BGMI model.

#### 3.3.3.2 Proposed Action

Cumulative effects under the Proposed Action would be similar to the No Action Alternative in terms of groundwater quantity and quality. Under the Proposed Action, the Betze Pit lake would have a slightly altered chemistry due to the quantity of waste rock placed in the pit.

#### 3.3.3.3 Bazza Waste Rock Facility

Cumulative effects under this alternative would be similar to the Proposed Action.

### 3.3.4 Mitigation Measures and Monitoring

#### 3.3.4.1 Existing Monitoring Plans and Programs

The following ongoing water monitoring programs or plans are designed to monitor surface and groundwater activities and potential impacts in the CESA:

1. Boulder Valley Monitoring Plan (BVMP): Since 1990, BGMI has conducted monthly monitoring and semi-annual reporting of surface water and groundwater resources in Boulder Valley and the Boulder Flat Hydrographic Basin related to mine dewatering and water management activities. Surface monitoring stations are located on Bell, Brush, Rodeo, and Rock creeks. Groundwater wells and

springs are monitored for water levels, flow rates in springs, and water quality. Surface water sites are monitored for water flow rates and water quality.

2. Seep and Spring Survey by BGMI: BGMI conducts annual seep and spring monitoring for water quality, flow rates, and vegetation at up to 36 sites in the Tuscarora Mountains.

3. Maggie Creek Basin Monitoring Plan (MCBMP): Newmont began this program of monthly monitoring and semi-annual reporting of surface water and groundwater in the Maggie Creek Basin in 1989. The MCBMP monitors surface water flow, depth to groundwater in wells, surface water quality, groundwater quality, and both spring flow and water quality in the Maggie Creek, Marys Creek, Susie Creek, and the southeast portion of Boulder Flat hydrographic basins. This monitoring plan is designed to monitor potential impacts from mine dewatering and water management activities at Newmont's Gold Quarry and Leeville mines.

4. Leeville Hydrologic Monitoring Plan: Newmont began reporting the results of ongoing monitoring of water resources in the vicinity of the Leeville Mine in 2003. Results of this monitoring plan are included in the MCBMP monitoring reports.

5. Seep and Spring Survey by Newmont: Since 1990, Newmont has been monitoring seeps and springs in the four hydrograhic basins near Gold Quarry that are part of the MCBMP. A total of 33 springs are monitored annually in the fall. Monitoring consists of measuring flow rates, water quality, and general site conditions.

6. The BLM Elko District Office has conducted lentic (springs, seeps, and ponds) and lotic (streams) assessments at selected grazing allotments in the Carlin Trend and surrounding areas. These assessments address the effects of livestock grazing on springs, seeps, ponds, and streams.

All water resources monitoring data and reports are made available on a semi-annual basis by BGMI and Newmont to the BLM, NDEP, and NDWR. These monitoring plans and programs would remain in effect until modified or cancelled by regulatory agencies and would provide the basis for assessing potential impacts to water resources. A pit lake monitoring plan will be prescribed in the final permanent closure plan and closure permit. This will be submitted to NDEP 2 years preceding cessation of mining operations. No additional monitoring is recommended beyond the current committed monitoring.

#### 3.3.4.2 Mitigation Measures

No additional mitigation is recommended beyond the current committed mitigation measures for all water resources that fall within the original 2000 EIS (BLM 2000a, 2003a) maximum predicted cumulative 10-foot drawdown in the uppermost aquifer (**Figures 3.3-27** and **3.3-48**). For those few springs that fall outside this original estimate of the maximum cumulative 10-foot drawdown but within the revised 2007 estimate of the maximum cumulative 10-foot drawdown in the uppermost aquifer (**Figure 3.3-48**), the mitigation and monitoring measures outlined in the Betze Project SEIS (BLM 2003a) also would apply. The existing Long-term Monitoring and Mitigation Trust Fund (see Section 2.2.1.13, Applicant-committed Environmental Protection Measures) would provide mitigation for unanticipated impacts.

### 3.3.5 Residual Impacts

No residual impacts would occur to groundwater resources under the Proposed Action. For the No Action Alternative, residual unavoidable adverse effects to groundwater resources would remain after full recovery of groundwater levels in the post-mining period. These impacts would include: the long-term residual drawdown in groundwater levels due to evaporation from the Betze Pit lake; reduction in baseflow to some streams due to permanent lowering of groundwater levels; and reduction in flow rates at some seeps and springs within the long-term residual groundwater drawdown cone.

## 3.4 Surface Water Resources

The surface water assessment focuses on two study areas: the immediate project area related to the Proposed Action and alternatives; and the encompassing CESA, in which the potential cumulative impacts of mining, mine dewatering, and other activities are examined.

The existing facilities and proposed disturbance are shown in **Figures 2-1** and **2-11**. As shown in **Figure 3.3-1**, the water resources CESA includes six groundwater basins designated by the NDWR. The CESA occupies approximately 2,073 square miles (NDWR 2005). The basin boundaries generally correspond to topographic divides, and they all drain southward to the Humboldt River. Elevations within the CESA range from approximately 8,800 feet in the Tuscarora Mountains to 4,500 feet on the Humboldt River near the Town of Battle Mountain.

### 3.4.1 Affected Environment

#### 3.4.1.1 Hydrometeorology

The hydrometeorological setting of the region has been described in some detail in previous environmental documents for the area (BLM 2000a,b).

Average annual precipitation varies widely within the region but generally increases with elevation. Most precipitation falls as snow in the mountains during winter and spring. Total annual precipitation averages less than 10 inches on Boulder Flat and generally ranges from 14 to 20 inches at higher elevations in the Tuscarora Mountains (U.S. Department of Agriculture Natural Resources Conservation Service [USDA-NRCS] 1998). Since 1993, the mean annual total precipitation at the Goldstrike Mine has been 11.4 inches (Cedar Creek Associates 2007a). Average monthly precipitation values for approximately 60 years of record at Elko and Battle Mountain are shown in **Table 3.4-1**. Total annual precipitation has averaged 9.7 inches at Elko and 8.0 inches at Battle Mountain for the period 1950 through 2006. Free water surface evaporation, which approximates the losses that may occur from a shallow lake, is approximately 44 inches per year in the region overall. Based on measurements since 1991 at the Goldstrike Mine, the free water surface evaporation there is approximately 36 inches per year. Overall, the vast majority of precipitation (up to 90 percent) is consumed by evapotranspiration (McDonald Morrissey Associates, Inc. 1996b).

**Table 3.4-1 Average Monthly Precipitation (in inches) at Elko and Battle Mountain, 1950 - 2006**

| Location | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elko | 1.19 | 0.82 | 0.94 | 0.87 | 1.01 | 0.76 | 0.40 | 0.48 | 0.54 | 0.64 | 1.00 | 1.09 | 9.71 |
| Battle Mountain | 0.79 | 0.64 | 0.69 | 0.90 | 1.07 | 0.85 | 0.27 | 0.32 | 0.52 | 0.59 | 0.67 | 0.78 | 7.96 |

Precipitation and resulting runoff vary widely between years and locations in the Basin and Range Province. As an example, **Figure 3.4-1** indicates the wide variation in total annual precipitation at the Elko and Battle Mountain meteorological stations. Periodic droughts can be seen in the 1950s, mid-1970s, late 1980s, early 1990s, and to some degree from 1999 through 2002. Generally, the years after 2002 have been wetter than average. In keeping with regional variability, annual precipitation at the BGMI operations totaled approximately 5 inches in 2001 and 21 inches in 2005.

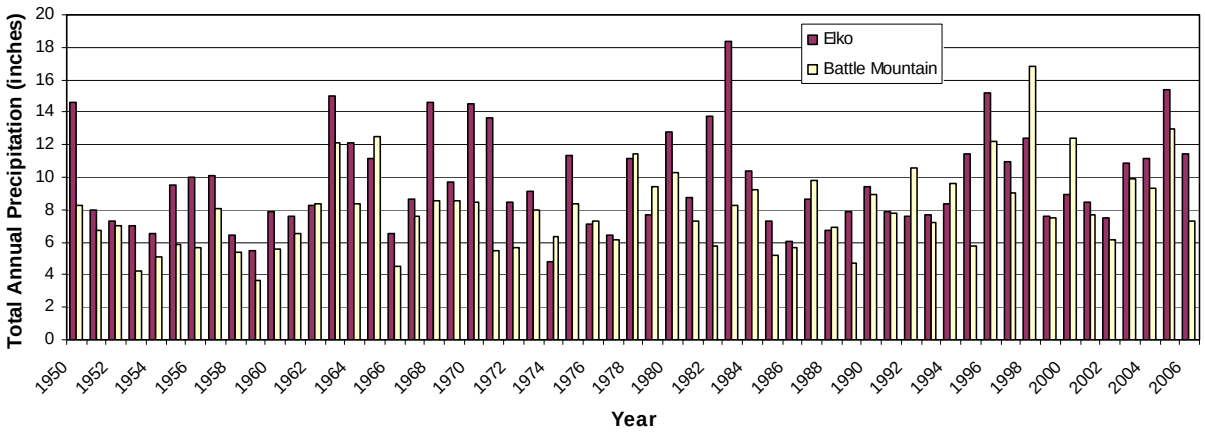



**Figure 3.4-1 Variation in Annual Precipitation at Elko and Battle Mountain**

### 3.4.1.2 Surface Water Flow and Channel Characteristics

A number of drainages occur in the study area (**Figure 3.3-1**), and their streams all flow toward the Humboldt River. On the eastern side of the Tuscarora Mountains, Marys Creek, Maggie Creek, and Susie Creek are major tributaries to the Humboldt River. These three drainages have been investigated by Newmont Gold Company (1991); Maurer et al. (1996); Zimmerman (1992); and the USGS (Prudic et al. 2006). Maggie Creek and Susie Creek exhibit perennial flows over most of their lengths.

On the western side of the Tuscarora Mountains, Rock Creek forms the major surface water network tributary to the Humboldt River. Rock Creek has both intermittent and perennial reaches interspersed along its length. The channel traverses the southwest portion of Boulder Flat and receives flow from Blue House Slough as well as from the Boulder Creek - White House Ditch - Blue House Ditch system before it joins the Humboldt River near Battle Mountain (**Figure 3.3-1**). Willow Creek and Antelope Creek are major tributaries to Rock Creek to the north and west of BGMI's operations, and Boulder Creek the major stream through Boulder Valley from the north. Rodeo Creek, Bell Creek, and Brush Creek, which pass through the project area, are tributaries to Boulder Creek. These drainages and their watershed characteristics were described previously in the Betze Project Draft EIS and subsequent SEIS (BLM 1991a, 2000a, 2003a).

Surface water flows in the CESA originate from snowmelt, infrequent rainfall events, and groundwater discharges through the stream channel or from seeps and springs. Large flow rates may occur in the winter or early spring as a result of rain on snow or frozen ground, but more commonly the annual high-flow events occur from snowmelt in the spring. Occasionally, isolated flooding may result from intense local thunderstorms, which most often occur from late spring through the fall. The seasonal duration of stream flow has been identified through field surveys for streams in the CESA. These are shown for stream reaches in **Figure 3.3-1.** Flow occurrence in tributary reaches is typically either ephemeral or intermittent. Perennial reaches occur along tributary streams draining the Tuscarora Mountains and elsewhere, as indicated in **Figure 3.3-1**.

### 3.4.1.3 Mine Water Management

In its upper reaches, Rodeo Creek is an ephemeral channel that was diverted in the mine area by Newmont in 1990 with approvals from the State of Nevada. Flows from catchments upstream of BGMI's property on Rodeo Creek are attenuated by the Rodeo Creek Diversion Dam, which consists of an earthen dam with an ungated 66-inch-diameter reinforced concrete pipe (RCP) outlet. **Figure 2-4** shows the Rodeo Creek Diversion closure options in the pit area. The Brush Creek diversion re-routes flows from Brush Creek to Rodeo Creek just downstream of the Rodeo Creek Diversion Dam.

The recently completed Brush Creek diversion was designed and constructed to adequately convey runoff from a 100-year/24-hour storm event. It contains concrete or rip-rap reinforced sections and grade controls as needed. The diversion has a flatter gradient and greater length than the native ephemeral channels it replaces. Since the diversion may accumulate sediment, BGMI conducts periodic inspections and performs maintenance as needed to maintain the channel structure and its flow capacity.

During final reclamation and closure activities BGMI would control run-on onto project components from the Brush Creek system in accordance with NDEP regulations (NAC 519A-345) and closure guidance (NDEP-BMRR 2000). At that time, separate reinforced channels may be configured to control runoff through the property. Proposed channel designs would be submitted to NDEP, and constructed as determined through the agency review process. Drainage controls would be designed and constructed for the long-term, and would be inspected for performance during the required post-reclamation and closure monitoring period.

Other existing water management features that involve surface water resources have been described in previous assessments for the BGMI project area and the CESA (BLM 2000a,b). These features are summarized in Section 2.2.1.12, Water Management Operations. Briefly, they consist of flow routing, detention, and water application features such as the Boulder Valley Canal, TS Ranch Reservoir, embankments to control springflows, and a number of center pivot or flood-irrigated fields. Pumped groundwater that is not used in mining, processing, or irrigation is infiltrated/injected through TS Ranch Reservoir infiltration ponds, injection wells, or discharged to the Humboldt River through an approved outfall in lower Boulder Valley. These features are generally depicted in **Figure 2-3**.

During the past few years, mine dewatering rates have decreased steadily. An average pumping rate of about 38,000 gpm (about 85 cfs) occurred in the year 2000; about 25,000 gpm was the average pumping in the year 2003. During late 2006 and early 2007, mine dewatering by BGMI averaged 18,136 gpm (40.4 cfs, or about 29,300 acre-feet per year) (BGMI 2007a). Beginning in August 2003, the Boulder Valley water management system began receiving excess mine water from the Newmont Leeville operations. Center pivot irrigation at TS Ranch was conducted in October 2006, and pond infiltration occurred between November 2006 and February 2007. The water treatment plant did not operate during late 2006 and early 2007, and no water was discharged to the Humboldt River during that time. BGMI has an existing permit to discharge to the Humboldt River, but has not done so since February 1999 and is not proposing to do so under any alternative considered in this analysis.

#### 3.4.1.4 Boulder Valley Surface Water Monitoring

Before mine dewatering activities, flow data for selected Boulder Valley streams were collected and were available for the Betze Project EIS (BLM 1991a,b). These baseline data indicate that the upper third of Rodeo Creek was ephemeral, but downstream reaches were perennial or intermittent. Bell Creek was perennial in its headwater reaches, but it became intermittent with perennial pools nearer its confluence with Rodeo Creek. Brush Creek was perennial in its headwaters and middle reach, but it was ephemeral downstream near Rodeo Creek. Boulder Creek was perennial in its upper headwater reaches, primarily because of springflows. Boulder Creek became ephemeral near Rodeo Creek and downstream (BLM 1991a,b).

As discussed in Section 3.3.1, BGMI has conducted water resources monitoring in Boulder Valley since 1990. Quarterly or semi-annual monitoring reports have been submitted to the state since 1991. Newmont monitors water resources in the eastern part of the CESA and in the vicinity of its Leeville Project. Locations of current surface water monitoring locations in Boulder Valley and the CESA are shown in **Figure 3.4-2**. In addition, both BGMI and Newmont conduct spring and seep monitoring within the CESA. The Elko District Office of the BLM also has conducted spring, seep, and stream assessments in the area, focusing on effects from grazing.

Descriptions of stream flows in the CESA prior to 1999 are presented in earlier NEPA documents (BLM 2000a,b). Based on data collected in the mine area since 1999, Rodeo Creek in its uppermost reaches (Station RC-AA; **Figure 3.4-2**) appears to be an ephemeral stream that may exhibit more intermittent flows farther downstream at Station RC-A (BGMI 2007f). Intermittent flows in the spring at Station RC-A ranged from

approximately 200 to approximately 700 gpm (approximately 0.4 to 1.5 cfs) during 2004 through 2006. Downstream at Station RC-B, Rodeo Creek is an intermittent stream with substantially larger discharge magnitudes as a result of Brush Creek additions and other contributing tributaries. Flows of approximately 1,700 and 2,500 gpm (3.8 and 5.6 cfs) occurred at Station RC-B in the springtime of 2005 and 2006, respectively. Measured flows also increased substantially between Station RC-B and the farthest downstream monitoring location, Station RC-C, largely due to contributions from Bell Creek and other tributaries. Some flow losses occur on the alluvial fan system between Bell Creek at BL-1 and Rodeo Creek RC-C.

Since 1999, Bell Creek appears to generally lose flow to the valley alluvium along its length between Stations BL-2 (upstream at the valley head) and BL-1 (downstream on the fan system). This trend is somewhat inconsistent, however, with larger flow rates at BL-1 on occasion (BGMI 2007f). Variable snowmelt and/or discharges from springs may account for these differences. Since the year 2000, Brush Creek has consistently lost slight amounts of flow in a downstream direction from Station BR-1 to BR-2 (**Figure 3.4-2**).

Years of lower precipitation between approximately 1999 and 2002 are reflected in reduced streamflows on Bell Creek, Brush Creek, and lower Rodeo Creek. In general, flows in these streams tended to increase again during and after 2004 (BGMI 2007f). A similar pattern occurred on uppermost Antelope Creek at Station ANT-1A. However, downstream at ANT-1 and other stations, Antelope Creek loses flow to the valley alluvium. Based on additional data collected since 1999, Antelope Creek is intermittent or exhibits discontinuous pools as it crosses the valley alluvium.

Upstream of the Sheep Creek Range, Rock Creek flows were relatively consistent between 1999 and early 2007. These flows were substantially reduced from those occurring between 1996 and 1998. It appears that total annual precipitation may not correlate well with upper Rock Creek flows. Rock Creek gains substantial flow as it passes through the Sheep Creek Range. Just upstream of the Sheep Creek Range, Rock Creek at Station RKC-3 (**Figure 3.4-2**) has shown variable flow seasonality since 1999; downstream at Station RKC-4, it has been perennial. Immediately downstream of the Sheep Creek Range, flows in Rock Creek increased during 2004 and after, lagging behind precipitation increases. Except for this short reach downstream of the Sheep Creek Range, Rock Creek often goes dry in Boulder Valley.

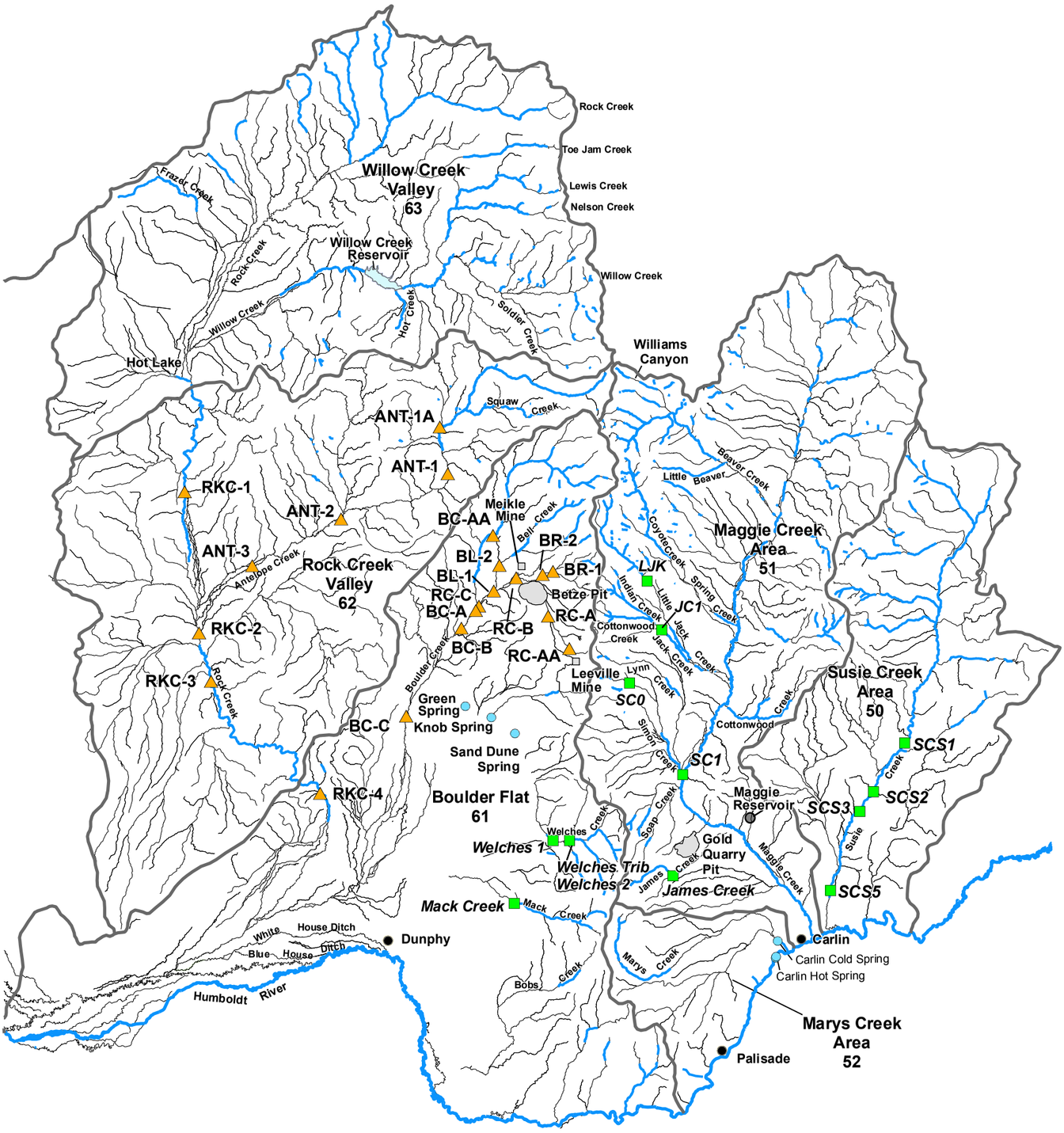
Since the early 1990s, data for Boulder Creek indicate that it is intermittent in its upper reaches (at Stations BC-AA, BC-A, and BC-B) and probably ephemeral at BC-C and downstream until it terminates at Boulder Flat. The stream typically goes dry in late summer and fall. In general, flow rates decreased after 1999. Flow gains and losses are inconsistent along the channel length. Flows in lower Boulder Creek may be affected by seepage contributed by irrigation.

#### 3.4.1.5 Surface Water Rights

Past inventories of surface water rights and applications for surface water rights provided information on locations and status within the hydrologic study area. This information was presented in previous NEPA documentation for the project area and the CESA (BLM 2000a,b). The primary uses for the water are stock watering, municipal uses, irrigation, and domestic uses.

#### 3.4.1.6 Surface Water Quality

Surface water quality standards are established by the State of Nevada to protect waters of the state. Many standards are developed for specific designated beneficial uses, as defined in NAC 445A.122. Applicable water quality standards are prescribed in NAC 445A.144 (standards for toxic materials applicable to designated waters) and in NAC 445A.121 through 445A.127, inclusive. Relevant standards also were discussed extensively in previous NEPA documentation for the project area and the CESA (BLM 2000a,b).




**LEGEND**

- Newmont Surface Water Monitoring Site
- BGMI Surface Water Monitoring Site
- Groundwater Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach

N

0 5 10 Miles

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: Newmont 2007; BGMI 2007f.

**Betze Pit Expansion Project**

Figure 3.4-2

Current Surface Water Monitoring Locations in the Cumulative Effects Study Area

Stream water quality within the hydrologic study area is monitored by BGMI on a monthly basis and reported semi-annually. The following basins and their streams are monitored (**Figure 3.4-2**) (BGMI 2007f):

- Boulder Flat: Bell Creek, Boulder Creek, Brush Creek, Rodeo Creek; and
- Rock Creek Valley: Antelope Creek, Rock Creek.

Surface water samples are dominated by calcium, magnesium, and sodium cations, and bicarbonate was the dominant anion (BGMI 1999). Total dissolved solids concentrations ranged from 106 mg/L in middle Boulder Creek at Station BC-B to 519 mg/L in Rodeo Creek at Station RC-A (**Figure 3.4-2**). Values of pH were typically neutral to alkaline, ranging from a low of 7.08 standard units in Boulder Creek at Station BC-B to 8.9 standard units in Rock Creek at Station RKC-2.

Metals concentrations were typically below applicable Nevada water quality standards, but there were incidences of elevated total arsenic on Rodeo Creek upstream of the mine. Total arsenic concentrations were 200 micrograms per liter (µg/L) at Station RC-AA and 123 µg/L at Station RC-A. The current Nevada drinking water standard for total arsenic is 50 µg/L; 100 µg/L for irrigation use, and 200 µg/L for livestock watering. The fourth quarter 2006/first quarter 2007 monitoring report indicates that water quality standards were met elsewhere for other constituents (BGMI 2007f).

## 3.4.2 Environmental Consequences

The primary issues related to surface water resources include:

- Reduction in surface water quantity through 2015 (No Action Alternative);
- Impacts to surface water quality from the construction, operation, and closure of tailings facilities, waste rock facilities, surface water diversions, and other mining and processing facilities; and
- Impacts from flooding, erosion, and sedimentation associated with mine construction, operation, and closure activities.

### 3.4.2.1 No Action Alternative

Under the No Action Alternative, groundwater pumping will continue through 2015. This would reduce streamflows in the vicinity of the Betze Pit and in some outlying areas for an extended period of time. Reduced streamflows would be most noticeable along perennial and intermittent stream reaches near the Betze Pit and Bazza Waste Rock Facility. Part of the flow in these streams is contributed by groundwater seeping into the channels over time ("baseflow"). These long-term baseflows create perennial and intermittent streams in the study area.

Extending the period of groundwater pumping would reduce baseflows for a greater length of time. This would continue to shorten the seasonal duration of streamflows as well as reduce flow rates. The locations and magnitudes of these effects were assessed previously (BLM 2000a,b), and are expected to be similar under the No Action Alternative. The affected areas anticipated within the 10-foot groundwater drawdown area are similar to previous assessments (BLM 2000a,b; Zhan 2007). These areas are shown in **Figure 3.3-26**.

In general, the areas where streamflows could be reduced include a portion of Antelope Creek just upstream of the valley alluvium, upper Boulder Creek, and upper Brush, Bell, and Rodeo creeks, as described for the No Action Alternative in the groundwater discussion. Potential impacts to springs, which are closely tied to stream baseflows, also are part of that discussion (see Section 3.3.2.1, No Action Alternative, Comparison of 2000 and 2007 Groundwater Models).

Part of Rodeo Creek will be diverted southward around the Betze Pit to expand mining of the pit to the northwest under current NDEP authorizations (Permit # TNEV 2008309, Appendix A). A total of 28.1 acres of

disturbance will occur as a result of the planned and authorized diversion of Rodeo Creek around the south end of the Betze Pit. The Rodeo Creek Diversion will route flows from upstream catchments around the Betze Pit and back into the original channel downstream of the pit. This diversion is further discussed in Section 2.3.6. Routed flows return to Rodeo Creek west of the pit (**Figure 2-4**). Middle Rodeo Creek currently has an ephemeral flow regime, and this would continue with the diversion built under the No Action Alternative. Overall watershed areas contributing to the Boulder Valley stream system would remain the same.

No impacts to streamflow magnitudes or surface water quality in Rodeo Creek are anticipated as a result of the diversion. Ephemeral channel segments would be removed, but they would be replaced with lengths of diversion channel. The Rodeo Creek Diversion would roughly approximate the same length and gradient as the original channel. Long-term diversion designs and modifications for the Rodeo Creek Diversion will be completed, if necessary, during final reclamation and closure.

Under the No Action Alternative, Rodeo Creek and Brush Creek would continue to provide ephemeral streamflows to the valley fill system in the project area and downstream during active mining. These flows are typically lost to infiltration and evapotranspiration before they reach Boulder Creek, or shortly after. Water quality impacts on the Humboldt River are not anticipated because Boulder Creek is not a tributary to the Humboldt River.

Rodeo Creek was originally diverted in the early 1990s by Newmont. At the time, the channel traversed the current Betze Pit. The creek was subsequently diverted to the north, and has been stabilized by riprap, concrete grade controls, and geosynthetic clay linings at selected locations. The existing channel is essentially trapezoidal in section and does not support riparian vegetation.

At the end of mining as a closure option, Rodeo Creek may be diverted into the Betze Pit and the corresponding pit lake that would eventually form (Section 2.2.1.12). Streamflows from Brush Creek and upper Rodeo Creek would form part of the pit lake. Water quality in the pit lake is expected to improve as a result. The pit lake is discussed further in Section 3.3.2.2.

Based on data prior to mine dewatering, Rodeo Creek was perennial at Station RC-A (BLM 1991a,b). Streamflow durations were then intermittent at Station RC-B, and transitioned to ephemeral or weakly intermittent at Station RC-C (**Figure 3.4-2**). In its lower reach, Brush Creek was perennial and contributed substantially to peak flow rates at Stations RC-B and RC-C during the spring (BLM 1991a,b). In addition to other watershed characteristics, these flow regimes were likely related to the occurrence of geologic factors along the channels, such as faults, the occurrence of fractured or non-fractured bedrock, and seepage losses to the valley alluvium.

Mine dewatering impacts to Brush Creek flows and vegetation have occurred since 1993 and were documented in earlier NEPA assessments (BLM 2000b). Under current mine-water management, Brush Creek is an intermittent stream with a short perennial section in the uppermost portion of a central headwater tributary. Currently at Station RC-A and downstream, Rodeo Creek is weakly intermittent, flowing seasonally only in springtime during years of average or greater precipitation. It remains dry during below-average precipitation years, and is ephemeral upstream of RC-A (**Figure 3.4-2**).

In general, potential impacts to surface water quality during operations would be avoided by continuing compliance with existing NDEP permit approvals and operation of the mine water management infrastructure, as needed. As described in Section 2.2.1, Current Mining Operations or Facilities that Will Continue Unchanged, BGMI uses mine water in ore processing, dust control, and other mining or processing applications. In addition, excess water is discharged for agricultural applications and infiltration or injection. Treatment plants exist in these discharge circuits. No water has been discharged to the Humboldt River since February 1999. Although BGMI maintains its NDEP permit, it does not anticipate discharges to the river in the future.

BGMI operations have incorporated a SWPPP since 1994, and modifications and improvements have been implemented, as necessary. The principal storm water management practices are implemented, inspected, and maintained in accordance with Nevada General Discharge Permit NVR300000. Periodic evaluations have determined that the SWPPP is effective in controlling the discharge of pollutants from the property. Ongoing inspections and periodic improvements ensure that BGMI continues to comply with permit requirements as operations proceed (BGMI 2007d).

In addition to containment, staff training, and response procedures at equipment facilities or processing components, BGMI implements and maintains runoff and sediment controls along haul roads, at tailings facilities, and at waste rock disposal areas. These are particularly relevant to the project alternatives. Berms, ditches, sediment traps, detention ponds, and other BMPs are utilized and maintained at these components. Site inspections and periodic flyovers are made, and control measures are built, repaired, or modified as needed to maintain the effectiveness of the SWPPP.

As a result of implementing the SWPPP and complying with approved permits, little or no impact to surface water quality is anticipated during construction or operations associated with the No Action Alternative.

After mining ceases and post-mining drainage patterns are established, impacts to surface waters would occur from the mine closure option of diverting streamflows into the pit. These impacts would be minimal because in pre-existing conditions, most runoff in Rodeo Creek and Boulder Creek was lost to seepage and evapotranspiration in Boulder Valley. The overall loss of contributing watershed (24 square miles) in the Boulder Flat basin (560 square miles) represents approximately 4.3 percent of the larger basin. Since flows originating in the Rodeo Creek watershed rarely contribute to downstream flows, the re-routing of Rodeo Creek into the Betze Pit would not cause a substantial loss of surface water in Boulder Valley or the Humboldt River.

#### 3.4.2.2 Proposed Action

Potential impacts to surface water resources associated with the Proposed Action include changes to:

- Channel extent and morphology; and
- Surface water quality.

Through existing project approvals by the State of Nevada, mine dewatering has been authorized through 2015. In addition, construction of the Brush Creek diversion has been reviewed and approved by the State. Construction of the Rodeo Creek Diversion south of the Betze Pit will be reviewed and approved by the State. Since the diversions are not located on federally administered lands, no BLM authorization is required.

As a mine closure option, Rodeo may be diverted into the pit (which may occur in both the Proposed Action and No Action alternatives as described in Section 2.2.1.12). Impacts to surface water resources from diverting Rodeo Creek into the Betze Pit at the end of mining would be similar to those described for surface water resources under the No Action Alternative described above. Some differences in pit lake water quality may result; these differences are described in Section 3.3.2.2.

Hydrologic investigations indicate that approximately 3,600 acre-feet of runoff would collect in the Betze Pit from a 100-year/24-hour storm occurring on the contributing 24-square-mile watershed if all of the rainfall was routed into the pit. In the long-term reclaimed condition, when the pit lake is at its anticipated steady state, over 100,000 acre-feet of flood storage would remain between the seasonal maximum pool elevation and the lowest crest of the pit wall. Under these conditions, pit outflows would not be expected from the storm events (BGMI 2007a).

Runoff water quality would be adversely affected by construction activities as new project facilities are built. Similar to the assessment for the No Action Alternative, impacts to surface water quality under the Proposed

Action would be avoided or minimized by implementing a revised project SWPPP and complying with the conditions of permit approval. Therefore, minimal impacts to surface water quality would occur during construction or operations associated with the Proposed Action. At most locations, implementation of runoff, erosion, and sedimentation BMPs would reduce these impacts to negligible levels.

During active mining and afterward, runoff from the proposed Clydesdale Waste Rock Facility and Goldstrike No. 3 Tailings Facility could be affected by geochemical constituents in the materials placed in those areas.

The proposed Clydesdale Waste Rock Facility closely borders both Rodeo Creek and its tributary Bell Creek. Potential impacts from the proposed waste rock facility and its associated haul road include:

- Channel disturbance, erosion, sedimentation, and stream geometry changes; and
- Degradation of surface water quality from waste rock and road runoff.

These impacts could occur either during construction, operations, or after mining and reclamation. Bell Creek, which closely borders the facility on the east, flows on an intermittent, seasonal basis. Flows from both Bell Creek and Rodeo Creek typically decrease in a downstream direction due to evapotranspiration and seepage into the valley fill. In addition, BGMI would construct the proposed waste rock facility with a 100-foot setback between the bottom of the slopes and the tops of the creek banks. These factors would avoid impacts to these surface water resources.

Haul road and culvert placement will disturb a portion of Bell Creek, a drainage deemed non-jurisdictional by the USACE (USACE 2006). Similar to the No Action Alternative, the implementation of runoff erosion and sedimentation controls as described in BGMI's current SWPPP would reduce the impact. The crossing would be designed to safely convey the 100-year/24-hour storm event. The approach and departure channel sections would be stabilized against potential scour. Sediment and runoff from the road and embankments could degrade water quality. The potential for this would be minimized by construction of 6- to 8-foot-high berms at the margins of the road, and by applying concurrent reclamation and erosion control practices. The berms would control drainage from the road surface, and other control practices, such as rock filters, erosion control blankets, or silt fences would minimize erosion and sedimentation from road and ditch features. If waste rock that has adverse geochemical characteristics is used for roadfill near the Bell Creek crossing, runoff water quality could be degraded. However, this impact would be avoided by construction procedures proposed by BGMI. PAG materials would not be used in haul road construction because of their low bearing strength and poor trafficability. Suitable haul road and embankment material is typically durable and calcareous. In addition, BGMI would test waste rock materials used for construction near drainages. Materials with adverse geochemical characteristics would not be used. BGMI would obtain and comply with a "Working in Waters" permit from NDEP Bureau of Water Pollution Control. This would promote careful construction and stabilization at creek crossings. As a result, minimal surface water impacts are anticipated.

The proximity of the Clydesdale Waste Rock Facility to both channels is likely to increase sediment loads and turbidity in streamflows. The steep topography of the adjacent waste rock slopes would accentuate storm and snowmelt runoff, with attendant erosion and sedimentation, into the creeks. Over the long term, these impacts are likely to occur even with BMPs and slope breaks implemented on the facility. More rapid runoff from waste rock slopes, even after reclamation, is likely to promote gullying along the channel banks bordering the facility. These effects would be adverse impacts along several miles of stream channels. To minimize these potential impacts, the toe of the Clydesdale Waste Rock Facility would be set back 100 feet from the tops of the banks along Bell Creek and Rodeo Creek.

Other potential impacts to surface water quality could be generated by the geochemistry of waste rock materials in the facility. Such impacts could include seepage containing acids or other water quality contaminants (e.g., elevated concentrations of metals or metalloids). These impacts would be minimized by the implementation of BGMI's Waste Rock Management Plan for the Clydesdale Waste Rock Facility (Schafer and Geosystems Analysis 2004) as follows:

- Isolation of potentially acid-generating materials at depths within the Clydesdale Waste Rock Facility;
- Use of selected cover materials; and
- Implementation of BMPs to minimize slope lengths, provide free drainage, and revegetate the post-mining surface.

In the geochemical data reported for the proposed waste rock facility (Schafer 2008b), arsenic levels are commonly elevated above the current Nevada drinking water standard (0.05 mg/L). Additionally, concentrations of several other water quality constituents were elevated above standards. It should be noted, however, that column tests provide an indication of interstitial water, and general fate and transport conclusions about water quality constituents would need to further account for hydrologic conditions at the facility.

The reclamation design for the proposed Clydesdale Waste Rock Facility consists of 12 inches of suitable topsoil material. In addition, a 6-foot-thick cover comprised of Carlin material or a combination of Carlin material and topsoil would be used as an evapotranspirative cover for waste rock with potentially acid generating properties. This cover technique has been successfully utilized on both the AA Leach Pad Facility and portions of the Bazza Waste Rock Facility and has demonstrated the ability to preclude or greatly reduce the infiltration of meteoric water into the underlying material. These covers have been investigated for their efficacy by both trenching and observation and through the use of instrumentation to measure the flux of meteoric water in the cover horizon. In addition, the moisture content of the proposed facility would generally be below field capacity, which is the point at which significant drainage would occur. Waters of the state would be protected by this approach. As a result, no substantial impacts to surface water quality are anticipated as a result of the materials that would be stored in the proposed Clydesdale Waste Rock Facility.

A similar approach to covering project components has already been employed at the mine by BGMI with considerable success. Reclamation at the existing AA Leach Pad utilized a cover with capillary barrier effects (CCBE), as well as a comprehensive drainage network on the surface to enhance surface water runoff and sediment control. Soon after the work was completed, an extremely intense storm event (1.6 inches of rainfall during a 20-minute period) occurred at the site on June 1, 2002. Damage on the reclaimed pad included rilling and gullying on the surface, and limited gullying within the drainage channels. BGMI also collected extensive hydrologic data, which indicated that the cover system maintained its overall integrity during the storm event. The results of the investigations indicate that there is a strong upward hydraulic gradient during non-precipitation periods due to evapotranspiration. In addition, there is no water seepage into the reclaimed pad, and no significant lateral flow was observed in the cover slopes. The observed draindown rates are steadily decreasing (i.e., without spikes), and closely follow the modeled rates (BGMI 2003).

Based on experience with this severe storm, BGMI revisited the design of surface drainage features at the AA Leach Pad and made repairs and upgrades. This experience is being carried on to the reclamation and closure design for other components, including the proposed components and the existing Bazza Waste Rock Facility (Schafer and Geosystems Analysis 2006). Surface drainage improvements include revised channel cross-sections, substantially thicker layers of constructed channel bed materials that promote armoring and limit scour, the placement of rock vortex weirs at selected locations, rigid boundary channel linings (e.g., articulated concrete blocks or oversized riprap) as needed, and constructed cascades of rock weirs and pools at selected locations (Schafer and Geosystems Analysis 2006).

Revegetation efforts on Carlin materials at the AA Leach Pad indicate that, although the growth of perennial cover may initially lag somewhat when compared to topsoil revegetation, the differences can be insignificant in as little as 2 years. In addition, the diversity and plant density of desirable woody species on Carlin materials are far superior to those on topsoiled areas. Active transpiration of deeper-rooted species continues well into the fall on the revegetated Carlin materials, as opposed to nearby native vegetation where plants become senescent in August.

Based on their experience, improved surface drainage practices, and successful cover results in the project area, BGMI would avoid or minimize long-term impacts to surface water resources from reclamation of the proposed components. Short-term impacts would be avoided by concurrent reclamation practices and storm water management.

The Goldstrike No. 3 Tailings Facility would be a lined and monitored facility operated and reclaimed in compliance with NDEP regulations. As described in Chapter 2.0, a network of gravel and perforated pipe underdrains would convey drainage from springs or seeps within the Brush Creek basin. In lieu of the gravel and perforated high-density pipe, fabric wrapped polyethylene wick drains may be used. Tailings delivered to this facility is planned to be a thickened product, which will result in a smaller water pool than conventional sub-aerial tailing facilities. Tailings will be deposited so that the beach angle falls away from the embankment. Any supernatant solution or storm water accumulation will be accumulated on the eastern side of the facility away from the dam embankment. The facility would have an over drain system located in the area of the supernatant pond to minimize any hydraulic head on the lining system. Solution from this system would be routed to the process circuit for reuse. Since the tailings delivered to this facility is to be thickened, the amount of water reporting to this system will be lower than that of a conventional facility. The facility will be designed to retain the Probable Maximum Flood (PMF) during operation.

Surface water run-on would be routed away from the facility by the existing Brush Creek Diversion, which is designed to safely accommodate the 100-year/24-hour runoff event (see discussion under the No Action Alternative). During operation of the Goldstrike No. 3 Tailings Facility, samples will be taken of the resident tailings and a characterization study will be performed (NAC 445A.431). Reclamation of the Goldstrike No. 3 Tailings Facility would entail contouring (through tailings deposition) to prevent pooling of meteoric water, placement of a soil cover, revegetation, and construction of a spillway. The spillway would be designed to safely pass the PMF and lesser runoff events. Drainage would be to the Rodeo Creek Diversion. Further details about the operation, reclamation, and closure of this facility are presented in Chapter 2.0.

The proposed features and practices used to manage this facility during operational and post-mining phases would avoid or minimize potential impacts to surface water resources. Further details about reclamation practices are presented in Chapter 2.0 and in the Reclamation Plan that accompanies the POO Amendment. The permanent closure procedures (including monitoring) for the proposed tailings facility would be defined and implemented according to NDEP regulations (NAC 445A.446-447) and the Final Permanent Closure Plan developed at that time. Inspections, and corrective actions if necessary, would be conducted during the reclamation and closure monitoring period. If over the long term, a stable and free-draining configuration at the tailings facility were compromised in some way, any discharges would collect in the Betze Pit.

#### 3.4.2.3 Bazza Waste Rock Facility Alternative

Considerations for surface water resources under this alternative would consist of the same primary issues discussed for the No Action Alternative. Potential effects on surface flows, water quality, and flooding and sedimentation, as discussed for the No Action Alternative and the Proposed Action, would generally apply to this alternative as well. However, the potential impacts from the Clydesdale Waste Rock Facility and its associated haul roads (as discussed for the Proposed Action) would not apply to the Bazza Waste Rock Facility Alternative. Under this alternative, the stream stability and water quality impacts that may occur in Bell Creek and Rodeo Creek from the Proposed Action would be avoided.

Enlarging the Bazza Waste Rock Facility would consist of increasing its height while adhering to slope stability requirements. Due to the operating schedule and related nature of materials, lower quality growth media would be used on at least part of the facility, and reclamation would be delayed for a number of years. Depending on the design and construction of this alternative, steeper slopes may result when reclamation takes place. Potential impacts on surface water would differ somewhat from those of the No Action Alternative due to these factors.

Reclamation would be delayed for 7 years under this alternative. Since the SWPPP would be implemented for this alternative as well as the other alternatives, surface water impacts due to reclamation scheduling would be minimized.

Steeper slopes, if they occur, would accelerate runoff and erosion from the facility. This could degrade water quality in nearby surface drainages. If steeper slopes were near the top of the facility (i.e., restricted to the lifts raised by additional waste rock disposal), the potential for off-site water quality impacts would be less. Downslope benches, drains, and catchments would somewhat control the offsite movement of runoff and sediment. Control practices, including BMPs and structures to manage runoff and sediment, would need to be more substantial during and after operations in order to minimize potential impacts and comply with reclamation permit requirements.

Successful stabilization of the Bazza Waste Rock Facility would be more difficult to achieve under this alternative. The use of less suitable growth media would make revegetation success more difficult and time-consuming. When combined with the potential for steeper or longer slopes, the likelihood of long-term erosion and sedimentation impacts on surface water quality would be somewhat more than that of the No Action Alternative. BGMI would be bonded under regulatory requirements for reclamation. Given the state and federal requirements for successful reclamation and stabilization, and BGMI's extensive reclamation experience at the site, these impacts are not likely to occur. However, the impacts would be more difficult, expensive, and time-consuming to avoid.

### 3.4.3 Cumulative Impacts

The CESA for surface water resources is shown in **Figure 3.3-1**. The past and present actions and RFFAs in this area are identified in Section 3.1.

#### 3.4.3.1 No Action Alternative

Cumulative impacts to surface water resources would result from other mining projects and watershed uses within the CESA. These impacts are within the area that was disclosed and mitigated in the 2000 and 2003 Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48** and described in Section 3.3.3.1.

In addition to mining activities, other watershed factors may create cumulative impacts to surface waters and related resources. Floods and wildfires are known to have occurred in the CESA, particularly during recent years in the Willow Creek, Maggie Creek, and Susie Creek watersheds (AATA 2006; BLM 2007b). In general, runoff, erosion, and sedimentation are substantially increased over the short term when wildfires occur. Flooding usually occurs as a result of burned watershed conditions until ground cover and soil conditions recover. The combination of these factors often leads to unstable stream channels and banks. In turn, adverse impacts on stream morphology, aquatic habitats, and water quality are likely until more resilient watershed conditions are restored.

Other surface water quality impairments already exist within the CESA or may be generated by watershed conditions in the future. Currently Maggie Creek is listed as impaired for total phosphorus and pH, and Simon Creek is impaired for TDS (NDEP 2005b). In addition, mercury accumulations have been reported in fish and surface water in six waterbodies in northern Nevada (NDOW 2005; NDEP 2007b,c). Fish sampling has shown that Comins Lake (White Pine County), Wildhorse Reservoir (Elko County), Chimney Reservoir (Humboldt County), Lahontan Reservoir (Churchill County), Rye Patch Reservoir (Pershing County), and Little Washoe Lake (Washoe County) each had multiple fish species with average wet weight methylmercury levels of 1.0 ppm or more. Fish consumption health advisories have been issued by the State of Nevada for each of these waterbodies, of which six are outside the CESA.

Mercury naturally occurs in geologic formations in northern Nevada, where it is often found as mercuric sulfide. The largest source of atmospheric mercury from Nevada industries is caused by processing gold through precious metals mining and processing operations (NDEP 2007b). However, the largest overall contributions

to atmospheric mercury in Nevada come from global sources outside the region. Mercury also is carried in smokestack emissions from coal-fired power plants, and the State of Nevada recently added a program to control mercury emissions from such sources, including gold mining operations. Continued mining and processing of precious metals in northern Nevada (along with other local and global sources) will continue to contribute to mercury concentrations in regional surface waters, possibly including those within the CESA. Section 3.11, Air Quality, provides a detailed discussion on mercury.

Cumulative impacts to water quality within the CESA also result from agricultural uses. Irrigation diversions and returns increase total dissolved solids concentrations and water temperatures, as well as introducing fertilizer, herbicide and pesticide constituents. Livestock grazing along stream corridors and at springs can reduce bank stability through trampling, and increase erosion, sedimentation, and fecal coliform concentrations. Water quantity is affected by consumptive uses through crop transpiration.

Other non-mining activities in the CESA include transportation and recreational uses of watersheds. These uses add to surface disturbance, particularly through unpaved roads and thoroughfares, which in turn provides sources of erosion and sedimentation. Suspended sediment increases turbidity, generally increases water temperature, and frequently increases biological oxygen demand. In combination, these factors create cumulative impacts to surface water quality and quantity.

#### 3.4.3.2 Proposed Action

Cumulative impacts to surface water resources from the Proposed Action would be similar in nature, duration, and extent to those described for the No Action Alternative and in previous NEPA documentation (BLM 2000a,b, 2003a). The major proposed components, notably the Clydesdale Waste Rock Facility and Goldstrike No. 3 Tailings Facility, would occupy a minimal portion of the Boulder Creek watershed. Approximately 7,882 acres are currently authorized for disturbance under the No Action Alternative. The additional 1,180 acres that would be disturbed under the Proposed Action would bring the total project disturbance to approximately 9,062 acres, or about 2.6 percent of the Boulder Flat Hydrographic Basin (348,160 acres). This would be a minimal incremental increase in disturbance within the basin (less than 0.4 percent).

With respect to surface water quantity and quality, the proposed expansion would still be located above the valley fill sediments where most surface flows are lost to seepage and then to evapotranspiration or groundwater recharge. The additional disturbance would not change these conditions within the CESA. Water quality within the project area would be controlled by BGMI through the storm water control program, an agency-approved reclamation program, and ultimately the state closure program. All of these are conducted by BGMI during operations, or are under long-term bond. Little or no off-site water quality impacts are anticipated beyond those already described in previous NEPA documents (BLM 2000a, 2003a). With respect to potential cumulative impacts to surface water, there would be minimal difference between the Proposed Action and the No Action Alternative.

#### 3.4.3.3 Bazza Waste Rock Alternative

Cumulative impacts to surface water resources from the Bazza Waste Rock Alternative would be similar in nature, duration, and extent to those described for the No Action Alternative and in previous NEPA (BLM 2000a, 2003a). The additional 608 acres that would be disturbed under the Bazza Waste Rock Alternative would bring the total project disturbance to approximately 8,490 acres, or about 2.4 percent of the Boulder Flat Hydrographic Basin (348,160 acres). This would be a minimal incremental increase in disturbance within the basin (less than 0.2 percent). With respect to potential cumulative impacts to surface water, there would be minimal difference between the Bazza Waste Rock Alternative and the No Action Alternative.

### 3.4.4 Mitigation Measures and Monitoring

No monitoring or mitigation is recommended for surface water resources. Existing monitoring and mitigation programs are sufficient for surface water resources.

### 3.4.5 Residual Impacts

Under the No Action Alternative, residual impacts to surface water resources would include the long-term impacts to flow magnitudes and durations in some perennial streams and springs from groundwater drawdown, and long-term modifications to the Rodeo Creek and Brush Creek stream channels. This impact has been discussed at length in earlier NEPA documents for the project (BLM 2000a, 2003a).

## 3.5 Soils and Reclamation

The study area for direct and indirect impacts for soils encompasses the undisturbed areas within the project boundary. The CESA encompasses the project boundary and includes surface disturbance associated with past and present actions and RFFAs within the Boulder Flat, Rock Creek Valley, Maggie Creek, and Marys Creek watersheds (**Figure 3.5-1**). The rationale for the selected CESA boundary is that this area contains the core Carlin Trend Mines that affect soil resources within watersheds that drain south to the Humboldt River. Soils within the currently permitted operations were described in the Betze Project EIS (BLM 1991a,b).

### 3.5.1 Affected Environment

The proposed project boundary lies within the Great Basin Section of the Basin and Range Province of the Intermountain Plateaus (USDA-NRCS 2006). Soils within the study area have developed on lower mountain slopes and hills including alluvial fans, pediments, and terraces. The dominant soil orders in this area are Aridisols and Mollisols.

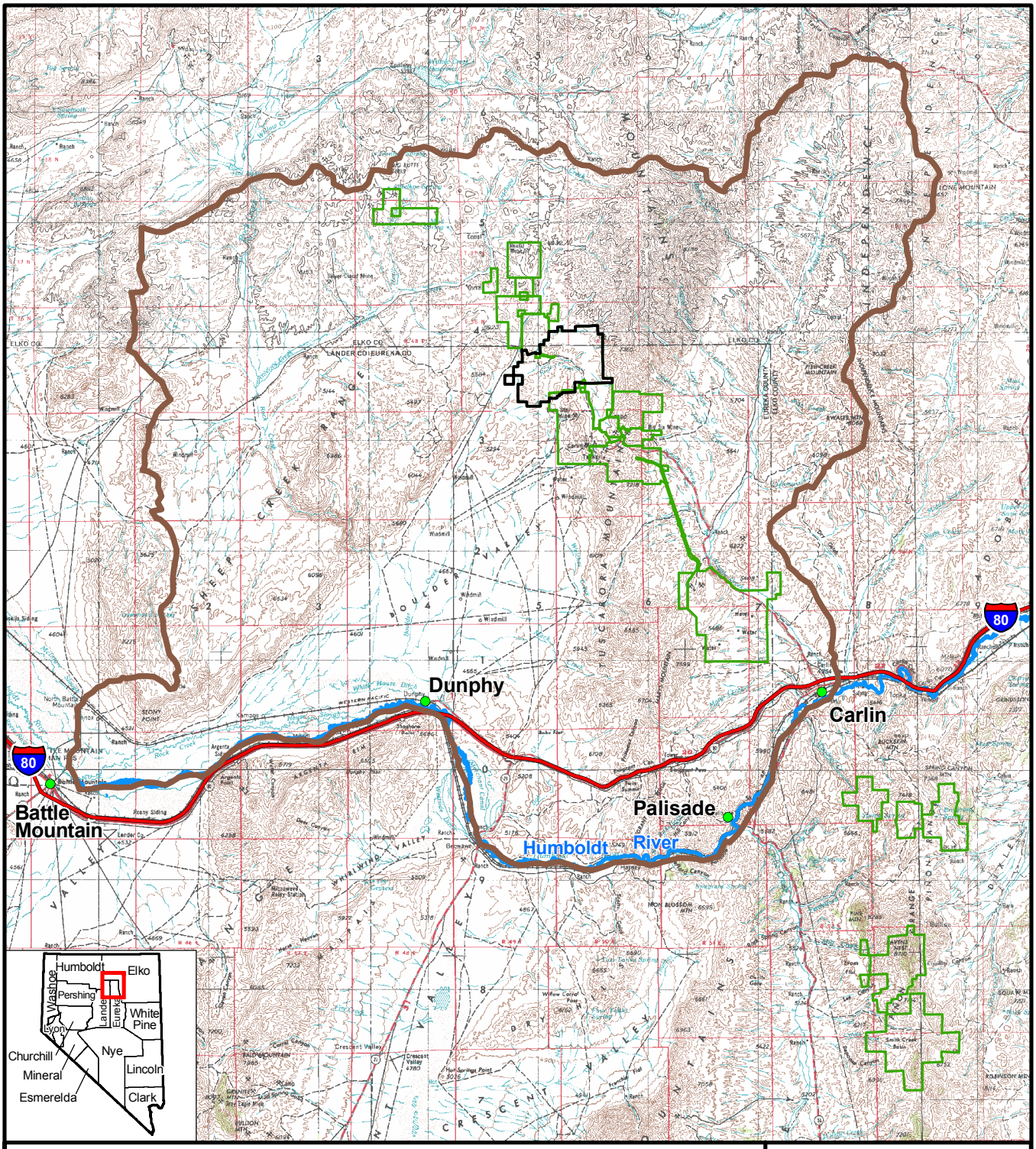
The soil information for the study area is based on Soil Survey Geographic (SSURGO) database review and analyses (USDA-NRCS 2007a). The occurrence of soils within the proposed project boundary is illustrated in **Figure 3.5-2**.

Soil Types within Project Boundary

The soils in the study area are highly varied and range in depth from shallow (i.e., less than 20 inches) to very deep (i.e., greater than 60 inches). The shallow soils lie in the northern and eastern portions of the study area at the base of the Tuscarora Range. Soils along ridge tops and slopes tend to be shallow with coarser textures. These soils are typically rocky and have coarse textured surfaces. The alluvial fans along the valley bottom include deep, coarse textured soils, whereas floodplains include deep, fine textured soils that formed in alluvium from mixed bedrock types. They are poorly drained soils with high water tables and often are richer in organic matter.

**Table 3.5-1** summarizes the physical and chemical characteristics and reclamation suitabilities of soil map units that occur within the proposed project boundary. The Betze project area has been previously disturbed by historic and recent mining activities. Where previous mining disturbance has occurred, it is assumed that growth media are no longer available and the previously mapped soil has been altered or removed. **Figure 3.5-3** displays topsoil suitability for the project area, displayed as a weighted average by the map unit. The proposed Betze expansion area is dominated by three soil associations. The corresponding Map Unit Identification (MUIDs) are Cherry Spring-Cortez-Chiara association (CG), Boulflat-Havingdon association (BM), and Slaven-Primeaux association (SE).

Cherry Spring soils are well drained and moderately deep to a strongly cemented duripan. The Cherry Spring series has a silt loam surface grading to a loam. The upper 36 inches are salvageable as reclamation media. The lower material is a hardened duripan and is not recommended for use as reclamation material. The Cortez soils are well drained and moderately deep to an indurated duripan. They have a silt loam surface overlying a gravelly clay above the duripan. The upper 10 inches are suitable reclamation material. Chiara soils are shallow to a duripan. The upper 4 inches are suitable for reclamation material. Chiara and Cortez soils have a saline-sodic subsoil beneath the duripan and should not be salvaged as reclamation material; these soils occur on fan piedmont remnants in the northern and western portions of the study area. Boulflat soils are moderately deep and well drained. These soils have a gravelly loam surface grading to a gravelly clay loam. The upper 13 inches can be salvaged as growth media; a duripan occurs at 23 inches. The Havingdon series consist of moderately deep, well drained soils. The Havingdon soils have a gravelly surface and a very gravelly subsoil overlying lithic bedrock. The upper 6 inches is suitable growth media. The Boulflat-Havingdon association occurs on mountain and foothill crests, side slopes, and shoulders. They occur in the northern portion of the study area. The Slaven soils are moderately deep, well drained soils that occur on hills and mountain side




**LEGEND**

- Soil Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries
- Towns

N

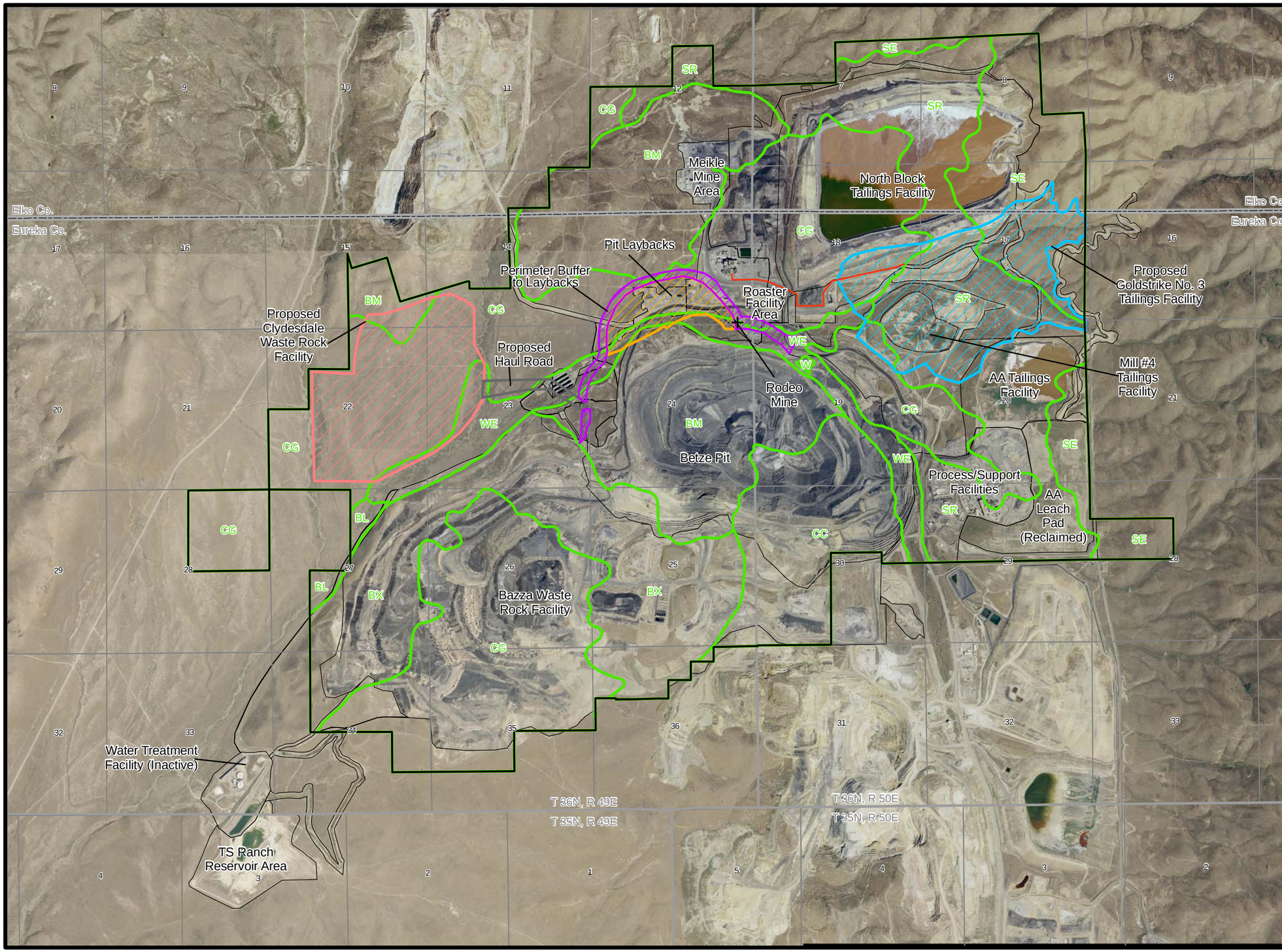
0 2.5 5 10 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.5-1

Soil Resources Cumulative Effects Study Area




## LEGEND

- Goldstrike Mine Operations Boundary
- Rodeo Backfill Shaft
- Tailings
- Pit Expansion
- Perimeter Buffer to Laybacks
- Waste Rock Facility
- Clydesdale Haul Road
- Tailings Pipeline

**SSURGO Soils**

BL = Bosco-Welch association

BM = Boulflat-Havingdon association

BX = Bucan-Humdun association

CC = Chen-Pie Creek-Ramires association

CG = Cherry Spring-Cortez-Chiara association

SE = Slaven-Primeaux association

SR = Stampede-Donna association

W = Water

WE = Welch-Bosco association

Source: USDA-NRCS 2007a.

N W E S

0 0.5 1 Miles

**Betze Pit Expansion Project**

Figure 3.5-2

Soil Types within the Proposed Project Boundary

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| SE | Slaven-Primeaux association (Slaven) | H1 | 836 | 0 | 5 | mountain | moderate | slight | No | Poor | D, OM, BR, T, R, slope | 0 |
| | | H2 | | 5 | 22 | | slight | | No | | | |
| | | H3 | | 22 | 26 | | | | No | | | |
| | Slaven-Primeaux association (Primeaux) | H1 | | 0 | 11 | mountain | severe | slight | No | poor | OM, BR, D, slope, R | 20 |
| | | H2 | | 11 | 20 | | severe | | No | | | |
| | | H3 | | 20 | 35 | | moderate | | No | | | |
| | | H4 | | 35 | 39 | | | | No | | | |
| | Slaven-Primeaux association (Cumulic Haplaquolls) | H1 | | 0 | 5 | flood plain | severe | moderate | Yes | fair | D, W | 5 |
| SR | Stampede-Donna association (Donna) | H1 | 1,6123 | 0 | 8 | fan remnant | moderate | slight | No | poor | T, D, E, R | 22 |
| | | H2 | | 8 | 22 | | moderate | | No | | | |
| | | H3 | | 22 | 38 | | | | No | | | |
| | | H4 | | 38 | 68 | | slight | | No | | | |
| | Stampede-Donna association (Stampede) | H1 | | 0 | 12 | fan remnant | severe | slight | No | poor | T, D, E, OM, slope | 28 |
| | | H2 | | 12 | 28 | | moderate | | No | | | |

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| | | H3 | | 28 | 33 | | | | No | | | |
| | | H4 | | 33 | 60 | | slight | | No | | | |
| CG | Cherry Spring-Cortez-Chiara association (Cherry Spring) | H1 | 3555 | 0 | 15 | fan remnant | severe | moderate | No | fair | Na, R, A, E, OM | 36 |
| | | H2 | | 15 | 36 | | severe | | No | | | |
| | | H3 | | 36 | 54 | | | | No | | | |
| | | H4 | | 54 | 60 | | slight | | No | | | |
| | Cherry Spring-Cortez-Chiara association (Chiara) | H1 | | 0 | 4 | fan remnant | severe | moderate | No | poor | NA, D, Na, E, OM | 4 |
| | | H2 | | 4 | 13 | | severe | | No | | | |
| | | H3 | | 13 | 17 | | | | No | | | |
| | Cherry Spring-Cortez-Chiara association (Cortez) | H1 | | 0 | 10 | fan remnant | severe | moderate | No | poor | T, Na, R, A, S, OM | 10 |
| | | H2 | | 10 | 22 | | slight | | No | | | |
| | | H3 | | 22 | 48 | | | | No | | | |
| | | H4 | | 48 | 60 | | slight | | No | | | |
| BM | Boulflat-Havingdon association (Boulflat) | H1 | 1,740 | 0 | 4 | hill | moderate | slight | No | poor | slope, R, BR, D, OM | 13 |

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| | | H2 | | 4 | 13 | | slight | | No | | | |
| | | H3 | | 13 | 23 | | slight | | No | | | |
| | | H4 | | 23 | 34 | | | | No | | | |
| | | H5 | | 34 | 38 | | | | No | | | |
| | Boulflat-Havingdon association (Havingdon) | H1 | | 0 | 6 | hill | severe | slight | No | poor | slope, R, T, BR, OM | 6 |
| | | H2 | | 6 | 21 | | slight | | No | | | |
| | | H3 | | 21 | 25 | | | | No | | | |
| | Boulflat-Havingdon association (Brock) | H1 | | 0 | 5 | fan remnant | severe | slight | No | poor | slope, R, D, OM | 0 |
| | | H2 | | 5 | 14 | | slight | | No | | | |
| | | H3 | | 14 | 18 | | | | No | | | |
| WE | Welch-Bosco association (Welch) | H1 | 482 | 0 | 7 | flood plain | moderate | moderate | No | fair | R, T | 60 + |
| | | H2 | | 7 | 60 | | slight | | No | | | |
| | Welch-Bosco association (Bosco) | H1 | | 0 | 15 | flood plain | slight | slight | No | poor | R, D, OM | 15 |
| | | H2 | | 15 | 46 | | slight | | No | | | |

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| | | H3 | | 46 | 70 | | slight | | No | | | |
| | Welch-Bosco association (Welch) | H1 | | 0 | 5 | flood plain | moderate | moderate | Yes | fair | W, T, R | 60 + |
| | | H2 | | 5 | 60 | | slight | | Yes | | | |
| BX | Bucan-Humdun association (Bucan) | H1 | 1,293 | 0 | 7 | hill | severe | slight | No | poor | slope, T, R, OM | 7 |
| | | H2 | | 7 | 25 | | severe | | No | | | |
| | | H3 | | 25 | 50 | | slight | | No | | | |
| | | H4 | | 50 | 54 | | | | No | | | |
| | Bucan-Humdun association (Bucan) | H1 | | 0 | 7 | hill | moderate | slight | No | poor | slope, T, R, OM | 7 |
| | | H2 | | 7 | 25 | | severe | | No | | | |
| | | H3 | | 25 | 50 | | slight | | No | | | |
| | | H4 | | 50 | 54 | | | | No | | | |
| | Bucan-Humdun association (Humdun) | H1 | | 0 | 8 | mountain | severe | moderate | No | poor | slope, OM, E | 30 |
| | | H2 | | 8 | 30 | | severe | | No | | | |
| | | H3 | | 30 | 60 | | severe | | No | | | |

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| CC | Chen-Pie Creek-Ramires association (Chen) | H1 | 645 | 0 | 8 | mountain | slight | slight | No | poor | slope, T, R, BR, OM, D | 0 |
| | | H2 | | 8 | 17 | | slight | | No | | | |
| | | H3 | | 17 | 21 | | | | No | | | |
| | Chen-Pie Creek-Ramires association (Pie Creek) | H1 | | 0 | 5 | hill | slight | slight | No | poor | slope, T, BR, D | 21-30 |
| | | H2 | | 5 | 21 | | moderate | | No | | | |
| | | H3 | | 21 | 30 | | moderate | | No | | | |
| | | H4 | | 30 | 34 | | | | No | | | |
| | Chen-Pie Creek-Ramires association (Ramires) | H1 | | 0 | 9 | mountain | slight | slight | No | poor | slope, T, R, BR, OM, D | 26-34 |
| | | H2 | | 9 | 26 | | moderate | | No | | | |
| | | H3 | | 26 | 34 | | slight | | No | | | |
| | | H4 | | 34 | 38 | | | | No | | | |
| | Chen-Pie Creek-Ramires association (Cumulic Haplaquolls) | H1 | | 0 | 5 | flood plain | severe | moderate | Yes | fair | W, D | 5 |
| BL | Bosco-Welch association (Bosco) | H1 | 47 | 0 | 15 | flood plain | moderate | slight | No | poor | R, D, OM | 15 |

**Table 3.5-1 Physical and Chemical Characteristics and Reclamation Suitabilities of Soil Map Units Occurring within the Proposed Project Boundary**

| MUID[1] | Map Unit Name | Horizon | Acres | Depth (inches) | | Geomorphic Description | Erosion Hazard of Bare Surface | | Hydric Rating | Topsoil Suitability | Limiting Factors[4] | RSD[5] (inches) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Top | Bottom | | Water[2] | Wind[3] | | | | |
| | | H2 | | 15 | 46 | | slight | | No | | | |
| | | H3 | | 46 | 70 | | slight | | No | | | |
| | Bosco-Welch association (Welch) | H1 | | 0 | 7 | flood plain | severe | moderate | No | fair | R, T | 60 |
| | | H2 | | 7 | 60 | | moderate | | No | | | |
| | Bosco-Welch association (Welch) | H1 | | 0 | 5 | flood plain | severe | moderate | Yes | fair | W, T, R | 60 |
| | | H2 | | 5 | 60 | | moderate | | Yes | | | |

[1]Map Unit Identification.

[2]Water erosion hazard class determined from Soil Erodibility Factor (Kw) and slope.

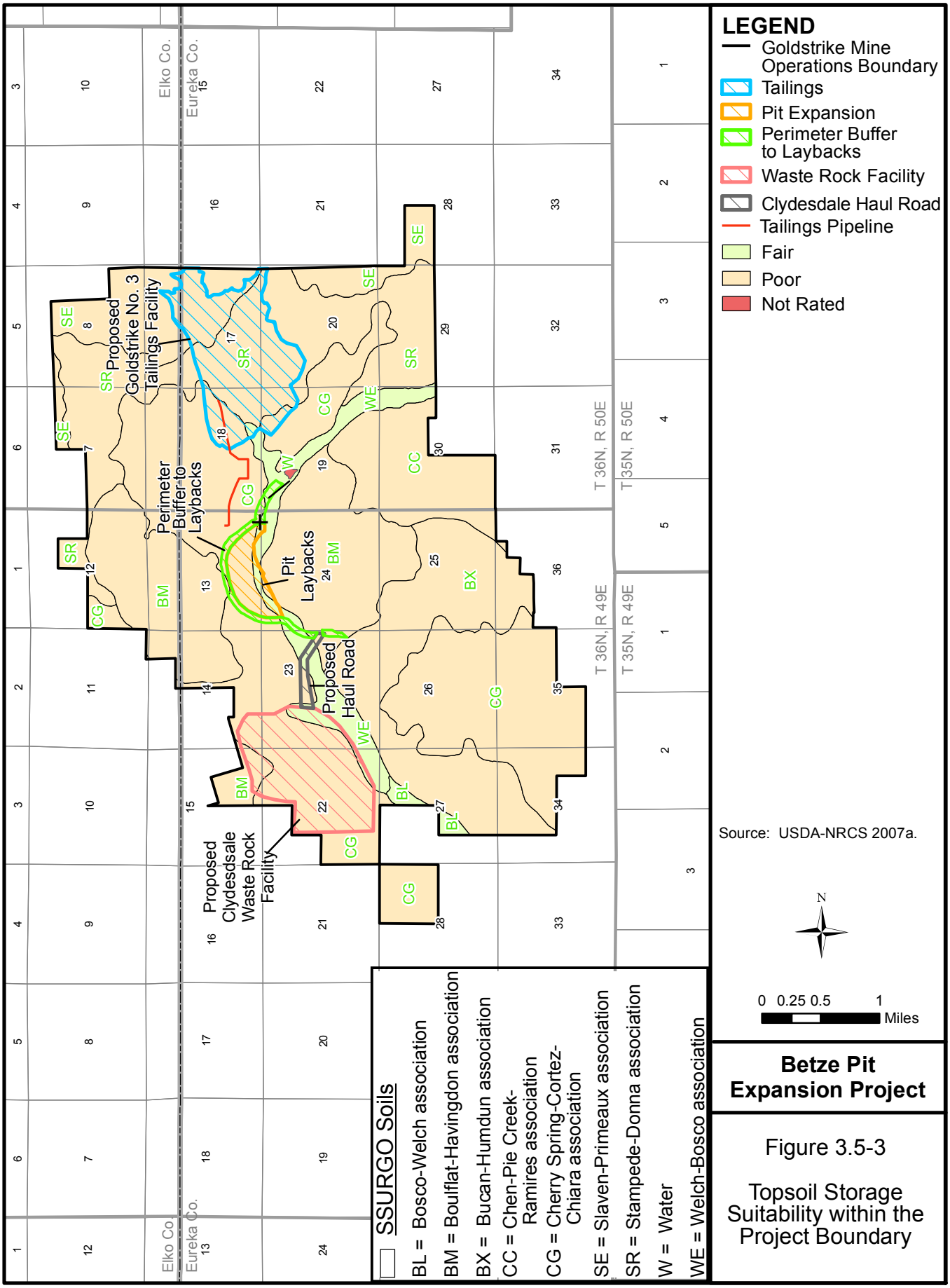
[3]Wind erosion hazard class based on Wind Erodibility Group Rating.

[4]Limiting Factors:

A = High Alkalinity
BR = Depth to Bedrock
C = High Carbonates
D = Droughty
E = Erosion
Na = Sodium Content
OM = Low Organic Matter
R = Rock Fragments
S = Salinity
Slope = Slope
SD = Too Sandy
T = Too Clayey
W = Depth to Watertable

[5]Recommended Soil Salvage Depth.

Source: USDA-NRCS 2007a.


LEGEND
Goldstrike Mine Operations Boundary
Tailings
Pit Expansion
Perimeter Buffer to Laybacks
Waste Rock Facility
Clydesdale Haul Road
Tailings Pipeline
Fair
Poor
Not Rated
Source: USDA-NRCS 2007a.
N
0 0.25 0.5 1 Miles
Betze Pit Expansion Project
Figure 3.5-3
Topsoil Storage Suitability within the Project Boundary
SSURGO Soils
BL = Bosco-Welch association
BM = Boulflat-Havingdon association
BX = Bucan-Humdun association
CC = Chen-Pie Creek-Ramires association
CG = Cherry Spring-Cortez-Chiara association
SE = Slaven-Primeaux association
SR = Stampede-Donna association
W = Water
WE = Welch-Bosco association
Proposed Goldstrike No. 3 Tailings Facility
Perimeter Buffer to Laybacks
Pit Laybacks
Proposed Haul Road
Proposed Clydesdale Waste Rock Facility
Elko Co.
Eureka Co.
T 36N, R 50E
T 35N, R 50E
T 36N, R 49E
T 35N, R 49E

slopes. The entire soil profile is very to extremely gravelly to lithic bedrock and is not recommended for growth media. The Primeaux series consist of moderately deep well drained soils that occur on uplands. The upper 20 inches is suitable for growth media. The SE association is found in the northern and eastern portions of the study area.

The Welch-Bosco and Bosco-Welch associations occur to a smaller extent in the mid-western portion of the study area on flood plains, stream terraces, and inset fans. The Welch series are very deep, poorly drained and very poorly drained soils. These soils are very fertile and have a clay loam surface and subsoil. The entire profile (60+ inches) is suitable for growth media. The Bosco series are very deep and are somewhat excessively drained. They occur on nearly level, recent stream terraces and deltaic fans at the mouth of streams. The soil is very gravelly throughout the profile.

In summary, most of the undisturbed soils found within the Betze expansion area have suitable growth media characteristics in the upper portions of the soil profiles. The underlying substratum is not recommended for salvage as growth media in all but floodplain soils due to rock fragments and/or undesirable physical and chemical properties. Where an indurated duripan is encountered, soil salvage activities should be halted.

Since BGMI began operating the Goldstrike Mine in 1987, topsoil has been stripped from all disturbed areas and stockpiled. Prior to 1987, a comprehensive topsoil removal program had not been initiated, so not all of the available topsoil was recovered for reclamation. However, growth media shortages are not anticipated because, in addition to topsoil, pit alluvium from the Carlin Formation would be used for reclamation. Carlin material was utilized as growth media on selected areas for reclamation of the AA Leach Pad. Over time the Carlin material had a higher cover of perennial grasses and shrubs (**Figure 3.5-4**) than the topsoiled areas and fewer annual exotic species (Zhan et al. 2006). The Carlin material used for reclamation of the Bazza Waste Rock Facility would likely have higher gravel and cobble contents and lower plant available water capacity. Textures range from silt loam to loamy sand. BGMI estimates that available topsoil stockpiles, in conjunction with the 49 million tons of mined Carlin material, would be sufficient for reclamation efforts outlined in the Reclamation Plan.

### 3.5.2 Environmental Consequences

Mining activities could impact the soil resource when soils are disturbed. Impacts also may occur post-mining when the final growth medium is redistributed during reclamation activities. Issues related to soils and reclamation during the proposed Betze Pit Expansion Project include the following:

- Potential erosion impacts;
- Availability of suitable soils and growth media for revegetation; and
- Potential for successfully reclaiming mine-related disturbance.

<u>Erosion</u>

Susceptibility to erosion is a function of characteristics such as soil texture and structure, topography, surface roughness, soil cover (made up of vegetation, duff/litter, rock, and woody debris), and climate. Erosion also may be influenced by the length of time the soils are bare and by disruption of drainage and erosion control structures. Erosion resulting from water occurs primarily on loose, non-cohesive soils on moderate to steep slopes, particularly during high intensity storm events. Soil erosion is typically accelerated on slopes with lower than average drainage density. Wind-induced erosion often occurs on dry, fine, sandy soils where vegetation cover is sparse and strong winds are prevalent.

Soils subject to water erosion include steeply sloping land with shallow soils. Erosion hazard of the native soils across the project area are shown in **Table 3.5-1**. Sandy and silty textured, sparsely vegetated

**Figure 3.5-4 Carlin Material Vegetative Cover on AA Pad in 2006 Leach Pad at Treatment Area H6 with 3:1 Slope and West Aspect (Cedar Creek Associates 2007a)**

soils are subject to wind erosion. Although accelerated erosion due to mining-related soil disturbance could occur at any stage of the project, the maximum potential for erosion within the study area would be expected while soils are loose, with no established cover. Erosion also will be of concern after reclamation work has occurred but before a vegetative cover has been reestablished. If the ground surface is left smooth and bare during this period, winds could dislodge soil particles and rainfall intercepting bare surfaces could result in increased erosion.

Soil Productivity

The mixing of soil horizons during excavation, piling, and reapplication for reclamation would lower soil productivity by diluting the physical, biological, and chemical properties of the topsoil with less productive subsoil. Segregation of topsoil helps to mitigate these effects. If topsoil is lost, mitigation can be difficult because it may take many years for a topsoil horizon to form naturally.

Physical and chemical properties such as high sodium content, high alkalinity, low organic matter, high salinity, rock fragments, high carbonates, and high sand or clay content have a negative effect on soil productivity and can alter revegetation potential and other reclamation work.

Soil Compaction and Rutting

Soil compaction occurs when soil particles are pressed together and the pore spaces between them are reduced while bulk density is increased. Moist fine textured soils are most susceptible to severe compaction. However, compaction also may occur on loamy to coarse textured soils and under drier conditions due to multiple passes by heavy mechanical equipment.

Soil that is excessively compacted is limited in its ability to function. Compaction damages soil structure and reduces pore space, which impedes the movement of air and water to plant roots and can result in lower growth rates and hinder revegetation. Compaction reduces infiltration and results in excessive surface runoff, erosion, nutrient loss, and potential water-quality problems. Detrimental soil compaction, when extreme and unmitigated, can result in an irretrievable reduction in soil productivity.

Rutting occurs when the soil strength is not sufficient to support the applied load from vehicle traffic. Rutting affects the surface hydrology of a site as well as the rooting environment. The process of rutting physically severs roots and reduces the aeration and infiltration of the soil, thereby degrading the rooting environment. Rutting also disrupts natural surface water hydrology by damming surface water flows, creating increased soil saturation upgradient from ruts, or by diverting and concentrating water flows creating accelerated erosion. Rutting is most likely to occur on moist or wet fine textured soils but also may occur on dry sandy soils due to their low soil strength.

Soil compaction and rutting could result from the movement of heavy mining vehicles. The degree of compaction would depend on the moisture content and texture of the soil at the time of impact. Compaction would be most severe where heavy equipment operates on moist to wet soils with high clay contents. Detrimental compaction also can occur on soils of various textures and moisture contents if multiple passes are made by high ground-weight equipment (i.e., rubber-tired heavy equipment).

Soil Contamination

Soil contamination could result from material spills during mining activities. If large spills occur, contamination could result in the removal and disposal of large amounts of soil. Saturated soils have the potential to diffuse contaminants.

Soil Crusts

Biological soil crusts are considered an important component in dry arid ecosystems. In dry arid environments biological soil crusts are essential for soil stability due to less vegetative growth and soil

cover. They provide soil stability, prevent erosion, fix nitrogen, increase infiltration rates, and may reduce noxious weed migration. No data exists on soil crust coverage of the study area, however, research shows that biological soil crusts do best where sedimentary parent materials are found (Belnap et al. 2003). Crusts are very sensitive to ground disturbances, but in moister sagebrush habitats, crusts should begin to recover within a couple decades and form reasonably well developed communities after a few more decades (Nevada Department of Conservation and Natural Resources 2002).

Reclamation

During development of mining projects in Nevada, suitable soil resources and/or growth media substitutions are salvaged as land disturbance proceeds. These materials typically are stockpiled and protected for later use in seedbed reconstruction during agency-approved reclamation programs.

State and federal regulatory programs that address project reclamation are administered by the NDEP and BLM. Within NDEP, the BMRR oversees reclamation planning and bonding for state and private lands as required under NAC Chapter 519A.010-519A.415. In addition, a Memorandum of Understanding (MOU) for Mining and Mineral Related Activities exists between NDEP, BLM, and the USFS to coordinate the state and federal reclamation programs. Entered into in July 2002, this agreement ensures that adequate reclamation planning and programs address affected lands within a study area.

Under the MOU and applicable regulations, mining companies must develop detailed reclamation plans and establish financial assurances for their successful implementation. Such plans address concurrent reclamation and stabilization practices that are implemented as a project proceeds, as well as post-mining practices that are implemented during the final stages of project completion. Concurrent reclamation typically consists of revegetation, erosion controls, and associated drainage practices that minimize the impacts of clearing and accelerated erosion during project activities. Final reclamation is conducted following completion of mining and processing activities.

Final reclamation programs are oriented to control accelerated erosion, sedimentation, and drainage, as well as protect public safety and restore approved productive land uses. Typically, to address this latter objective, productive vegetation communities must be successfully re-established as an outcome of recontouring, growth media reconstruction, and revegetation efforts.

As part of agency activities under the CWA, NDEP also administers the USEPA-approved state program to issue storm water permits. This program involves additional regulations for controlling accelerated erosion and sedimentation, storm water drainage and discharges, and associated water quality. Plans and activities implemented under this program also avoid or minimize potential impacts to soil resources, and promote overall site stabilization as a project proceeds. Water quality regulations and related guidance for mining projects are administered by NDEP under NAC Chapter 445A. These regulations also form part of the inter-agency MOU for Mining and Mineral Related Activities.

#### 3.5.2.1 No Action Alternative

The proposed expansion of the Goldstrike Mine would not occur under the No Action Alternative, and associated impacts to soils from further mining or processing components would not occur. Under this alternative, the existing mine would continue to operate as currently authorized.

Rodeo Creek Diversion

Rodeo Creek would be diverted from its current alignment north of the Betze Pit and routed south of the pit (**Figure 2-4**). Where diverted, the hydric soils associated with the current Rodeo Creek alignment would be permanently altered. The soils currently associated with Rodeo Creek are the Welch-Bosco association. These soils formed from alluvial processes on floodplains and stream terraces. The soils that become associated with the diversion may take on hydric characteristics.

Soil Suitability and Reclamation Success

Reclamation procedures and schedules would continue unchanged. Growth media resources have been salvaged to the extent practical during current mining activities, and reclamation progress has been satisfactory under approved state and federal guidelines. Reclamation of the Bazza Waste Rock Facility would continue to proceed in stages and would not be completed until 2018. Less Carlin formation growth media would be available for use in reclamation of the Bazza Waste Rock Facility, potentially affecting reclamation success.

Water Management Activities

The groundwater drawdown effect associated with a continuation of dewatering activities through 2015 under the No Action Alternative may have drying effects on the hydric soils associated with wetlands, seeps, and springs within the predicted 10-foot drawdown contour (**Figure 3.3-26**). This would change the microbial and chemical characteristics of the soils and alter the vegetative community. The projected 10-foot drawdown contour for the No Action Alternative is similar to the 10-foot drawdown contour projected in the Betze Project SEIS (BLM 2000a, 2003a) (**Figure 3.3-26**). As a result, impacts to hydric soils are predicted to be similar to the impacts described in the Betze Project SEIS. These impacts to hydric soils are within the cumulative effects 10-foot drawdown area that was disclosed and mitigated for in the Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48**. Upland soils would not be affected by groundwater drawdown.

#### 3.5.2.2 Proposed Action

Surface Disturbance

The proposed expansion of the Betze project area would result in approximately 1,180 acres of new disturbance to soils.

*Soil Suitability and Reclamation Success*

Soil mapping units that are located in proposed disturbance areas are shown in **Figure 3.5-2**. Replacement of vegetative growth media is proposed for major disturbances associated with the proposed project. Salvaged growth media would comprise both native soil materials and Carlin Formation pit alluvium. The Carlin Formation material is physically and chemically suitable for plant growth, and has successfully been used for revegetation efforts within the currently authorized project area. The recommended salvage depth for native soil material is identified in **Table 3.5-1**.

Much of the disturbance from the proposed expansion of the Betze Pit and Clydesdale Waste Rock Facility would occur where the Cherry Spring-Cortez-Chiara soils are mapped. These soils are shallow to moderately deep to a duripan and are gently sloping. The proposed Goldstrike No. 3 Tailings Facility would be constructed over the existing (inactive) Mill No. 4 Tailings Facility and would occur where the Stampede-Donna association is mapped. The Stampede series is moderately deep to a duripan. The upper 12 inches should be recovered for use as growth media. The clay subsoil from 12 to 28 inches may be recovered and stockpiled separately for use as an evapotranspiration cover for the reclamation of the Clydesdale Waste Rock Facility. The haul road from the Betze Pit to the Clydesdale Waste Rock Facility would cross the Welch-Bosco floodplain soils. The Welch series is poorly drained with a thick dark organic surface. Where disturbed, the entire soil profile can be salvaged for reclamation. However, these are sensitive and productive soils, so disturbance should be avoided where possible. The Bosco series is a gravelly loam throughout the profile and somewhat excessively drained. The upper 15 inches of the Bosco series may be salvaged. The high gravel content can be diluted through mixing or may be used as a mulch type of material to retain water. See **Table 3.5-1** for approximate recovery depths.

Overall site productivity is primarily a matter of revegetation success. Productivity varies with vegetation community, but more importantly, with land management objectives as they relate to the establishment of

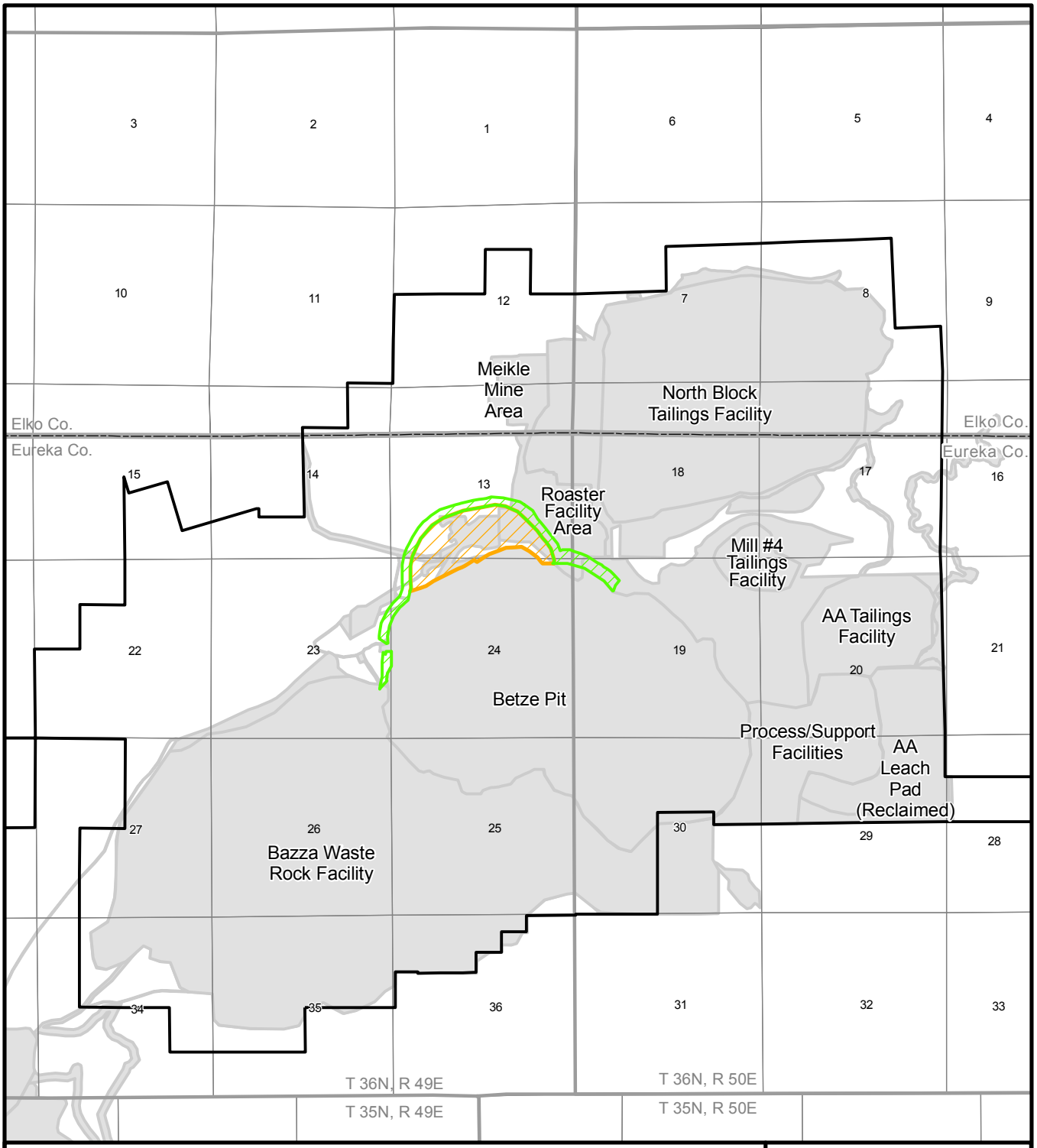
desirable or productive vegetation types. In contrast, soil quality is an inherent soil resource characteristic involving aeration, permeability, texture, salinity and alkalinity, microbial populations, fertility, and other physical and chemical characteristics that are accepted as beneficial to overall plant growth and establishment. Based on this concept, there would be impacts to the existing quality of native soils from project-related disturbance. Growth media excavation, transport, storage, and redistribution would modify existing soil structure, generating adverse impacts relative to aeration and permeability. It is likely that some mixing of textural zones would occur, as well as mixing of saline and/or alkaline materials with relatively salt-free materials. This mixing may create adverse chemical impacts to soil quality for seedbeds. Currently existing microbial populations would likely decrease during growth media stockpiling and storage. Due to these probable effects, the initial soil quality of reconstructed seedbeds and root zones would be less than that of the existing soil resources. In addition, compaction from vehicular traffic would occur during construction of the transmission line re-route and haul road, decreasing soil quality in those areas. A permanent irreversible loss of soil productivity would occur on approximately 129 acres in association with the proposed pit laybacks and perimeter buffer, which would not be backfilled and would fill slowly with water after closure. Irretrievable impacts for the proposed project are shown in **Figure 3.5-5**.

Over time, these impacts would be reduced based on BGMI's commitment to reclaim project components and successfully restore productive post-mining land uses. These objectives would be attained through the use of BMPs, as well as the use of site-adapted plant species for reseeding. In addition, state and federal reclamation requirements require revegetation monitoring in comparison with established quantitative standards for the locale. A period of overall reclamation monitoring (and maintenance as necessary) also is required prior to agency approval of reclamation bond release. Based on these requirements, it is likely that short- to long-term (e.g., up to 10 years or more) decreases in soil quality would not limit the attainment of overall post-mining land use objectives. Over time, soil quality on reclaimed and revegetated sites would resemble pre-mining conditions. Significant effects on the desired post-mining site productivity from soil quality impacts are not anticipated.

To address potential erosion concerns for the Clydesdale Waste Rock Facilities, erosion and sedimentation were modeled using the Water Erosion Prediction Project (WEPP) for Windows model 2006.500. Modeling was performed on two common particle size diameters for ROM Carlin material, which also exhibited some similarities to salvaged soil materials (Schafer and Geosystems Analysis 2006). ROM #1 consisted of a silt loam alluvium with 50 percent rock fragments and ROM #3 consisted of a sandy loam alluvium with 50 percent rock fragments. In addition, modeling was performed for a reference area consisting of a native soil, Slaven extremely gravelly loam, using an average slope for the map unit. Vegetation data was used to estimate total soil cover from the initial planting to the 6$^{th}$ year of vegetative growth (Cedar Creek Associates 2007a). William Elliot, one of the scientists involved in the development of the WEPP model, was consulted for ideal management scenarios that would best mimic the planted slopes of the Waste Rock Facilities (Elliot 2008).

Modeling results indicate erosion would exhibit similarities to typical erosion rates on nearby native slopes. Average annual sediment yield the first year after seeding was 0.2 ton per acre for the ROM #1 and 0.1 ton per acre for the ROM #3. The native soil resulted in an average annual sediment yield of 0.1 ton per acre based on existing soil cover as detailed in the Revegetation Monitoring Report (Cedar Creek Associates 2007a). Over time, as the vegetative cover is established (generally by the third growing season), the ROM #3 exhibited no annual sediment yield. The annual sediment yield for ROM #1 declined to 0.1 ton per acre by the second growing season. Based on these results, erosional impacts are not expected to compromise the ET covers on the Waste Rock Facilities.

An additional issue for the Proposed Action concerns the final reclamation configuration of the Clydesdale Waste Rock Facility. Hillslope and drainage characteristics of the proposed component are of concern, given recent storm and drainage impacts on mining components in the region. As indicated in the Surface Water discussion (Section 3.4), a substantial storm event occurred in the BGMI project area shortly after reclamation activities had been completed at the AA Leach Pad. Although overall cover integrity was successfully maintained, the surface drainage system required re-design and repair. As a result, these




**LEGEND**

- Goldstrike Mine Operations Boundary
- Pit Expansion; Irretrievable Impact
- Perimeter Buffer to Laybacks; Irretrievable Impact

N

0 0.25 0.5 1 Miles

Source: BGMI and SRK 2007; BGMI 2007a.

**Betze Pit Expansion Project**

Figure 3.5-5

Irretrievable Impacts to Soil Resources

06/25/2008

revised design concepts have been carried forward in current site activities, as well as in the existing Final Permanent Closure Plan for the Bazza Waste Rock Facility (Schafer and Geosystems Analysis 2006).

Due to a number of resource considerations and potential impacts, the reclaimed Clydesdale Waste Rock Facility should have similar soil and drainage characteristics, vegetation, and habitat when compared to natural hillslopes in the vicinity of the project. For this to be possible, slope stability and soil erosion rates need to approximate those that exist nearby. To accomplish this, it is recommended that constructed drainage basins should have drainage areas, basin relief ratios, valley gradients, and drainage densities that are similar to those found in undisturbed areas nearby. In addition, channels should have geomorphic characteristics that are comparable to those found on undisturbed hillslopes nearby. In order to achieve these goals and mitigate potential adverse impacts related to site stability, surface drainage, wildlife habitat, and visual resources, additional mitigation is recommended (SOILS-1).

Although preliminary component designs for the Proposed Action are sufficient to proceed with NEPA assessments, additional design work remains to be completed if the Proposed Action were to actually be undertaken. As a result, BLM-approved design criteria such as drainage density, basin relief ratios, achievable average hillslopes, and other geomorphic and drainage characteristics have not yet been determined for the Clydesdale Waste Rock Facility.

#### 3.5.2.3 Bazza Waste Rock Facility Alternative

The impacts associated with this alternative would be similar to the Proposed Action except soil disturbance would be approximately 572 acres less because the Clydesdale Waste Rock Facility and the haul road associated with the facility would not be constructed. Impacts associated with construction, operation, and reclamation of the Clydesdale Waste Rock Facility would not occur.

The distance traveled between the pit and the Bazza Waste Rock Facility would be increased. With increased distance traveled, there is an increased risk of displacement and rutting when the road is wet. Traffic induced dust emissions and related wind erosion could increase. There could be additional impacts associated with increased road maintenance on the existing haul road to the Bazza facility. Typically, immediately after a native surface or graveled road is maintained erosion increases. Surface erosion is dependent on soil type, road surfacing, road grade, age of the road, traffic volumes, maintenance practices, and the effectiveness and spacing of drainage features. Very fine soils are easily displaced and rutted when wet. Coarse soils with few fines have little cohesiveness and can be easily eroded. Typically, native surface roads experience greater erosion of the road surface than do graveled roads. BMPs would be implemented to reduce these impacts, including storm water and dust controls.

Under the Bazza Waste Rocky Facility Alternative, reclamation on the Bazza Waste Rock Facility would occur approximately 7 years later than with the Proposed Action. This would result in extended storage of the reclamation material such as Carlin material and soil growth media. Long-term and increased storage of Carlin material has proven difficult due to slope stability issues, safety, and low soil strength when wet (see Section 2.4, Bazza Waste Rock Facility Alternative). Much of the Carlin Material from the pit alluvium would be disposed of in the Bazza facility due to poor storage ability and would be unavailable for reclamation use. Under this alternative, the height of the Bazza Waste Rock Facility would increase by approximately 100 feet over the maximum height of the facility under the Proposed Action. Waste rock would be handled according to the Bazza Waste Rock Management Plan (Schafer and Geosystems 2004) and the facility reclaimed according to the reclamation plan.

It is assumed for this alternative that reclamation of higher elevation lifts on the Bazza Waste Rock Facility would follow the approach set forth in the Final Permanent Closure Plan for the Bazza Waste Rock Facility (Schafer and Geosystems Analysis 2006). A geomorphic approach to reclamation was analyzed in that document, and surface drainage configurations and stability were considered in detail. As described for the proposed Clydesdale Waste Rock Facility under the Proposed Action assessment, the erosion rates of Carlin materials were modeled using the WEPP for Windows 2006.500. Very low erosion rates were predicted from average slopes. Even if topsoil or other growth media were used, erosion from reclaimed

Bazza waste rock slopes would likely be within soil loss tolerances. Surface erosion is not expected to compromise the ET cover or revegetation success for the Bazza Waste Rock Facility alternative.

### 3.5.3 Cumulative Impacts

The CESA (**Figure 3.5-1**) encompasses the project boundary and includes surface disturbance associated with past and present actions and RFFAs within the Carlin Trend and the soils that drain the Carlin Trend to the confluence with the Humboldt River (Section 3.1).

Information on soil resource disturbances in the CESA was developed from aerial photo interpretation, soil survey information, and previous EISs.

#### 3.5.3.1 No Action Alternative

Dewatering impacts associated with nearby mining activities, including the Goldstrike Mine, will continue to contribute to cumulative impacts in the study area. Impacts include changes to the drying of hydric soils, soil microbial community, reduced riparian and wetland vegetation and increased susceptibility of the soil to erosion. These impacts are within the cumulative effects 10-foot drawdown area that was disclosed and mitigated for in the CIA (BLM 2000b) and Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48** and discussed in Section 3.3.3.1.

#### 3.5.3.2 Proposed Action

Cumulative impacts to soils result from surface disturbance related to mining, fire, grazing, farming, recreation, industrial development, roads, municipalities, and other natural and anthropogenic activities within the analysis area.

In addition to mining activities in the CESA, the Newmont TS Power Plant is scheduled to be completed in the first half of 2008 (PR News Wire 2006). A permanent loss of soil productivity is expected in the disturbance area. Soil erosion and mixing may occur during construction.

Municipalities such as Dunphy, Battle Mountain, and Carlin contribute to a decrease in soil quality in the CESA. Typically runoff and erosion increases substantially in compacted areas or on paved surfaces. Soils are often anthropogenically altered in and around municipalities.

Numerous major wildfires have occurred in the study area creating additional regional impacts to soils (BLM 2007b,c). High severity wildfires result in increased water repellent (hydrophobicity) soil, which limits infiltration, combustion and increased mobility of some soil nutrients, mortality of some soil organisms, combustion of surface soil organic matter and loss of effective ground cover that leaves the soil susceptible to erosion and could contribute to noxious weed spread (Korb et al. 2004). Detrimental and severe soil effects can occur down to 10 centimeters (cm) below the surface (Massman et al. 2003). Areas with detrimental soil conditions can persist for decades.

Mining occurs throughout the study area. Mining disturbances include salvage and stockpile of soil for use in reclamation. Growth media excavation, transport and storage, and redistribution would modify existing soil structure, generating adverse impacts relative to aeration and permeability. It is likely that some mixing of textural zones would occur, as well as mixing of inhibitive horizons, such as saline and/or alkaline materials, with growth media. This may create adverse chemical impacts to soil quality for seedbeds. Whatever microbial populations currently exist would likely decrease during growth media stockpiling and storage. Soil erosion may occur before a protective cover crop can be established on stockpiles. Once a cover crop is established, soil erosion would be minimized. Similarly, redistribution of soil during reclamation would leave the soil vulnerable to wind and water erosion. Compaction also may occur during reclamation if repeated passes with heavy equipment occur over growth media.

Mining-related activities have resulted in an estimated 34,000 acres of soil disturbance in the Carlin Trend. The Proposed Action incrementally would increase soil disturbance within the CESA and related impacts by 1,180 acres. It is assumed that portions of past mining-related disturbances have been reclaimed, and ongoing reclamation at existing operations would continue to reduce impacts to soils. The incremental addition of soil impacts as a result of the Proposed Action would be temporary in nature for most of the project facilities, pending completion of successful reclamation. Based on permitting requirements relative to reclamation, it is assumed that the majority of the soil disturbance and associated impacts as a result of future activities also would be reclaimed and temporary.

#### 3.5.3.3 Bazza Waste Rock Facility Alternative

Cumulative impacts to soil resources for the Bazza Waste Rock Facility Alternative would be similar to those described for the Proposed Action except that there would be an incremental decrease in cumulative soil disturbance of 572 acres.

### 3.5.4 Mitigation Measures and Monitoring

#### 3.5.4.1 Issue

Uncertainties exist about hillslope and drainage parameters at the proposed Clydesdale Waste Rock Facility and whether or not they could be successfully achieved at the proposed site. Long-term site stabilization and the restoration of productive post-mining land uses would require the successful achievement of a satisfactory reclamation design for the proposed facility volume within a proposed footprint.

Recommended Mitigation Measure S-1

BGMI shall prepare a conceptual plan for reclaimed morphometry and hydrology of the Clydesdale Waste Rock Facility and present this plan to BLM for review and approval. This plan will outline and depict how BGMI intends to construct watersheds, hillslopes, and channels that mimic natural conditions, thereby minimizing erosion and promoting long-term stability. BGMI shall use drainage area, basin relief ratios, valley gradients, drainage densities, channel characteristics, and any other useful parameters from comparable nearby landforms to compute and justify watershed characteristics of the proposed facility. This conceptual plan must be approved by BLM before the Waste Rock Facility reaches one-half of its proposed volume. In addition, this conceptual plan must be submitted by January 1, 2009.

Further mitigation will be based on BLM's response to the conceptual Clydesdale plan. If BLM determines that the plan is adequate, no additional mitigation will be required. If the conceptual plan is inadequate, BLM will work with BGMI to reach an acceptable solution. If the solution does not fall within the Proposed Action (e.g., footprint of the facility is not large enough to store proposed waste rock volume), BGMI may be required to conduct additional environmental analysis and submit the appropriate supplemental NEPA documents. The conceptual plan along with any adjustments or additional mitigation must be approved by BLM before the proposed Clydesdale Waste Rock Facility reaches one-half of its proposed volume.

Effectiveness

The additional reclamation design and its implementation for the proposed Clydesdale Waste Rock Facility would mitigate the potential for accelerated erosion and drainage instability to compromise the ET cover and post-mining land uses at that component. Potential adverse impacts to long-term site stability, water quality, wildlife habitat, and visual resources would be avoided or minimized.

### 3.5.5 Residual Impacts

Residual adverse effects to soils would include a permanent irreversible loss of soil productivity on approximately 129 acres in association with the proposed expansion of the pit, which would be partially backfilled and at closure will slowly fill with water.

## 3.6 Aquatic Resources

The aquatic resources study area for direct and indirect impacts encompasses the Boulder Creek subbasin. The CESA includes the Maggie Creek subbasin and Antelope Creek drainage (part of Willow Creek subbasin) (**Figure 3.6-1**). The CESA for aquatic biology was defined based on the area that was used in the hydrology modeling analysis. The linkage to the hydrology analysis provided coverage for aquatic biology resources within the area potentially affected by groundwater drawdown for cumulative actions. The types of information used to characterize aquatic resources consist of habitat and distribution/occurrence information for fish, amphibian, and invertebrate species or groups. This discussion focuses on new or updated information available since the Betze Project Draft and Final SEIS (BLM 2000a, 2003a).

### 3.6.1 Affected Environment

#### 3.6.1.1 Habitat and Aquatic Biology Resources

Boulder Creek Subbasin

Aquatic habitat in the Boulder Creek subbasin consists mostly of intermittent and ephemeral channels that are part of Rodeo, Bell, Brush, and Boulder creeks (**Figure 3.6-1**). Portions of Brush Creek have been dry since 1994 as a result of mine dewatering (Adrian Brown Consultants 1999; AATA 2006). Habitat conditions and aquatic communities are assumed to be similar to descriptions provided in the Betze Project Draft and Final SEIS (BLM 2000a, 2003a), because no channel modifications or management changes have been implemented during the past 4 years with the exception of the Brush Creek diversion channel. Habitat quality was rated as poor in the lower and middle portions of these streams as a result of relatively low flows, grazing, and erosion (JBR 1994). Perennial stream sections exist in upper Boulder Creek where moderate quality habitat is present. Previous sampling in the subbasin has collected Lahontan speckled dace (*Rhinichthys osculus robustus*) in areas where water is present on a fairly consistent basis. Macroinvertebrate sampling in these streams revealed a low number of taxa (3 to 16) that were tolerant of limited habitat conditions (JBR 1994, 1992b). The most abundant taxa included chironomid midges, elmid beetles, and ostracods. The headwater areas of Boulder Creek contain a more diverse and abundant macroinvertebrate community as a result of more persistent flow and higher quality habitat.

Willow Creek and Rock Creek Subbasins

Two tributaries, Antelope Creek (Rock Creek Subbasin) and Willow Creek (Willow Creek Subbasin), are located north of the Betze Mine. Antelope Creek is an intermittent stream that drains much of the area west of the Sheep Creek Range. Six monitoring spring sites have been monitored in this drainage (AATA 2006). Consistent annual flow was observed only at two of the springs located in the headwaters of the drainage. Due to the intermittent nature of Antelope Creek, fish habitat is limited, although they have been observed in Antelope Creek where the road from Rossi Mine to the Hollister Mine crosses the creek. The only aquatic surveys performed have focused on springsnails, which are discussed in Section 3.6.1.2.

Aquatic habitat has been characterized at three monitoring sites in Upper Willow Creek between Willow Creek Reservoir and upper portions of the drainage as part of Barrick's UWCHEP. This monitoring plan was established in 2003 in Nelson, Lewis, and Willow creeks to mitigate potential direct, indirect, and cumulative effects identified in the Betze SEIS. The UWCHEP includes pasture fencing and prescription grazing with benefits for 20 miles of aquatic habitat and over 12,000 acres of upland acres. Recent surveys in 2006 have shown improvements in riparian and stream habitat conditions (Cedar Creek Associates 2007b). Streambank conditions at the three Willow Creek monitoring sites were characterized has having stable streambanks (58 to 93 percent of optimum conditions) and moderately developed vegetative cover (55 to 75 percent of optimum conditions) (Cedar Creek Associates 2007b). Fish communities are expected to be similar to perennial sections of upper Boulder Creek.

Maggie Creek Subbasin

Based on studies conducted in 1987 through 1997, aquatic habitat and fish and invertebrate communities in the Maggie Creek subbasin were described in the Betze Project Draft and Final SEIS (BLM 2000a, 2003a) (**Figure 3.6-1**). The following information provides a summary of aquatic resources in this subbasin with emphasis on studies conducted since 1997.

Diverse aquatic habitat conditions are present in the Maggie Creek subbasin. The lower reaches of tributary streams such as Little Jack, Coyote, and Lynn creeks often dry up during the summer months. In contrast, the headwaters of Little Jack, Coyote, and Simon creeks and the wet-meadow areas along lower Coyote and Little Jack creeks exhibit stable vegetated channels with higher volumes in the summer months. The following mitigation and monitoring plans have resulted in improved habitat conditions in this subbasin:

- Maggie Creek Watershed Restoration Project Monitoring Program (included in 1993 and 2002 SOAP and SOAPA mitigation plans). Studies by Open Range Consulting (2007) showed an increase of 193 acres of wetland riparian vegetation and a 1.8-mile increase in stream length (due to additional stream sinuosity) along Maggie Creek between 1994 and 2006. Sediment loading has been reduced by more than 8,000 tons per day (expressed as total suspended solids) during similar flow conditions in 2005. Habitat quality improved as a result of increased woody riparian vegetation (overhanging cover), improved pool quality, and depth at the shore-water interface (Trout Unlimited 2007).
- Mitigation Plan for the 2002 Leeville Project: A conservation easement was extended for the Maggie Creek Watershed Restoration Project.

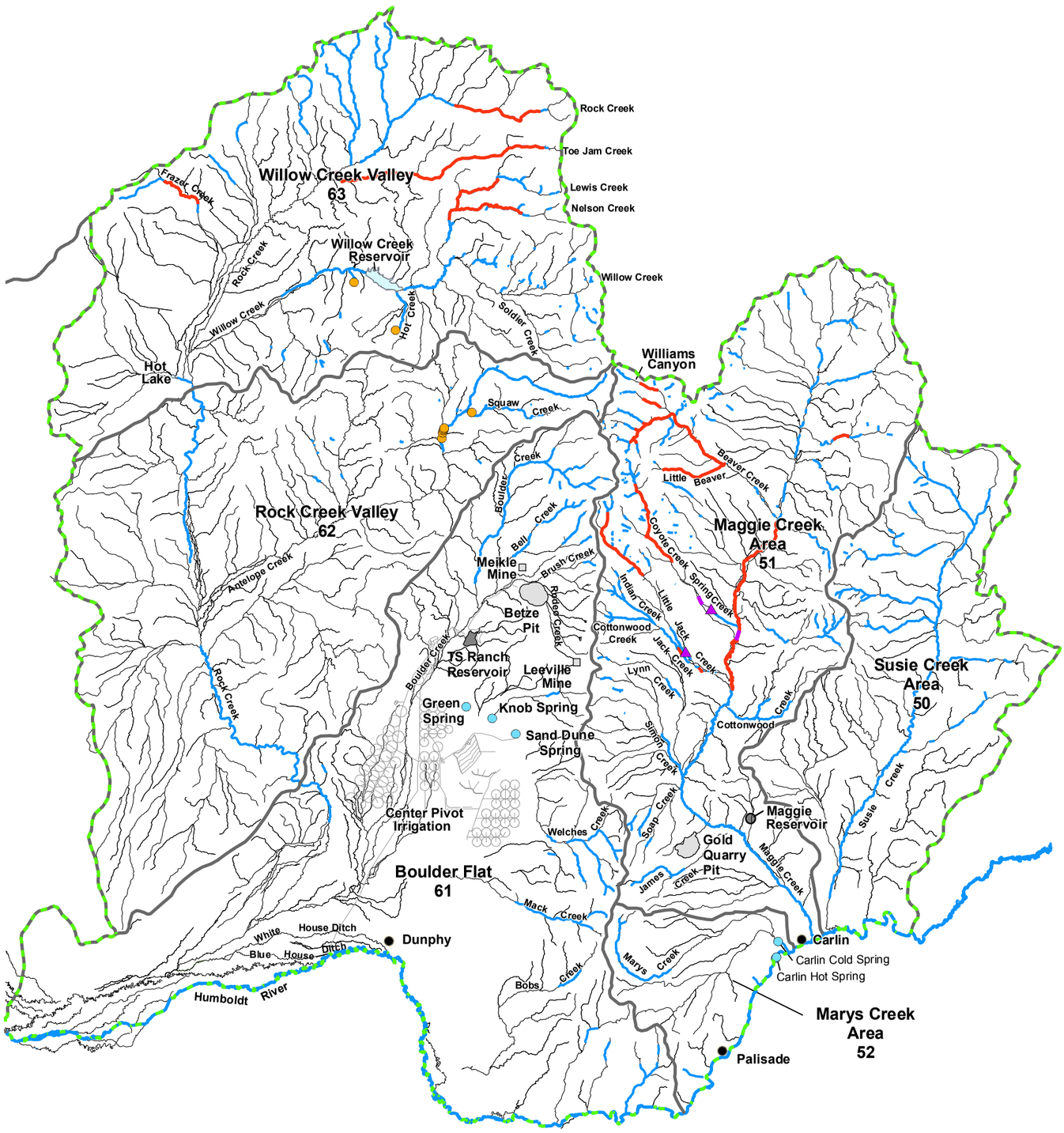
Habitat surveys have been conducted by the BLM in portions of the Maggie Creek subbasin between 2000 and 2006 (BLM Elko Field Office Files, as cited in BLM 2007b). The studies showed the following condition ratings based on an average bank cover and bank stability in relation to optimum conditions: poor (James and Indian Jack creeks), good (Maggie and Susie creeks), and excellent (Coyote and Little Jack creeks and the Beaver Creek drainage). Flooding in 2005 and 2006 caused widespread erosion in the subbasin, but the streams with good and excellent condition ratings have recovered to pre-flood habitat quality (BLM 2007b).

Fish communities in the Maggie Creek subbasin mainly consist of a mixture of trout, sucker, and minnow species (**Table 3.6-1**). Speckled dace represented the most common and widespread species. LCT is the only trout species presently occurring in the Maggie Creek subbasin. Previous surveys have collected brook trout in Spring Creek (tributary to Coyote Creek), but none were found in 1997 (BLM 2007b). Additional information for LCT, a federally listed species, is provided in the Special Status Species section. The remaining game fish species present in this subbasin is smallmouth bass (*Micropterus dolomieu*), which was collected in lower Maggie Creek in 2006 and 2007 (MFG, Inc. 2006 as cited in BLM 2007b).

Macroinvertebrate communities in the Maggie Creek subbasin reflect variable abundance and composition depending on habitat conditions. In most instances, moderately diverse and productive communities were reported in the headwater portions of tributary streams (JBR 1992c; AATA 1998, 1997). Macroinvertebrate composition in the headwater areas of the subbasin streams also contained taxa that were indicators of good water quality conditions. The most abundant taxa included mayflies, caddisflies, Diptera, midges, and amphipods. The middle and lower portions of the streams were dominated by pollution-tolerant taxa such as chironomid midges, oligochaete worms, blackfly larvae, and mayflies (*Baetis* spp.).

### 3.6.1.2 Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed species that are protected under the Endangered Species Act (ESA), species of concern as identified by the U.S. Fish and Wildlife Service (USFWS), and species designated as state sensitive by the BLM. Nevada State protected lists are provided by NDOW (2007a).




**LEGEND**

- Lahontan Cutthroat Trout
- Spotted Frog Potential Habitat
- Spotted Frog Collection Sites
- Springsnail Locations
- Lahontan Cutthroat Trout, Spotted Frogs, and Springsnails Cumulative Effects Study Area
- Groundwater Basin Boundary
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Note: USGS 2007 line graph database. Hydrographic Area Boundary locations are approximate.

Source: BGMI 2007a; BLM 2000a.

N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.6-1

Current Distribution of Lahontan Cutthroat Trout, Spotted Frogs, and Springsnails Occurrence

**Table 3.6-1 Fish Species in Maggie Creek Subbasin**

| Common Name | Scientific Name | Drainage | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Buck Rake Jack | West Cottonwood | Coyote | Indian | Jack | Little Jack | Maggie | Lone Mountain Creek (Maggie Creek Headwaters) | Beaver Creek Drainage | Susie |
| Lahontan cutthroat trout | *Oncorhynchus clarki henshawi* | -- | -- | X | -- | -- | X | X | X | -- | -- |
| Lahontan redside shiner | *Richardsonius balteatus* | -- | -- | -- | -- | -- | X | X | -- | X | X |
| Lahontan speckled dace | *Rhinichthys osculus* | X | X | | X | X | X | X | -- | X | X |
| Mountain sucker | *Catostomus platyhynchus* | -- | -- | -- | -- | -- | -- | X | -- | -- | X |
| Smallmouth bass | *Micropterus dolomieu* | -- | -- | -- | -- | -- | -- | X | -- | -- | -- |
| Tahoe sucker | *Catostomus tahoensis* | -- | -- | -- | -- | -- | -- | -- | -- | X | -- |

Source: BLM 2007b; JBR 1992c; AATA 1997; Valdez et al. 1994.

In accordance with the ESA, as amended, the lead agency (BLM) in coordination with the USFWS must ensure that any action that they authorize, fund, or carry out would not adversely affect a federally listed threatened or endangered species. In addition, as stated in Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-121), it also is BLM policy "to conserve listed species and the ecosystems on which they depend, and to ensure that actions requiring authorization or approval by the BLM are consistent with the conservation needs of special status species and do not contribute to the need to list any special status species, either under the provisions of the ESA or other provisions" identified in 6840 Policy. The BLM has engaged in discussions with the USFWS.

Five species or groups of special status aquatic species were evaluated for potential occurrence within the study area and CESA. These include one federally listed fish species (LCT), one federal candidate amphibian species (Columbia spotted frog), one state protected and BLM sensitive amphibian (northern leopard frog), one BLM sensitive mollusk species (California floater), and one group of special concern mollusks (springsnails). The potential occurrence and habitat requirements are discussed below for these species.

Fish Species

*Lahontan Cutthroat Trout*

Detailed information on LCT distribution, abundance, and habitat use of the Maggie Creek subbasin is provided in the Betze Project Draft and Final SEIS (BLM 2000a, 2003a). The following discussion focuses on LCT studies that have been conducted since the Betze Project SEIS. The present distribution of LCT within the Maggie Creek subbasin is limited to the following streams: Little Jack Creek, Jack Creek, Coyote Creek, Beaver Creek, Little Beaver Creek, Toro Canyon, Williams Canyon, mainstem Maggie Creek, and Lone Mountain Creek (**Figure 3.6-1**). In total, approximately 94 miles of potential LCT habitat occurs within this subbasin (Elliott 2004). The distribution of LCT has expanded in Maggie Creek and three of its tributaries (Little Jack, Coyote, and Beaver creeks), as a result of replacing three road culverts and an irrigation diversion in 2005 (Neville and DeGraaf 2007). These perched culverts were known to inhibit but not totally prevent movement of LCT populations between the various streams. The goal of the restoration program is to reconnect these local populations into a metapopulation.

Abundance estimates for LCT were initiated at 44 monitoring sites in Little Jack, Coyote, and Beaver creeks (Neville and DeGraaf 2007). Numbers have fluctuated in these tributaries as a result of environmental factors and restoration practices. Environmental factors that have affected LCT abundance in recent years have included a large fire in 2001 and drought in 2004. LCT population count estimates in 2006 included 378 in Beaver Creek, 141 in Coyote Creek, and 451 in Little Jack Creek. Additional population and tagging studies are proposed to determine if the restoration efforts are re-establishing a connected metapopulation.

LCT spawning typically occurs in April through July depending on stream conditions including flow, water temperature, and elevation (Coffin and Cowan 1995). Spawning habitat consists of gravels in riffle areas. The presence of young-of-the-year fish in Little Jack, Coyote, and Beaver creeks has shown successful spawning in recent years (Neville and DeGraaf 2007).

Amphibians

*Columbia Spotted Frog*

The Columbia spotted frog occurs in wetland habitats, streams, or springs during the breeding season (**Figure 3.6-1**). After the breeding season is completed, they may move considerable distances to upland areas in grassland, shrub, and forest communities (BLM 2000a, 2003a). The potential occurrence of Columbia spotted frog in the study area is discussed in the Betze Project Draft and Final SEIS (BLM 2000a, 2003a). The entire upper Humboldt watershed is considered potential habitat. Columbia Spotted frog has not been observed in the Boulder Valley area. It has been collected in Coyote and Little Jack creeks in the Maggie Creek subbasin.

The Columbia spotted frog occurs primarily in Central Nevada (Nye County) and northeastern Nevada (Elko and Eureka counties), usually at elevations between 5,600 and 8,700 feet (USFWS 2007a). This species prefers quiet aquatic habitats including perennial streams, ponds, springs, lakes, and marshes (USFWS 2007a). The Columbia spotted frog may travel to uplands during wet weather, expanding localized populations. Females begin laying eggs in late April and May, and tadpoles emerge by August. This species has not been documented within or near the study area. The nearest known population is located east of the study area along Maggie Creek, lower Coyote Creek, and lower Little Jack Creek (BLM 2002a). Although previous surveys have not observed this species within the study area, there is marginal habitat along Boulder Creek. The potential for this species to occur within the study area is considered moderate.

*Northern Leopard Frog*

The northern leopard frog is broadly distributed in limited and isolated habitats from eastern Nevada to northern and western Nevada. Most Nevada populations are highly localized and isolated from one another (Wildlife Action Plan Team [WAPT] 2006). This species inhabits permanent water with rooted aquatic vegetation such as springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes (WAPT 2006). In summer, the northern leopard frog commonly inhabits wet meadows and fields. This species takes cover underwater, in damp niches, or in caves when inactive. Eggs are laid and larvae develop in shallow, still, permanent water (typically), generally in areas well exposed to sunlight (WAPT 2006). Eggs are typically attached to vegetation just below the surface of the water. Females begin laying eggs in late April and May, and tadpoles emerge by August. Marginal habitat for this species occurs along Boulder Creek on the far western edge of the study area. The potential for this species to occur within the study area is considered moderate.

Mollusks

*Springsnail Species*

Springsnails, a group of mollusks that are found in perennial springs and seeps, are considered important organisms due to their restricted distribution and native origin. As a result of taxonomic identification difficulties at the species level, most of the records are genus level. The most common genus in the general area is *Pyrgulopsis*. Springsnails usually inhabitat spring sources or wetted areas located immediately downstream of

the source. Other habitat characteristics include low to moderate discharges, stable substrates consisting of gravel, cobble or boulders, and dense aquatic vegetation (McGuire 1996, 1992).

Springsnails have been collected from a limited number of locations within the study area (**Figure 3.6-1**). Based on surveys conducted by McGuire (1995, 1996 as cited in BLM 2003a), springsnails were collected in eight of 41 springs in the study area. None of these sites are located within the Boulder Valley subbasin. The closest springs with known springsnail populations are located in the Antelope and Squaw creek drainages, which are situated in the Rock Creek Valley groundwater basin. Springsnail populations also have been recorded at sites in the Maggie Creek subbasin in Willy Billy Spring and Warm Spring near the Humboldt River (McGuire 1992, as cited in BLM 2000b).

*California Floater*

Recent records for the freshwater mussel, California floater, are limited to Rock Creek Canyon (lower and middle canyon sections) and the mainstem of Maggie Creek (Evans 2008). No habitat or individuals have been observed in the Boulder Valley subbasin. No additional specimens or habitat have been identified since surveys conducted by McGuire (1995 as cited in BLM 2003a). Habitat at collection sites in Nevada primarily have consisted of small permanent streams with pools or runs and varying substrates.

## 3.6.2 Environmental Consequences

The primary issues related to aquatic resources include:

- Loss or changes in existing aquatic habitat; and
- Potential impacts to special status species.

### 3.6.2.1 No Action Alternative

Under the No Action Alternative, project activities that would affect aquatic communities include:

- Surface disturbance activities in the mine area;
- Diversion of Rodeo Creek; and
- Continuation of mine dewatering through 2015 under the current mine plan.

These activities would cause impacts only to the Boulder Creek subbasin. The Antelope Creek area would sustain impacts only from dewatering. Impacts associated with each type of activity are discussed below.

Surface disturbance activities would involve vehicle traffic and mining activities at the existing waste rock dump, Betze Pit, and tailings facilities. Culverts would be constructed on Bell Creek. These activities would generate soil disturbance within the drainages for Bell, Rodeo, and Brush creeks. By implementing engineering design and BMPs for erosion control, sediment input to these intermittent streams would be minor. Construction activities also would involve a reroute of Rodeo Creek, which is not an action involving BLM authorization. A 3.8-mile segment of the stream would be removed and replaced with a new 2.3-mile segment that would direct flow around the southern portion of the Betze Pit. The new channel would be earthen material with a liner. The reroute would result in a temporary loss of aquatic habitat for Lahontan speckled dace and macroinvertebrates in Rodeo Creek. After the new stream segment is established, dace and invertebrates likely would recolonize the stream. The net effect of the reroute would be a reduction of approximately 1.5 miles of intermittent stream habitat.

Aquatic communities such as algae, plankton, vascular plants, benthic macroinvertebrates, and possibly fish could eventually develop in the current mine plan pit lake. Populations are expected to remain low and not represent a substantial food source (BLM 2000a).

The mitigation specified in the Betze Project SEIS (BLM 2003a) addressed all direct, indirect, and cumulative impacts within the projected maximum cumulative 10-foot drawdown contour (**Figure 3.3-48** and **3.6-2**). Therefore, the 2007 groundwater model results show that there are no new impacts to aquatic resources as a result of dewatering.

#### 3.6.2.2 Proposed Action

The Proposed Action activities that would affect aquatic communities include the diversion of Rodeo Creek into the pit lake at mine closure and surface disturbance activities in the mine area. These activities would be limited to the intermittent sections of Boulder and Bell creeks within the mine area. No dewatering would occur as part of the Proposed Action.

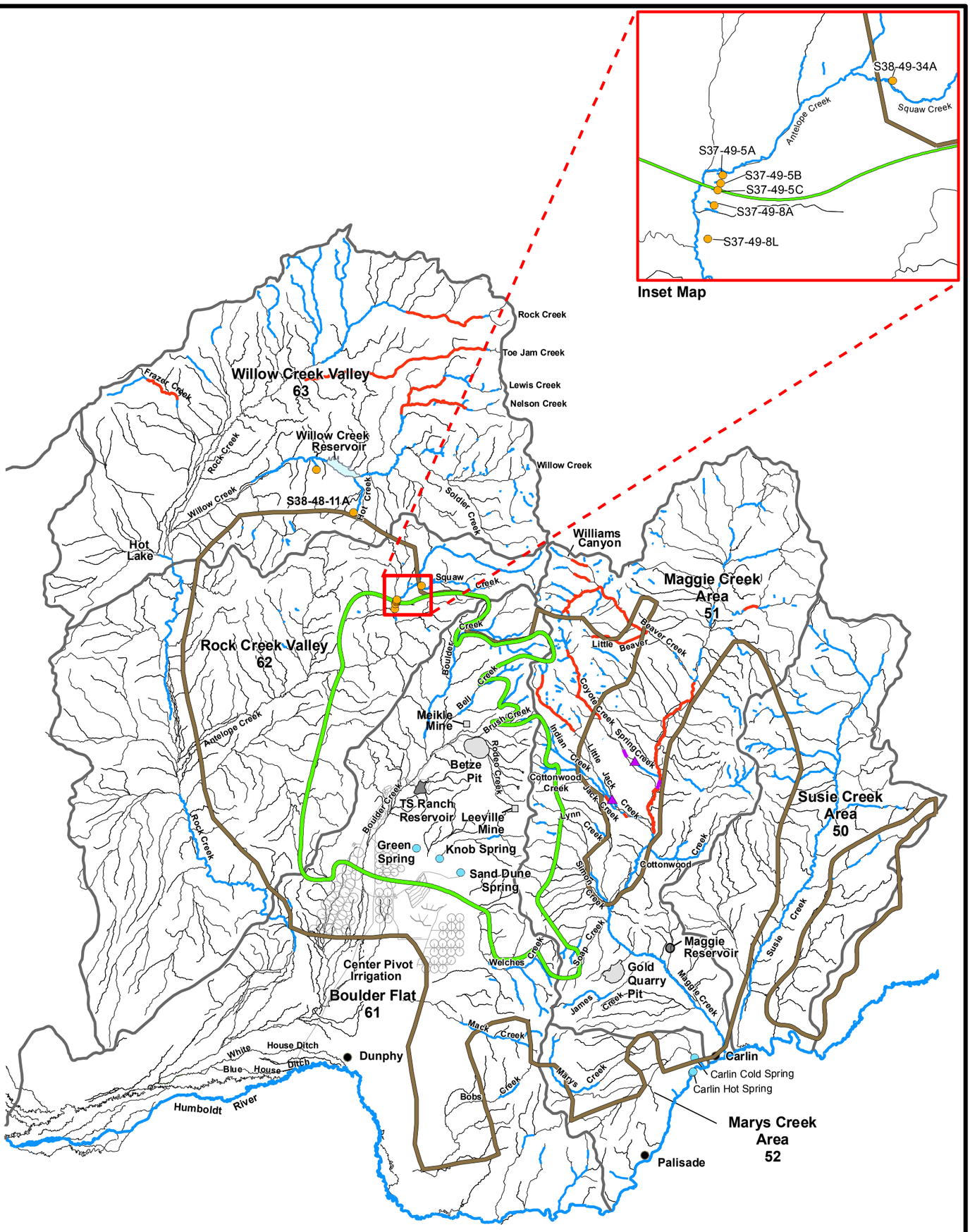
The diversion of Rodeo Creek into the pit lake (which may occur in both the Proposed Action and No Action Alternative as described in Section 2.2.1.12) would occur after mining is completed in 2016. This action would require a State of Nevada decision with no BLM authorization. Stream rerouting would result in a short-term loss of intermittent stream habitat that currently exists in the mine area. It is assumed that the reroute would remove approximately half of the 2.3-mile section of Rodeo Creek. A new section of Rodeo Creek would be constructed to connect with the pit lake. Within 1 year, macroinvertebrates would begin recolonizing the manmade channel. Lahontan speckled dace also could utilize the new channel. The occurrence and distribution of dace would be related to the frequency of flow events. Due to the intermittent nature of the channel, no consistent habitat would be available for aquatic species.

The input of water via Rodeo Creek to the pit lake would improve water quality conditions in the lake through additional dilution of pit lake water. Although this change would be beneficial to aquatic organisms expected to colonize the lake, it would likely not alter the abundance or diversity of macroinvertebrates. The overall lack of shallow shoreline areas would be the key factor contributing to the predicted low production in the lake in terms of macroinvertebrate and macrophyte communities. Some macrophyte and macroinvertebrate communities may develop in the southeast portion of the pit where water will not be as deep due to backfill.

Due to the intermittent nature of the source water (Rodeo Creek), the potential introduction of Lahontan speckled dace would be limited. If fish were washed into the pit lake, the overall habitat would not be conducive to the development of productive dace populations.

Surface disturbance activities associated with vehicle traffic and mining activities would occur at the proposed Clydesdale Waste Rock Facility and Betze Pit. These activities would generate soil disturbance within the drainages for Bell and Rodeo creeks. By implementing BMPs for erosion control, sediment input to these intermittent streams would be minor.

After mining is completed, a pit lake would begin filling in Year 14. Since the lake would contain steep banks and lack shallow bays or shoreline areas (except on the southeast portion of the pit), overall biological productivity is expected to be low. Macroinvertebrate communities would colonize the bottom substrates, but their diversity in terms of the number of taxa is expected to be low due to depths and lack of shallow shoreline areas except in the southeast portion of the pit. Aquatic macrophyte (large-size) plant growth likely would be limited for the same reasons.




**LEGEND**

- Lahontan Cutthroat Trout
- Spotted Frog Potential Habitat
- Spotted Frog Collection Sites
- Springsnail Locations
- Maximum Extent of 10-foot Drawdown Contour 2007 Model
- Maximum Extent of Cumulative 10-foot Drawdown Contour 2000 Model
- Groundwater Basin Boundary
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Source: BGMI 2007a; BLM 2000a.

N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.6-2

Predicted Maximum Drawdown (at 100 years post-mining) Direct Impacts in Relation to Lahontan Cutthroat Trout, Spotted Frogs, and Springsnails Occurrence



06/04/2008

#### 3.6.2.3 Bazza Waste Rock Facility Alternative

The Bazza Waste Rock Facility Alternative would result in the same impacts to aquatic resources as described for the Proposed Action.

### 3.6.3 Cumulative Impacts

The CESA for aquatic resources is shown in **Figure 3.6-1**. Past and present actions and RFFAs are identified in Section 3.1.

#### 3.6.3.1 No Action Alternative

Based on the model predictions for cumulative impact scenarios (**Figure 3.6-3**), surface water flows or water levels could be affected in the Boulder Creek subbasin and Antelope Creek drainage. Aquatic resources that would be affected by surface water reductions include native fish species, macroinvertebrates and springsnails.

The maximum cumulative 10-foot drawdown (**Figure 3.6-3**) would extend and overlap with a portion of Antelope Creek. Drawdown could affect one known springsnail location in the Antelope Creek drainage. The springsnail spring location on Squaw Creek is just outside the 2000 Model maximum cumulative 10-foot drawdown contour. However, adequate mitigation for potential impacts to that springsnail location was provided in the 2003 SEIS (BLM 2003a).

#### 3.6.3.2 Proposed Action

The Proposed Action would result in relatively minor effects on aquatic resources in the Boulder Creek drainage. Therefore, the Proposed Action would not contribute to cumulative impacts on aquatic resources.

#### 3.6.3.3 Bazza Waste Rock Facility Alternative

This alternative would not contribute to cumulative impacts on aquatic resources.

### 3.6.4 Mitigation Measures and Monitoring

Existing monitoring would continue in the Boulder Creek Subbasin and Antelope Creek. The Boulder Valley Monitoring Plan monitors stream flows and springs in the Boulder Creek drainage and Antelope Creek as part of the Betze EIS (BLM 1991a,b). An additional monitoring location was installed on Antelope Creek, as described in the Appendix A of the Betze SEIS (BLM 2003a). Springs in Upper Boulder Creek, Antelope Creek, and upper Bell Creek also are being monitored to detect changes in water levels and outflows and water quality (AATA 2006, 2007). As discussed in Section 3.3, Groundwater Resources and Geochemistry, monitoring results have not indicated effects from dewatering.

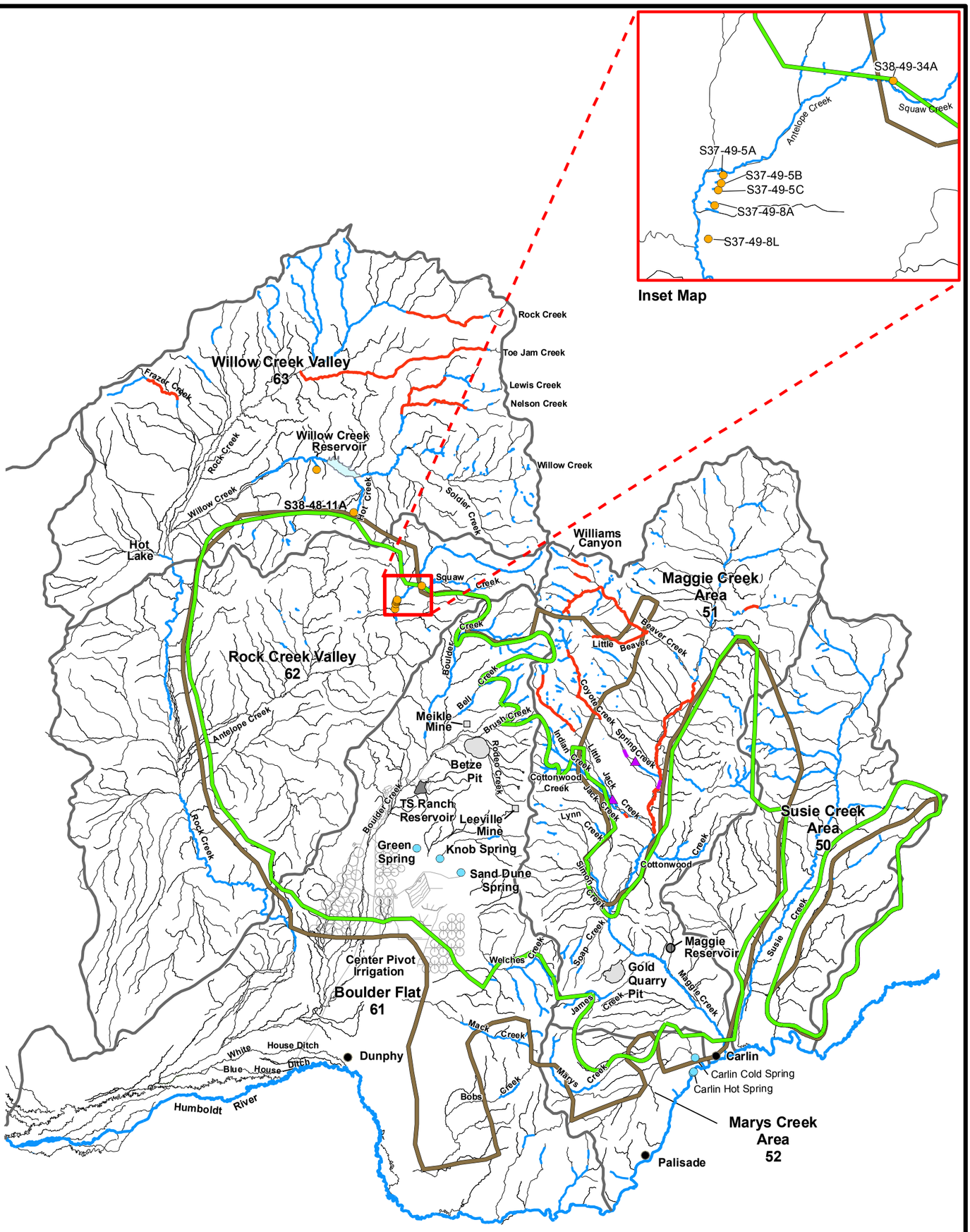
An ongoing monitoring program also exists in the Maggie Creek Subbasin, as described in the Leeville and SOAPA Cumulative Effects SEIS (BLM 2007b,c). Monitoring sites have been established in streams inhabited by LCT (Jack, Little Jack, Coyote, and Beaver creeks and numerous springs. Monitoring results have not indicated effects on stream segments or springs in the Maggie Creek Subbasin with the exception of Maggie Creek at the Narrows (BLM 2002b; Newmont 2007).

Existing mitigation for the Boulder Creek Subbasin, Antelope Creek, and Maggie Creek Subbasin have focused on improving riparian vegetation and aquatic habitat. The UWCHEP was implemented to improve riparian, aquatic, and upland habitat along 20.5 miles of stream in the Upper Willow Creek watershed as part of mitigation for the Betze Project SEIS (BLM 2003a). In addition, the Long-term Monitoring and Mitigation Fund was established by BGMI to mitigate unanticipated impacts to the environment, including biological resources, from the Betze Project (BLM 1991b). This trust fund would be sufficient to mitigate for unanticipated impacts to aquatic resources. No monitoring or mitigation is recommended for the Proposed Action because

impact levels are considered to be included in the 2000/2003 SEIS (BLM 2000a, 2003a) for which mitigation has already been implemented. No additional mitigation is considered necessary or appropriate.

### 3.6.5 Residual Impacts

No residual impacts on aquatic biology resources would occur as a result of the Proposed Action, No Action Alternative, or Bazza Waste Rock Facility Alternative, unless the dewatering 10-foot drawdown contour (No Action Alternative) affects the springs on Antelope Creek to such an extent that flow rates become too low to support resident springsnail populations. As each population is specific to a spring source, extensive flow reduction or springs drying up would cause an irretrievable loss of the specific springsnail population.




**LEGEND**

- Maximum Extent of Cumulative 10-foot Drawdown Contour (2007 Model)
- Maximum Extent of Cumulative 10-foot Drawdown Contour (2000 Model)
- Groundwater Basin Boundary
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)
- Lahontan Cutthroat Trout
- Spotted Frog Potential Habitat
- Spotted Frog Collection Sites
- Springsnail Locations

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.
Source: BGMI 2007a; BLM 2000a.

N

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.6-3

Predicted Maximum Extent of 10-foot Cumulative Drawdown in Relation to Lahontan Cutthroat Trout, Spotted Frogs, and Springsnails Occurrence



06/04/2008

## 3.7 Vegetation Resources

The vegetation resources study area for direct and indirect impacts encompasses the proposed project boundary (**Figure 3.7-1**). The CESA was chosen to encompass the project boundary, surface disturbance associated with existing activities, riparian and/or wetland habitats within the modeled cumulative 10-foot groundwater drawdown area, and RFFAs within the Carlin Trend (**Figure 3.7-2**).

### 3.7.1 Affected Environment

#### 3.7.1.1 Upland Vegetation

The study area is located entirely within the Boulder Flat Watershed Subbasin floristic region. This region is characterized by large, extensive valleys located between two mountain ranges: the Tuscarora Mountain Range to the north of Boulder Flat and the Sheep Creek Range to the southwest.

Vegetation cover types, acreage calculations, and community characterizations were compiled based on aerial interpretation, Southwest Regional GAP (SWReGAP) Analysis Project Land Cover analysis and site characterizations, along with the results of site-specific vegetation studies conducted in 1995 and 1994 for the 2000 Betze Project SEIS (BLM 2000a, 2003a; USGS 2004; Whitehorse Associates 1995; JBR 1994). These studies included the delineation of plant communities based on aerial photograph interpretation and on-site vegetation analysis. Vegetation assessments were completed within these plant communities to determine plant composition and to estimate foliar cover, forage production, and other vegetation parameters.

Three vegetation cover types and two land use cover types are located in the study area. The vegetation cover types include salt-desert shrubland, sagebrush shrubland, and grassland habitats. The land use cover types include developed lands (i.e., industrial/commercial) and barren lands. Distribution of vegetation cover types in these areas is strongly influenced by variations in landscape position, soil type, moisture, elevation, and aspect. Descriptions of the plant communities in each of these vegetation cover types are provided in the following text. Species nomenclature herein is consistent with the USDA NRCS Plants Database (USDA NRCS 2007b). **Figure 3.7-1** illustrates the vegetation cover types present within the vegetation resources study area. **Table 3.7-1** summarizes acreages for each vegetation cover type within the vegetation study area.

**Table 3.7-1 Vegetation Cover Types within the Study Area[1]**

| Vegetation Cover Type | Acres |
|---|---|
| Sagebrush Shrubland | 3,135.3 |
| Grassland | 34.1 |
| Salt-desert Shrubland | 19.1 |
| Riparian/Wetland | 0.0 |
| Industrial/Commercial | 7,029.1 |
| Barren | 2.6 |
| **Total** | **10,220.2** |

[1]Vegetation cover types were compiled based on USGS SWReGAP data. As such, spatial limitations are attributed to this data set since it was collected on a regional landscape level. Note that this data (i.e., vegetation cover types and their associated acreages) are approximate.

Source: USGS 2004.

Sagebrush Shrubland

The most dominant community within the study area, sagebrush shrubland, is characterized as a lower elevational basin community of the Great Basin and Inter-Mountain Basin ecoregions. This land use cover type comprises 31 percent of the mine operations boundary. Soils are typically deep, well-drained, and non-saline. These shrublands are dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), rubber rabbitbrush (*Ericameria nauseosa*), yellow rabbitbrush (*Chrysothamnus viscidiflorus*), greasewood (*Sarcobatus vermiculatus*), juniper species (*Juniperus* spp.), and saltbush species (*Atriplex* spp.). The herbaceous component, composed of Indian ricegrass (*Achnatherum hymenoides*), blue grama (*Bouteloua gracilis*), thickspike wheatgrass (*Elymus lanceolatus*), Idaho fescue (*Festuca idahoensis*), Sandberg bluegrass (*Poa secunda*), needle-and-thread grass (*Hesperostipa comata*), and Great Basin wildrye (*Leymus cinereus*), contributes less than 25 percent to this community (USDA NRCS 2007b; USGS 2004).

Grassland

This minor vegetation cover type is characterized as Inter-Mountain Basin Semi-Desert Grassland occurring on dry plains and mesas. This community occurs in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains. Sites are typically xeric. Substrates are often well-drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. Dominant perennial bunchgrasses and shrubs within this vegetation cover type are all very drought-resistant species and may include Indian ricegrass, three-awn (*Aristida* spp.), blue grama, needle-and-thread grass, muhly species (*Muhlenbergia* spp.), and galleta grass (*Pleuraphis jamesii*), as well as scattered shrub and dwarf-shrub species such as sage, saltbush, Mormon tea (*Ephedra nevadensis*), broom snakeweed (*Gutierrezia sarothrae*), and winterfat (*Krascheninnikovia lanata*) (USDA NRCS 2007b; USGS 2004).

Salt-desert Shrubland

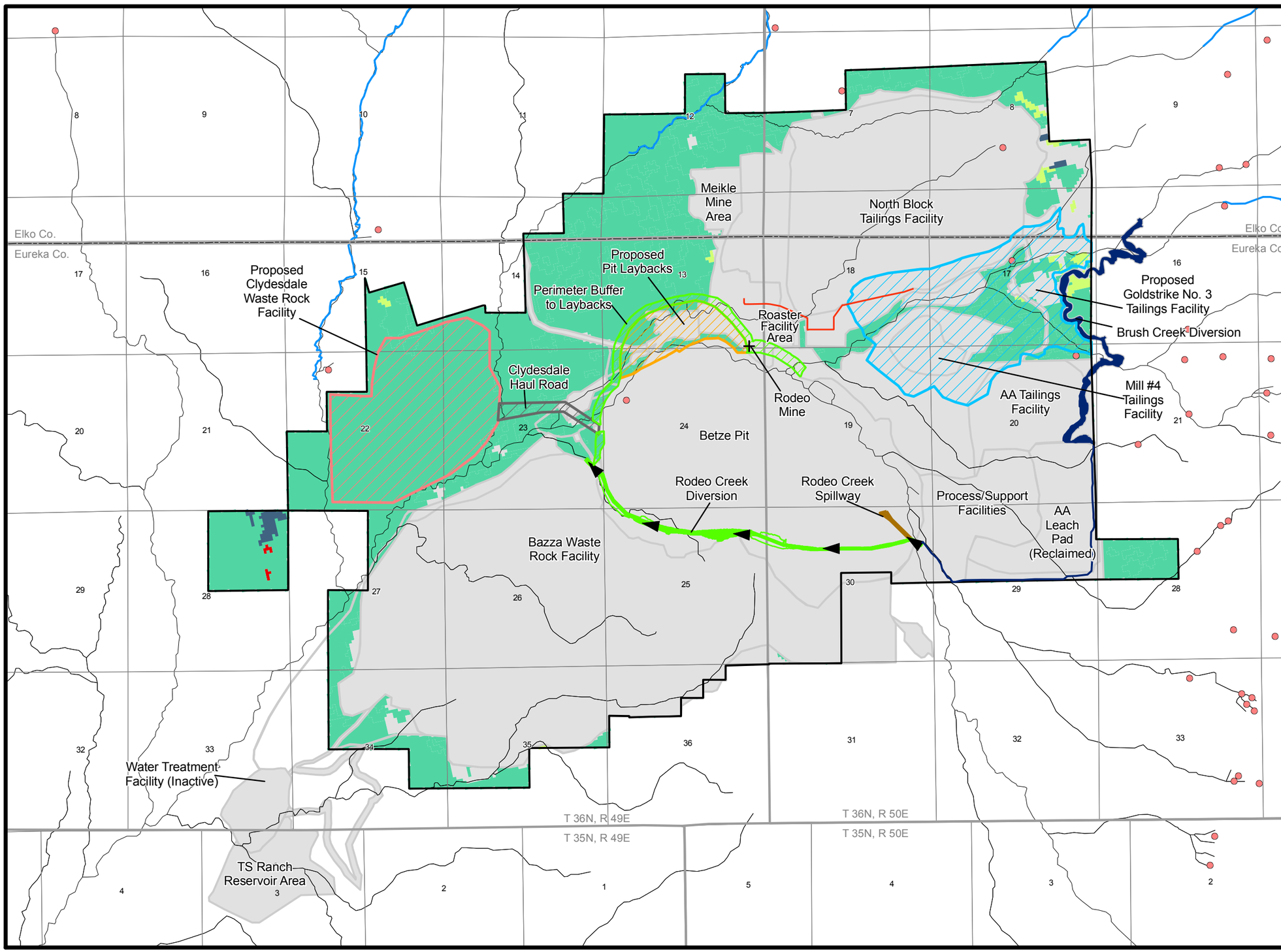
This minor vegetation cover type within the study area, the salt-desert shrubland, is characterized by open-canopied shrublands of typically lower elevational slopes, saline basins, alluvial slopes, and plains. Substrates are often saline and calcareous, medium to fine-textured, alkaline soils, but they may also include some courser-textured soils. The vegetation is characterized by an open to moderately dense shrubland dominated by shadscale saltbush (*Atriplex confertilfolia*), fourwing saltbush (*A. canescens*), cattle saltbush (*A. polycarpa*), spinescale saltbush (*A. spinfera*), greasewood, Wyoming big sagebrush, yellow rabbitbrush, rubber rabbitbrush, Mormon tea, spiny hopsage (*Grayia spinosa*), winterfat, and littleleaf horsebrush (*Tetradymia glabrata*). The understory is comprised of galleta grass, Indian ricegrass, blue grama, thickspike wheatgrass, western wheatgrass (*Pascopyron smithii*) and a small variety of forbs, including scalebud (*Anisocoma acaulis*), primrose (*Camissonia* sp., *Oenothera* sp.), Steve's dustymaiden (*Chaenactis stevoides*), and annual buckwheat (*Eriogonum* sp.) (USDA NRCS 2007b; USGS 2004).

Riparian/Wetland

Riparian/wetland habitat in the region is characterized as Great Basin foothill and lower montane riparian woodland and shrubland, North American arid west emergent marsh, and open water habitats (USDA NRCS 2007b; USGS 2004). Riparian/wetland communities are not present within the mine operations area.

Industrial/Commercial

This land use cover type is characterized by the existing mine operations within the study area and is generally sparsely vegetated with early seral stage species (USGS 2004). This land use comprises approximately 69 percent of the mine operations boundary.




**LEGEND**

- Goldstrike Mine Operations Boundary
- Tailings
- Pit Expansion
- Perimeter Buffer to Laybacks
- Waste Rock Facility
- Clydesdale Haul Road
- Tailings Pipeline
- Rodeo Creek Spillway (Post-mining Closure)

**Vegetation Cover Type**

- Barren
- Industrial/Commercial
- Grassland
- Sagebrush Shrubland
- Salt-desert Shrubland
- Perennial Stream
- Creek Diversion or Channel
- Stream or Drainage Pathway (Intermittent or Ephemeral)
- Seeps and Springs

Source: USGS 2004.

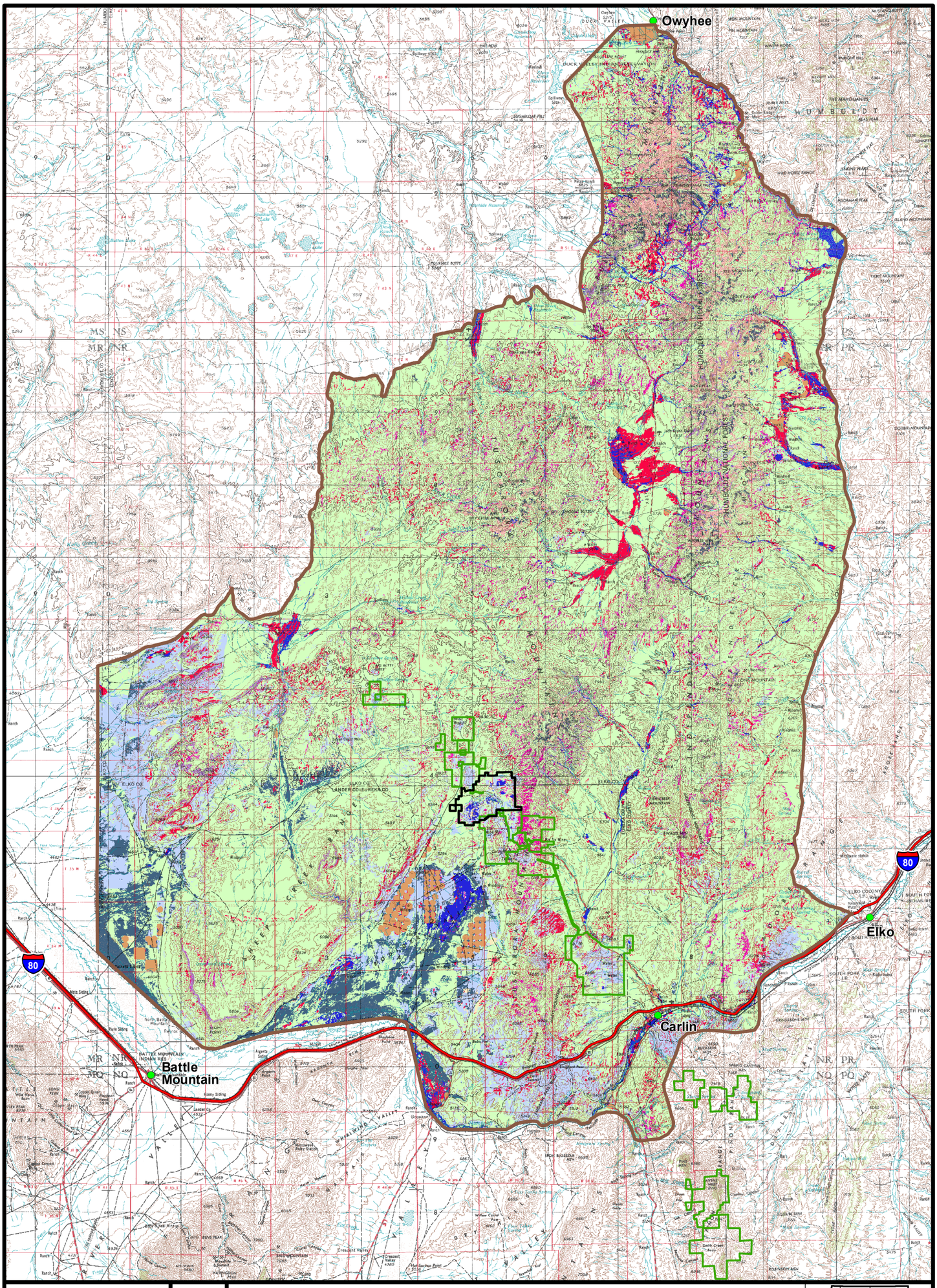
N W E S

0 0.5 1 Miles

**Betze Pit Expansion Project**

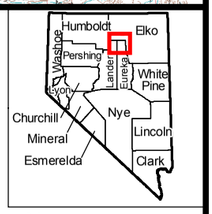
Figure 3.7-1

Vegetation Cover Types within the Study Area




**LEGEND**

- Vegetation Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries
- Agriculture
- Barren
- Cliff/Canyon
- Forest
- Grassland
- Industrial/Commercial
- Piñon-juniper Woodland
- Riparian/Wetland
- Sagebrush Shrubland
- Salt-desert Shrubland




N

0 5 10 Miles

Source: USGS 2004.

**Betze Pit Expansion Project**

Figure 3.7-2

Vegetation Cumulative Effects Study Area



06/05/2008

Barren

This minor land use cover type is characterized as: 1) barren areas of bedrock, desert pavement, scarps, talus, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, or other accumulations of earthen material; and 2) Inter-Mountain Basin Playa. Playa habitats are composed of barren and sparsely vegetated areas characterized by salt crusts with small saltgrass beds in depressions and sparse shrubs around the margins. These systems are intermittently flooded. The water is prevented from percolating through the soil by an impermeable soil subhorizon and is left to evaporate. Soil salinity varies greatly with soil moisture and thus affects species composition. Common species may include iodinebush (*Allenrolfea occidentalis*), greasewood, spiny hopsage, Lemmon's alkaligrass (*Puccinellia lemmonii*), Great Basin wildrye, saltgrass (*Distichlis spicata*), and saltbush. Generally, this vegetation accounts for less than 15 percent of the total herbaceous cover (USDA NRCS 2007b; USGS 2004).

#### 3.7.1.2 Wetlands and Riparian Areas

The wetlands and riparian resources study area and CESA would be the same as presented for Upland Vegetation described in Section 3.7.1.1. Wetland and riparian habitat characterizations were compiled based on color-infrared aerial photograph interpretation, agency consultation, and watershed descriptions as previously described in the Betze Project Draft EIS and subsequent Draft and Final SEIS (BLM 1991a, 2000a, 2003a). Only drainages within the wetland and riparian resources region (i.e., Boulder Flat Watershed Subbasin) were examined in this section; detailed discussions regarding surface water within the adjacent groundwater basins and seep and springs data are presented in Section 3.3, Groundwater Resources and Geochemistry, and Section 3.4, Surface Water Resources.

Within the Boulder Flat Watershed Subbasin, Bell, Brush, and Rodeo creeks pass through the study area as tributaries to Boulder Creek to the north (**Figure 3.3-1,** Boulder Flat Watershed Subbasin). Flow occurrence within these tributaries is either ephemeral or intermittent and varies by reach. A flow diversion for Brush Creek has been completed within the study area (**Figure 3.7-1**). As presented in Section 3.4, Surface Water Resources, Rodeo Creek will be diverted in 2009 from its current location in a man-made channel north of the Betze Pit into a newly constructed channel on the south side of the pit. Downstream of the pit, Rodeo Creek will flow in its original channel. Flows from catchments upstream of BGMI's property on Rodeo Creek are attenuated by the Rodeo Creek Diversion dam. The Brush Creek Diversion project re-routes flows from Brush Creek to Rodeo Creek just downstream of the Rodeo Creek Diversion dam.

Riparian communities adjacent to these waterbodies vary with elevation and flow occurence. Along intermittent reaches, an overstory of narrowleaf willow (*Salix exigua*), Pacific willow (*S. lucida* ssp. *lasiandra*), yellow willow (*S. lutea*), and Lemmon's willow (*S. lemmonii*) and understory of silver buffaloberry (*Shepherdia argentea*), basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), golden currant (*Ribes aureum*), Woods' rose (*Rosa woodsii*), and rubber rabbitbrush occur (USDA NRCS 2007b). Ephemeral reaches typically contain less hydrophytic vegetation species and may include sagebrush, rabbitbrush, and greasewood species, and bunchgrasses along the banks.

In compliance with the aforementioned agencies and regulations, a jurisdictional determination was received from the Sacramento District Office of the USACE for the study area. A jurisdictional determination for the proposed project was received by BGMI on November 20, 2006. At that time, the Sacramento District concluded, upon review of JBR's 2006 Boulder Creek Jurisdictional Status Review, that Bell, Brush, and Rodeo creeks and their associated ephemeral drainages in that basin are not currently regulated by the USACE under Section 404 and that the proposed project would not need a USACE permit to proceed with project implementation (USACE 2006). Based on the definitions provided above, no jurisdictional wetlands are present within the study area. Generally, no wetlands or riparian areas occur within the Goldstrike Mine operations boundary. Surface flows are intermittent to ephemeral within the mine area and most drainages, including Rodeo Creek, have been channelized to route flow around mine facilities.

#### 3.7.1.3 Special Status Plant Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed species that are protected under the ESA, species of concern as identified by the USFWS, and species designated as state sensitive by the BLM.

No threatened, endangered, rare, or sensitive plant species were identified as potentially occurring within the study area (BLM 2007d; Nevada Natural Heritage Program [NNHP] 2007; USFWS 2007b).

Based on the special status species analysis conducted for the Betze Project SEIS (BLM 2000a), the Lewis buckwheat, a BLM sensitive species, may occur within the CESA (**Figure 3.7-2**) based on presence of suitable habitat characteristics. The Lewis buckwheat (*Eriogonum lewisii*) is a Nevada endemic species known from Elko County and northern Eureka County. This species inhabits dry, exposed, shallow, relatively barren and undisturbed, rocky residual soils on convex ridgeline knolls and crests underlain by siliceous carbonate rocks, on flat to moderately steep slopes of all aspects. The species is generally associated with little sagebrush (*Artemisia arbuscula*) and squirreltail (*Elymus elymoides*) vegetation communities. Occasionally found at lower elevations on clay hills derived from silty carbonate or calcium-rich siliceous rock, this species inhabits elevations ranging from 6,470 to 9,720 feet amsl (NNHP 2001). Based on the presence of suitable habitat within the CESA, the potential for this species to occur is considered moderate.

State law under NRS 527.060-527.120 regulates the commercial harvest, possession, and transportation of any cactus, evergreen tree, or member of the Yucca or Agave genera (Nevada Legislature 2005a). These species, their associated habitats, and their potential for occurrence within the study area were analyzed based on habitat requirements and/or known distribution. Species that may be encountered within the study area include saint cactus (*Echinocereus engelmannii* var. *chrysocentrus*), Mohave prickly pear (*Opuntia erinacea* var. *utahensis*), Plains prickly pear (*Opuntia polycantha* var. *rufispina*), sand cholla (*Opuntia pulchella*), foxtail cactus (*Coryphantha vivipara* var. *rosea*), and hedgehog thistle (*Pediocactus simpsonii* var. *simpsonii*). Based on the presence of suitable habitat, the potential for these species to occur within the study area would be considered moderate.

#### 3.7.1.4 Noxious Weeds and Invasive Species

The noxious weeds and invasive species study area for direct and indirect impacts and the CESA would be the same as presented for vegetation. Definitions of terms and a brief listing of applicable regulations governing noxious weeds and invasive species are provided below.

A “noxious weed” is defined as any species of plant that is, or is likely to be, detrimental or destructive and difficult to control or eradicate (NRS 555.010-555.220). Noxious weeds have become a growing concern in Nevada based on their ability to increase in cover relative to surrounding vegetation and exclude native plants from an area. The spread of noxious weeds has resulted in substantial economic impacts on some sectors of the State of Nevada (state). As a result, the state has enacted laws requiring the control of noxious weed species (NRS 555.005, NAC 555.010). In addition, the federal Noxious Weed Act of 1974, as amended (7 United States Code [USC] 2801 et. seq.) requires cooperation with state, local, and other federal agencies in the application and enforcement of all laws and regulations relating to the management and control of noxious weeds. Recognizing these regulations, the BLM requires that NEPA documents consider and analyze the potential for the spread of noxious weed species and provide preventative rehabilitation measures for each management action involving surface disturbance.

The BLM considers plants “invasive” if they have been introduced into an environment where they did not evolve. As a result, invasive species usually have no natural enemies to limit their reproduction and spreading (Westbrooks 1998). Some invasive plant species can produce substantial changes to vegetation composition, structure, or ecosystem function (Cronk and Fuller 1995).

A list of the noxious weed species designated by the state and BLM Elko District Office is provided in **Table 3.7-2**. Under NRS 555.010-555.220, noxious weeds are classified into three categories: A, B, and C. Each category has specific control requirements, with the most stringent requirements for those species found in Category A.

**Table 3.7-2 Designated Noxious Weed Species Potentially Occurring within the Study Area**

| Common Name | Scientific Name | NRS Designated Noxious Weed Species Category[1] |
|---|---|---|
| Russian knapweed | *Acroptilon repens* | B |
| Camel thorn | *Alhagi camelorum* | A |
| Mayweed chamomile | *Anthemis cotula* | A |
| Giant reed | *Arundo donax* | A |
| Sahara mustard | *Brassica tournefortii* | B |
| Whitetop or hoary cress | *Cardaria draba* | C |
| Musk thistle | *Carduus nutans* | B |
| Purple starthistle | *Centaurea calcitrapa* | A |
| Diffuse knapweed | *Centaurea diffusa* | B |
| Iberian star thistle | *Centaurea iberica* | A |
| Spotted knapweed | *Centaurea maculata* | A |
| Malta starthistle | *Centaurea melitensis* | A |
| Yellow starthistle | *Centaurea solstitialis* | A |
| Squarrose knapweed | *Centaurea virgata* var. *squarrosa* | A |
| Rush skeletonweed | *Chondrilla juncea* | A |
| Water hemlock | *Cicuta maculata* | C |
| Canada thistle | *Cirsium arvense* | C |
| Poison hemlock | *Conium maculatum* | C |
| Common crupina | *Crupina vulgaris* | A |
| Houndstongue | *Cynoglossum officinale* | A |
| Leafy spurge | *Euphorbia esula* | A |
| Goat's rue | *Galega officinalis* | A |
| Hydrilla | *Hydrilla verticillata* | A |
| Black henbane | *Hyoscyamus niger* | C |
| Klamath weed | *Hypericum perforatum* | A |
| Dyer's woad | *Isatis tinctoria* | A |
| Tall whitetop or perennial | *Lepidium latifolium* | C |
| Dalmatian toadflax | *Linaria dalmatica* | A |
| Yellow toadflax | *Linaria vulgaris* | A |

**Table 3.7-2 Designated Noxious Weed Species Potentially Occurring within the Study Area**

| Common Name | Scientific Name | NRS Designated Noxious Weed Species Category[1] |
|---|---|---|
| Purple loosestrife | *Lythrum salicaria* | A |
| Eurasian water-milfoil | *Myriophyllum spicatum* | A |
| Scotch thistle | *Onopordum acanthium* | B |
| African rue | *Peganum harmala* | A |
| Green fountaingrass | *Pennisetum setaceum* | C |
| Sulfur cinquefoil | *Potentilla recta* | A |
| Austrian fieldcress | *Rorippa austriaca* | A |
| Mediterranean sage | *Salvia aethiopis* | A |
| Giant salvinia | *Salvinia molesta* | A |
| Carolina horse-nettle | *Solanum carolinense* | B |
| White horse-nettle | *Solanum elaeagnifolium* | B |
| Sow thistle | *Sonchus arvensis* | A |
| Johnson grass | *Sorghum halepense* | C |
| Austrian peaweed | *Sphaerophysa salsula* (= *Swainsona salsula*) | A |
| Medusahead | *Taeniatherum caput-medusae* | B |
| Saltcedar or tamarisk | *Tamarix ramosissima* | C |
| Puncture vine | *Tribulus terrestris* | C |
| Syrian bean caper | *Zygophyllum fabago* | A |

[1] No additional noxious weeds or invasive species were identified by Elko County. Elko County manages for the species listed by the State of Nevada in their jurisdiction.

Source: Nevada Department of Agriculture, Plant Industry Division 2006; Eklund-Brown 2007.

Category A includes noxious weeds, which are:

- Not found or limited in distribution throughout the state;
- Actively excluded from the state and actively eradicated wherever found; and
- Controlled by the state for all infestations.

Category B includes noxious weed species, which are:

- Established in scattered populations in some counties of the state;
- Actively excluded where possible; and
- Controlled by the state in areas where populations are not well established or previously unknown to occur.

Category C includes noxious weeds, which are:

- Currently established and generally widespread in many counties of the state; and
- Controlled and abated at the discretion of the state quarantine officer (Nevada Department of Agriculture 2006).

Baseline vegetation studies, which included field assessments and subsequent documentation of invasive non-native plant species occurrences, were conducted within BGMI's property boundary in 2006. Based on 2006 field observations, Scotch thistle and whitetop populations continue to colonize previously disturbed areas within the BGMI property boundary (specific to the BGMI operations area) (Cedar Creek Associates, Inc. 2007a). **Figure 2-10** shows the locations of noxious weed areas observed and treated during 2002 to 2006 within the Goldstrike Mine operations boundary.

## 3.7.2 Environmental Consequences

The primary issues associated with vegetation resources include direct and/or indirect impacts to upland vegetation, riparian/wetland habitats, special status plant species, and impacts associated with the introduction and/or spread of noxious weeds and invasive species.

### 3.7.2.1 No Action Alternative

Under the No Action Alternative, groundwater pumping will occur for an additional 4 years from 2012 through 2015 under State of Nevada authorizations and permits. **Figure 3.3-26** and **Figure 3.3-48** illustrate the maximum extent of the10-foot groundwater drawdown under the No Action Alternative and the mitigation provided for in the 2000/2003 Betze SEIS (BLM 2000a, 2003a) as described in Sections 3.3.3.1 and 3.3.4.2.

As stated in Section 3.4, Surface Water Resources, the Rodeo Creek Diversion will route flows from its existing channel north of the pit to a new channel south of the Betze Pit and back into the original channel downstream of the pit. As a mine closure option, Rodeo Creek flows may be diverted again at the end of mining into the pit, pending authorization by the State of Nevada.

<u>Upland Vegetation</u>

Under the No Action Alternative, the proposed project expansion would not be developed and existing facilities would continue to operate as currently authorized by the BLM and the State of Nevada. Construction of the Rodeo Creek Diversion to the south of the Betze Pit would result in disturbance to existing vegetation. However, most of the proposed diversion route occurs on previously disturbed land. Ongoing reclamation would minimize existing impacts to vegetation in mine-related disturbance areas (with the exception of the Betze Pit laybacks, which will not be reclaimed).

Under the No Action Alternative, no impacts to upland vegetation are anticipated as a result of dewatering activities because groundwater drawdown does not affect upland vegetation.

<u>Wetlands and Riparian Areas</u>

There would be no impacts to wetlands and riparian areas in the study area as a result of the No Action Alternative. No jurisdictional wetlands are present in the study area. There are no riparian communities in downstream reaches of Rodeo Creek below the Rodeo Creek Diversion, so there would be no impacts.

The mitigation specified in Appendix A of the Betze Project SEIS (BLM 2003a) addressed all direct, indirect, and cumulative impacts within the maximum cumulative 10-foot drawdown contour (**Figure 3.3-48**). Therefore, the 2007 groundwater modeling has not resulted in any new impacts to wetlands and riparian areas beyond those that were discussed and covered by mitigation in the Betze SEIS (BLM 2003a).

As discussed in the previous Betze Project SEIS (BLM 2000b, 2003a), wetland vegetation has developed within the CESA (**Figure 3.7-2**) subsequent to the appearance of Green, Knob and Sand Dune springs from infiltration activities at the TS Ranch Reservoir in an area of historically saline (sodic) soils. This area is located on private land held by Newmont, an adjacent land owner. At the end of infiltration activities, the water levels will gradually subside and the wetland vegetation will decline, being replaced over time by salt-tolerant species (BLM 2000b, 2003a), returning the area to its preexisting conditions. During the transition from wetland to salt-tolerant upland species, there may be a need to assist in the establishment of salt-tolerant species by seeding and the control of noxious/invasive species. This would aid in control of undesirable plant species and reduce potential particulate fugitive dust emissions. Any such measures employed would be subject to a private contractual agreement between BGMI and Newmont.

In addition, 10,000 acres of agricultural lands owned by Newmont are currently irrigated with mine dewatering water. When excess mine water is no longer available for irrigation Newmont may or may not continue irrigation depending on economics and water availability. That is a discretionary choice of a private landowner over which the BLM has no authority. If the land is taken out of production when dewatering ceases, adverse impact could result including accelerated eolian or surface water erosion, fugitive dust emissions, fire, and noxious/invasive species infestations. Mitigation to reduce such impacts would be the same as described in the paragraph above and is subject to the same limitations. At present, there are no commitments to conduct mitigation. BGMI has declined to pursue an agreement at this time.

Special Status Plant Species

As discussed in Section 3.7.1.3, Special Status Plant Species, the Lewis buckwheat may occur within suitable habitat within the 10-foot drawdown contour. Under the No Action Alternative, no impacts to the Lewis buckwheat are anticipated since this species is an upland plant species and all impacts under this alternative would be associated with groundwater drawdown and its associated impacts to riparian and wetland species and their habitats.

Noxious Weeds and Invasive Species

Existing BGMI weed control measures would continue to be implemented to prevent the establishment of new populations and to control existing populations in mine-related disturbance areas.

It is anticipated that a continued decrease or cessation of flow in seeps, springs, and intermittent waterbodies within the mine-related 10-foot groundwater drawdown contour may increase the likelihood of the potential establishment of noxious weeds and invasive species known to invade riparian/wetland habitats (e.g., saltcedar and Russian olive). Consequently, a decrease or cessation of flow may provide suitable habitat for noxious weeds and invasive species which prefer drier conditions.

#### 3.7.2.2 Proposed Action

Upland Vegetation

Under the Proposed Action, mine development and operation would remove approximately 867 acres of predominantly shrub-dominated vegetation communities (**Table 3.7-3**). This loss would represent a long-term impact as it would take up to 25 years following reclamation for mature shrub species to re-establish. A permanent loss of 129 acres of vegetation cover types would occur under the Proposed Action.

Reclamation would be completed on approximately 1,262 (85 percent) of the total proposed disturbance area. As discussed in Section 2.3.7.3, Reclamation, the Betze Pit is the only project component that would not be reclaimed. To minimize mine-related impacts to vegetation, reclamation would be conducted as soon as practical, with concurrent reclamation implemented to the maximum extent possible as discussed in Section 2.2.1.13, Applicant-committed Environmental Protection Measures. Reclamation activities would

## Table 3.7-3 Summary of Vegetation Cover Types Affected by the Proposed Action

| Facility | Vegetation Cover Type (acres) | | | | | | Summary Data (acres) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sagebrush Shrubland | Grassland | Salt-desert Shrubland | Riparian/ Wetland[1] | Industrial/ Commercial | Barren | Total Disturbed | Existing Authorized Disturbance | Proposed Action Net Disturbance | Bazza Waste Rock Facility Alternative Disturbance | Post-mining Reclaimed |
| Clydesdale Waste Rock Facility | 535 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 535.0 | 0.0 | 535.0 | 0.0 | 535.0 |
| Pit Layback and Buffer Perimeter | 100.5 | 0.0 | 0.0 | 0.0 | 114.5 | 0.0 | 215.0 | -86.3.0 | 128.7 | 128.7 | 0.0 |
| Goldstrike No. 3 Tailings Facility | 202.4 | 75.8 | 0.0 | 0.0 | 411.8 | 0.0 | 690.0 | -211.0 | 479.0 | 479.0 | 690.0 |
| Haul Road | 29.5 | 0.0 | 0.0 | 0.0 | 7.2 | 0.1 | 36.8 | 0.0 | 36.8 | 0.0 | 36.8 |
| **Total[2]** | **867** | **76** | **0** | **0** | **534** | **0** | **1,477** | **-297** | **1,180** | **608** | **1,262** |

[1]Vegetation cover types were compiled based on USGS SWReGAP data (USGS 2004). As such, spatial limitations are attributed to this data set since it was collected on a regional landscape level. Note that this data (i.e., vegetation cover types and their associated acreages) are approximate.

[2]Totals have been rounded to the nearest acre.

include, but are not limited to, the grading of final slopes, ripping of compacted soil, potential reapplication of growth media, and broadcasting of seed. Seed mixes, as described in Section 2.2.3.3, Seed Mixes, would be Reclamation monitoring conducted at the AA Leach Pad and the Bazza Waste Rock Facility has confirmed completion of successful reclamation as compared to adjacent undisturbed vegetation communities (i.e., vegetation composition, quality, and quantity) (Cedar Creek Associates 2007a).

Under the Proposed Action, reclamation of the Bazza Waste Rock Facility would be accelerated. Reclamation of the Bazza Facility would be substantially completed by the end of 2011, 7 years earlier than planned for the Bazza facility under the No Action Alternative.

Wetland and Riparian Areas

Under the Proposed Action, no surface disturbance-related impacts to wetland or riparian communities would occur because these communities are not present within the mine boundary. The potential impacts to Boulder Valley wetlands and irrigated lands when mine dewatering ends would be the same as discussed in Section 3.7.2.1 in the Wetlands and Riparian Areas subsection of the No Action Alternative. Mitigation to reduce such impacts would be the same and would be subject to the same limitations.

Special Status Plant Species

No threatened, endangered, rare, or sensitive plant species were identified as potentially occurring within the vegetation resources study area (BLM 2007d; NNHP 2007; USFWS 2007b), and as such, no impacts are anticipated. Based on habitat requirements and known distribution, cactus and/or members of the Yucca or Agave genera constitute a moderate potential for occurrence within the Proposed Action disturbance areas. However, NRS states that only the commercial harvest, possession, or transportation of such species would be regulated. Under the Proposed Action, these actions are not anticipated. However, if these actions would occur, landowner permission must be obtained prior to activity commencement.

Noxious Weeds and Invasive Species

Noxious weeds and invasive species readily invade areas that have been subject to surface disturbance, which typically lack, or have minimal vegetative cover. Under the Proposed Action, mine development and operation would remove or disturb approximately 1,180 acres of vegetation, of which 129 acres would not be reclaimed.

Implementation of BGMI's Reclamation Plan (Sections 2.2.3 and 2.3.7.3) would reduce the potential for noxious weeds and invasive species establishment in the study area. However, minor populations of non-native annual species (e.g., halogeton, cheatgrass) may become established in localized areas for short periods of time.

To stabilize the growth media, reduce soil erosion, and minimize the potential for the establishment of noxious weeds and invasive species, growth media stockpiles would be reclaimed with an interim seed mix. In addition, the design and construction of the proposed mine facilities would facilitate concurrent reclamation to the maximum extent possible. Successful reclamation of mine-related disturbance areas (including pit backfill areas) would result in the establishment of a permanent vegetative cover, which would minimize the potential establishment of noxious weeds and invasive species in the long term. Although the proposed Betze Pit would not be reclaimed, noxious weeds and invasive species would not likely become established in these areas due to the absence of soil and the formation of the pit lake in the long term. As described in Section 2.2.1.13, Applicant-committed Environmental Protection Measures, certified weed-free seed mixes and mulches would be used for reclamation. If noxious weeds and invasive species become established in project-related disturbance areas, a weed removal or spraying program would be implemented. As described in Section 2.2.3.4, Noxious Weed Management, weed control practices would be implemented during vegetation establishment to limit the growth and spread of invasive, nonnative species and facilitate successful revegetation with the proposed seed mixes. Weed control practices would be implemented in coordination with the BLM Elko District Office to limit the spread and introduction of noxious weeds in the study area.

#### 3.7.2.3 Bazza Waste Rock Facility Alternative

The Bazza Waste Rock Facility Alternative would result in the continued use of the Bazza Waste Rock Facility without construction of the proposed Clydesdale Waste Rock Facility. Under this alternative, the Bazza Waste Rock Facility would not be completely reclaimed until 2018, compared with 2011 for the Proposed Action. BGMI would implement existing management plans and would adhere to all applicable federal, state, and local requirements.

Upland Vegetation

Under the Bazza Waste Rock Facility Alternative, direct and/or indirect surface disturbance-related impacts to vegetation resources would be approximately 565 acres less than under the Proposed Action since the Clydesdale facility and haul road would not be constructed (**Table 3.7-3**). Anticipated impacts and mitigation measures would be the same as described for the Proposed Action.

The Bazza Waste Rock Facility Alternative would result in the loss of 0.5 million tons of Carlin Material (an excellent growth media) excavated from the proposed northwest laybacks of the Betze Pit. The material would be unavailable for future reclamation of the Bazza Waste Rock Facility because Carlin Material does not stockpile well due to its physical properties and slope stability concerns (see Section 2.4, Bazza Waste Rock Facility Alternative). The loss of Carlin Material would result in the use of lower quality growth media (i.e., subsoil or waste rock), which would be less conducive to vigorous and diverse plant growth. Lower quality vegetation production would reduce the available forage (including production rates and values) for wildlife species and the reclamation areas may be more susceptible to erosion (Cedar Creek Associates 2007a).

Wetlands and Riparian Areas

Under the Bazza Waste Rock Facility Alternative, no direct and/or indirect surface disturbance and water management-related activities affecting wetland and riparian resources would occur, and as such, no impacts are anticipated.

Special Status Plant Species

As stated in Section 3.7.1.3, Special Status Plant Species, no threatened, endangered, rare, or sensitive plant species were identified as potentially occurring within the vegetation resources study area (BLM 2007d; NNHP 2007; USFWS 2007b), and as such, no impacts are anticipated.

Noxious Weeds and Invasive Species

Under the Bazza Waste Rock Facility Alternative, direct and/or indirect surface disturbance-related impacts to noxious weeds and invasive species would be approximately 565 acres less than under the Proposed Action (**Table 3.7-3**). Anticipated impacts and mitigation measures would be the same as described for the Proposed Action. As stated above, the loss of Carlin Material for reclamation could adversely impact revegetation success. As a result, the inability for native desirable species to recolonize any given area would have a direct impact on the ability for noxious weed and invasive species to become introduced and/or spread at this site.

### 3.7.3 Cumulative Impacts

The cumulative effects study area for vegetation resources encompasses 2,389,957 acres and is shown in **Figure 3.7-2**. Past and present actions and RFFAs are described in Section 3.1. Past, present, and RFFAs, including wildland fires, within the CESA have resulted in approximately 996,039 acres of surface disturbance to vegetation resources from 1999 to mid-2007 (Section 3.1).

#### 3.7.3.1 No Action Alternative

Upland Vegetation

No direct or indirect impacts to upland vegetation in the study area are anticipated under the No Action Alternative. Consequently, no cumulative effects are anticipated.

Wetlands and Riparian Areas

Surface waterbodies, seeps, springs, within the 10-foot cumulative drawdown area effects are discussed in Sections 3.3 and 3.4, Groundwater Resources and Geochemistry and Surface Water Resources, respectively. Any riparian areas fed by these surface waterbodies, seeps, or springs within the CESA may be impacted as a result of combined groundwater pumping. However, these impacts are within the area that was disclosed and mitigated for in the 2000/2003 Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48** and described in Sections 3.3.3.1 and 3.3.4.2.

Species Status Plant Species

No direct or indirect impacts to special status plant species in the study area are anticipated under the No Action Alternative. Consequently, no cumulative effects are anticipated.

Noxious Weeds and Invasive Species

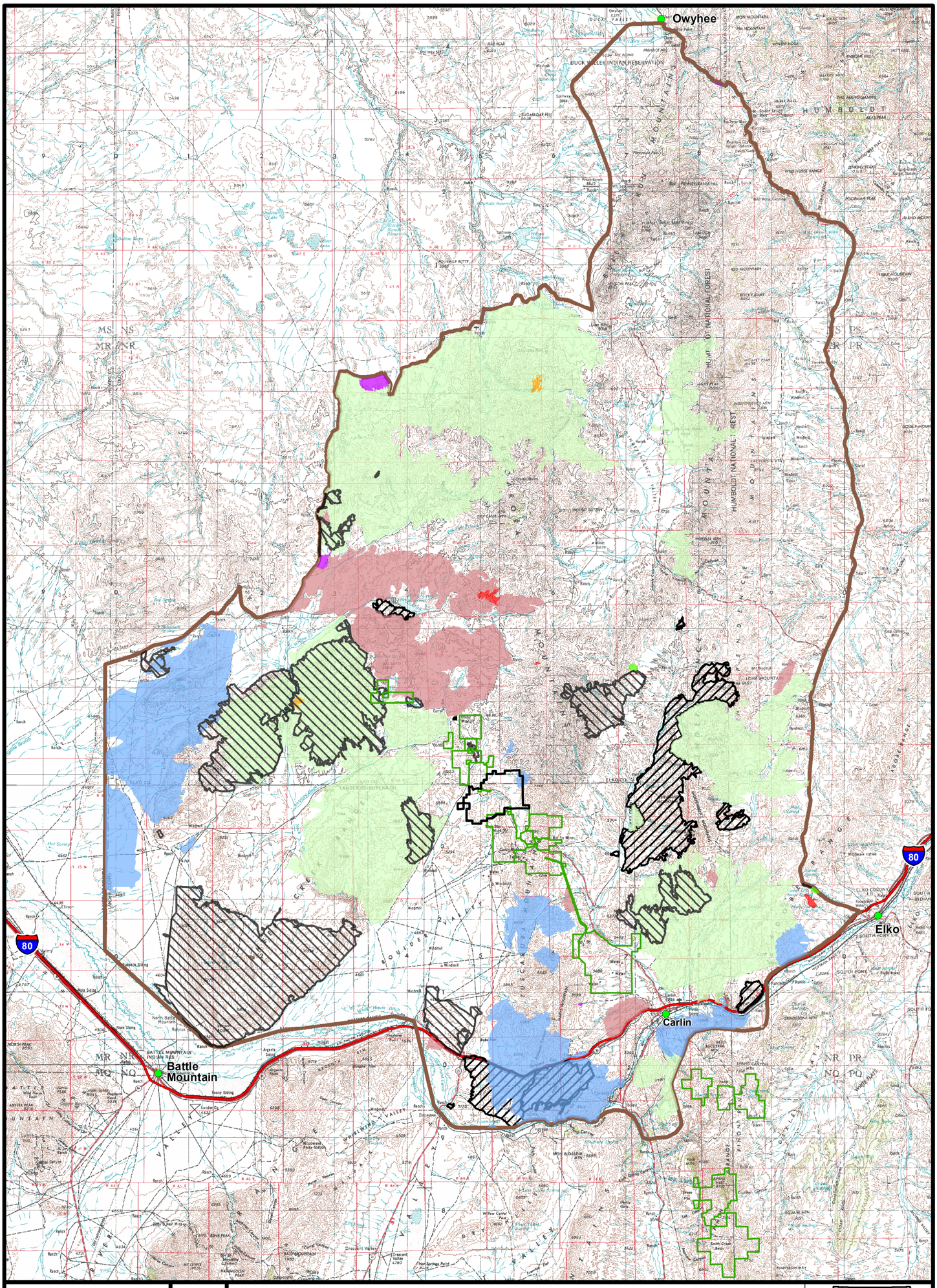
No direct impacts to noxious weeds and invasive species in the study area are anticipated under the No Action Alternative. Consequently, no cumulative effects are anticipated.

#### 3.7.3.2 Proposed Action

Upland Vegetation

The Proposed Action incrementally would increase surface disturbance-related impacts to upland vegetation resources within the CESA by approximately 1,180 additional acres, resulting in an overall cumulative effect to 996,039 acres of upland vegetation. It is assumed that portions of past disturbances have been reclaimed. Pending completion of successful reclamation, the incremental additional impacts to upland vegetation as a result of the Proposed Action would be temporary in nature for the majority of the surface disturbance-related areas, with the exception of the Betze Pit, which would not be reclaimed. The loss of mature shrubs would be minimal relative to the total acreage of woody species communities that occur within the CESA. The removal of woody species from these areas would result in a long-term change in vegetation structure since it would take up to 25 years for shrub species of similar stature to become re-established in these areas.

Surface disturbance associated with wildland fires accounts for approximately 920,471 acres (92 percent) of the total surface disturbance area within the CESA (**Figure 3.7-3**). Direct and indirect impacts to vegetation resources include the complete loss or partial removal of upland vegetation species, potential removal of belowground biomass, soil hydrophobicity, and the potential spread and/or introduction of noxious weeds and invasive species. Impacts to vegetation resources may vary depending on fire intensity, duration, and frequency. It is assumed that partial recolonization has occurred within wildland fire-related surface disturbance areas. Recovery timeframes for herbaceous and woody species would be relatively similar to those described above for other surface disturbance-related activities.

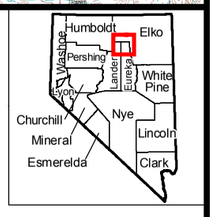



**LEGEND**

- Historical Fire Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries

**Fire Years**

- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007




N

0 5 10 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.7-3

Historical Fires - 1999 through July 2007 Cumulative Effects Study Area



06/05/2008

Wetlands and Riparian Areas

Cumulative impacts to wetland and riparian areas would not occur as a result of the Proposed Action.

Special Status Plant Species

No direct and/or indirect impacts occur for special status plant species, and as such, no cumulative impacts are anticipated.

Noxious Weeds and Invasive Species

It is assumed that the majority of the surface disturbance-related impacts within the CESA would be reclaimed, minimizing the introduction and/or spread of noxious weeds and invasive species. Implementation of BGMI's Reclamation Plan would minimize the introduction and/or spread of noxious weeds and invasive species within the Proposed Action disturbance areas, thereby minimizing the project's contribution to cumulative effects. Disturbance areas within the CESA not reclaimed would be prone to the establishment of noxious weeds and invasive species. However, due to the absence of soils and the formation of pit lakes, the potential for establishment would be less likely.

#### 3.7.3.3 Bazza Waste Rock Facility Alternative

Upland Vegetation

The Bazza Waste Rock Facility Alternative incrementally would increase surface disturbance-related impacts to upland vegetation resources within the CESA by approximately 608 additional acres, resulting in an overall cumulative effect to 995,467 acres of upland vegetation (approximately 565 fewer acres than under the Proposed Action). Anticipated cumulative impacts (including impacts resulting from wildfire) and recovery timeframes would be similar to those described under the Proposed Action.

Wetlands and Riparian Areas

No direct or indirect impacts to wetlands and riparian areas would occur under the Bazza Waste Rock Facility Alternative. Consequently, no cumulative effects are anticipated.

Species Status Plant Species

No direct or indirect impacts to special status plant species are anticipated under the Bazza Waste Rock Facility Alternative. Consequently, no cumulative effects are anticipated.

Noxious Weeds and Invasive Species

Cumulative impacts to noxious weeds and invasive species are similar to those described under the Proposed Action.

### 3.7.4 Mitigation Measures and Monitoring

Following construction, BGMI would revegetate disturbed areas in accordance with their Reclamation Plan. BGMI would monitor revegetation success using the presence/absence of noxious weeds and invasive species as an indicator, among others, of reclamation success. Weed infestations would be monitored as part of BGMI operations and maintenance surveys per the Reclamation Plan and BLM and NDEP regulations.

No new mitigation measures or monitoring programs beyond BGMI's current programs are proposed for vegetation resources. The reclamation activities, included as part of the Proposed Action, in conjunction with BMGI's Reclamation Plan, would substantially reduce surface disturbance-related impacts to vegetation resources.

Wetland and riparian impacts from groundwater drawdown associated with the No Action Alternative will be mitigated under existing mitigation from the 1991 Betze Project EIS and 2003 Betze Project SEIS. The 1991

EIS predicted 330 acres of wetland and riparian habitat would potentially be affected. The 2003 SEIS updated the dewatering analysis and predicted that fewer acres (150 acres) of wetlands and riparian habitat would be affected. Therefore, the current Wetland Mitigation Fund and Long-Term Monitoring and Mitigation Fund (Section 2.2.1.13) would mitigate for any additional impacts to wetlands and riparian areas.

### 3.7.5 Residual Impacts

Residual impacts to vegetation under the Proposed Action would include the permanent loss of vegetation from approximately 129 acres associated with the expansion of the Betze Pit, which would not be reclaimed. The loss of shrub-dominated communities from reclaimed facility areas would represent a long-term change in vegetation composition (i.e., shrub-dominated communities to grass/forb-dominated communities) under the Proposed Action and Bazza Waste Rock Facility alternatives.

## 3.8 Wildlife Resources

The study area for direct and indirect impacts for wildlife resources includes the proposed project boundary and riparian, perennial stream, spring/pond, and wetland habitats within the modeled mine-related 10-foot groundwater drawdown area. The CESAs for wildlife resources generally extend from the northern end of the Independence Range in the north to the Humboldt River and northern end of the Piñon Range to the south, and includes surface disturbance and water management activities associated with past and present actions and RFFAs, and wetlands and riparian habitat within the modeled groundwater drawdown area. The CESAs were determined by BLM and NDOW and include contiguous areas that provide very important seasonal habitat for wildlife species such as mule deer and pronghorn.

### 3.8.1 Affected Environment

As discussed in Section 3.7, Vegetation Resources, three vegetation cover types and two land use cover types are located within the study area. The vegetation cover types include salt-desert shrubland, sagebrush shrubland, and grassland habitats. The land use cover types are composed of developed lands (i.e., industrial/commercial) and barren lands. Sagebrush shrubland is the most common vegetation community within the study area. A variety of terrestrial wildlife species are associated with all of these upland communities, with greater species diversity occurring in areas exhibiting greater vegetative structure and soil moisture.

Available water for wildlife consumption is limited in the project region. Water sources in the vicinity of the project, particularly those that maintain open water and a multi-story canopy, support a greater diversity and population density of wildlife species than any other habitat types occurring in the region. Currently, the only riparian/wetland habitat occurring within the region is along upper Bell and Boulder creeks, which originate in the Tuscarora Mountains north of the study area.

Information regarding wildlife species and habitat within the study area and CESAs was obtained from a review of existing published sources, BLM, NDOW, and USFWS file information, as well as NNHP database information.

Wildlife species and habitats found within the study area are typical of the Great Basin region. The study area occurs primarily within sagebrush communities in Boulder Valley. Within the study area, wildlife habitat primarily is composed of salt-desert shrubland and sagebrush shrubland habitats.

#### 3.8.1.1 Big Game Species

The pronghorn population has been stable to increasing in game management unit 06 (NDOW 2007b). Pronghorn use in the project vicinity has increased in recent years due to the development of agriculture in Boulder Valley, restoration of fires, and favorable weather patterns (NDOW 2008b). In order to maintain pronghorn herd health and reduce the base population, NDOW has captured and removed 166 pronghorn in 2003 and 116 pronghorn in 2008 within hunt units 067 and 068 (both within game management unit 06), which includes Boulder Valley (Gray 2008). Gray (2008) estimated that there were 550 pronghorn in these hunt units as of Spring 2008. Approximately 70 percent of the pronghorn in hunt units 067 and 068 winter in Boulder Valley (Gray 2008). Use of the study area by pronghorn is highly dependent on water and forage availability. The study area contains both summer range and very important winter range (**Figure 3.8-1**).

Population numbers for mule deer in game management unit 06 for Elko and Eureka counties have been declining for the last few years due to the reduction in winter range quality (NDOW 2007b). Large-scale fires have caused a severe reduction in available forage and an increase of noxious weeds. Fire has affected the area's mule deer herd by severely limiting forage on transitional and winter range (NDOW 2007b). The study area consists of low-density mule deer habitat, consisting primarily of sagebrush shrublands habitat and mule deer intermediate (transitional) habitat, which serves as habitat during spring and fall migration. In addition, NDOW has designated a very important migration corridor located along the western portion of the study area (**Figure 3.8-2**). Details on the big game migration corridor are presented below.

A big game migration corridor occurs in the western portion of the study area along Rodeo and Bell creeks (**Figure 3.8-2**). This area would be disturbed with the development of a new waste rock facility. Seasonal big game movement corridors between summer and winter ranges in the study vicinity have been restricted due to mining operations in the project region (NDOW 2007b). By definition, a wildlife movement corridor is a linear habitat with a primary function of connecting at least two significant habitat areas (Harris and Gallagher 1989). Throughout the western U.S., big game relies on seasonal ranges to satisfy their annual nutritional and energetic requirements (Sawyer et al. 2005). Because seasonal ranges often occur great distances apart and across a mix of vegetation types and land ownership, maintaining migration corridors is often difficult and is considered a top priority by state game agencies (Sawyer et al. 2005). The proposed Betze Pit Expansion Project and other mining operations within the Carlin Trend are located in the vicinity of migration corridors that connect important summer and winter range for big game (mule deer, pronghorn, and elk).

Historically, a large herd of mule deer migrated south from their summer range in the Tuscarora Mountains to their winter range in the lower elevations of Boulder Valley (Lamp 2007b). Little Boulder Valley, the location of the Barrick Goldstrike Mine and Newmont's Genesis/Blue Star, Lantern, Mill #1, Boostrap/Capstone, Tara, and Rossi's barite operations, and Dee's Boulder Creek and Ren mines, was the original location of the historic mule deer migration corridor for movement to and from the winter range in the Dunphy Hills. Historically, up to 4,000 deer would migrate through this area twice annually. With the development of the Carlin Trend mines in Little Boulder Valley, the deer moved their migration pattern to the east side of the South Tuscarora Range. With the development now on the east side of the range, little opportunity for north/south movement remains (NDOW 2008b). The western edge of the proposed Betze Pit Expansion Project is an area that remains highly susceptible to fragmentation. This area is considered by NDOW to be a very important migration corridor for big game (Lamp 2007b). The migration corridor that extends along Bell and Rodeo creeks is used primarily by mule deer, but it also may provide an important movement corridor for pronghorn, and to a lesser extent, elk (Lamp 2007b).

The mountain lion also is classified as a big game species. Mountain lions are fairly common in north-central Nevada and occupy the higher elevations surrounding the study area (NDOW 2007b). They often travel between mountain ranges and valleys depending on prey availability.

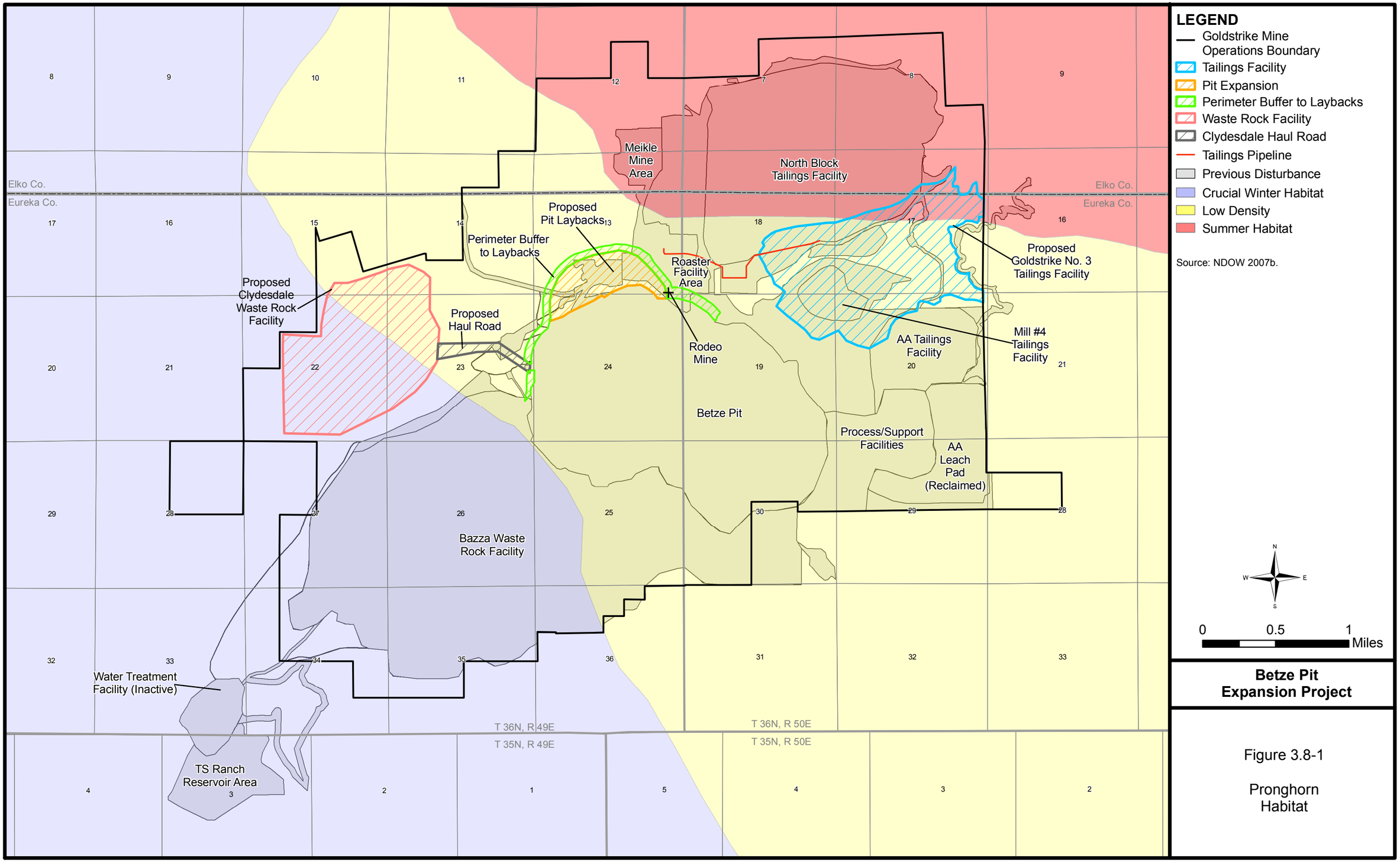
#### 3.8.1.2 Small Game Species

Upland game birds may occupy portions of the study area, although habitat is somewhat limited. Species that may occur in the study area are greater sage-grouse, chukar, Hungarian partridge, and mourning dove. Chukar are found in the hills surrounding Little Boulder Basin especially on rocky ridges and hillsides (BLM 1991b; Lamp 2007b). Hungarian partridge are found in riparian areas and terraces along Rodeo and Bell creeks (BLM 1991b; Lamp 2007b). Mourning doves are found in a wide range of habitats in close proximity to water and are most likely to occur within the study area during spring, summer, and early fall. The greater sage-grouse is a BLM sensitive species and is discussed in detail in Section 3.8.1.5, Special Status Species.

The pygmy rabbit is a game species that has been documented in the project vicinity (Lamp 2007b). Although the pygmy rabbit is considered a game species in Nevada, it also is a BLM sensitive species and is discussed in Section 3.8.1.5, Special Status Species. Other small game mammal species that could occur within the study area are mountain cottontail and black-tailed jackrabbit.

Furbearers that may occur within the study area include the badger, gray fox, kit fox, bobcat, and raccoon (Hall 1995). Additional mammals that may be found within the study area include coyote, long-tailed weasel, short-tailed weasel, spotted skunk, and striped skunk.

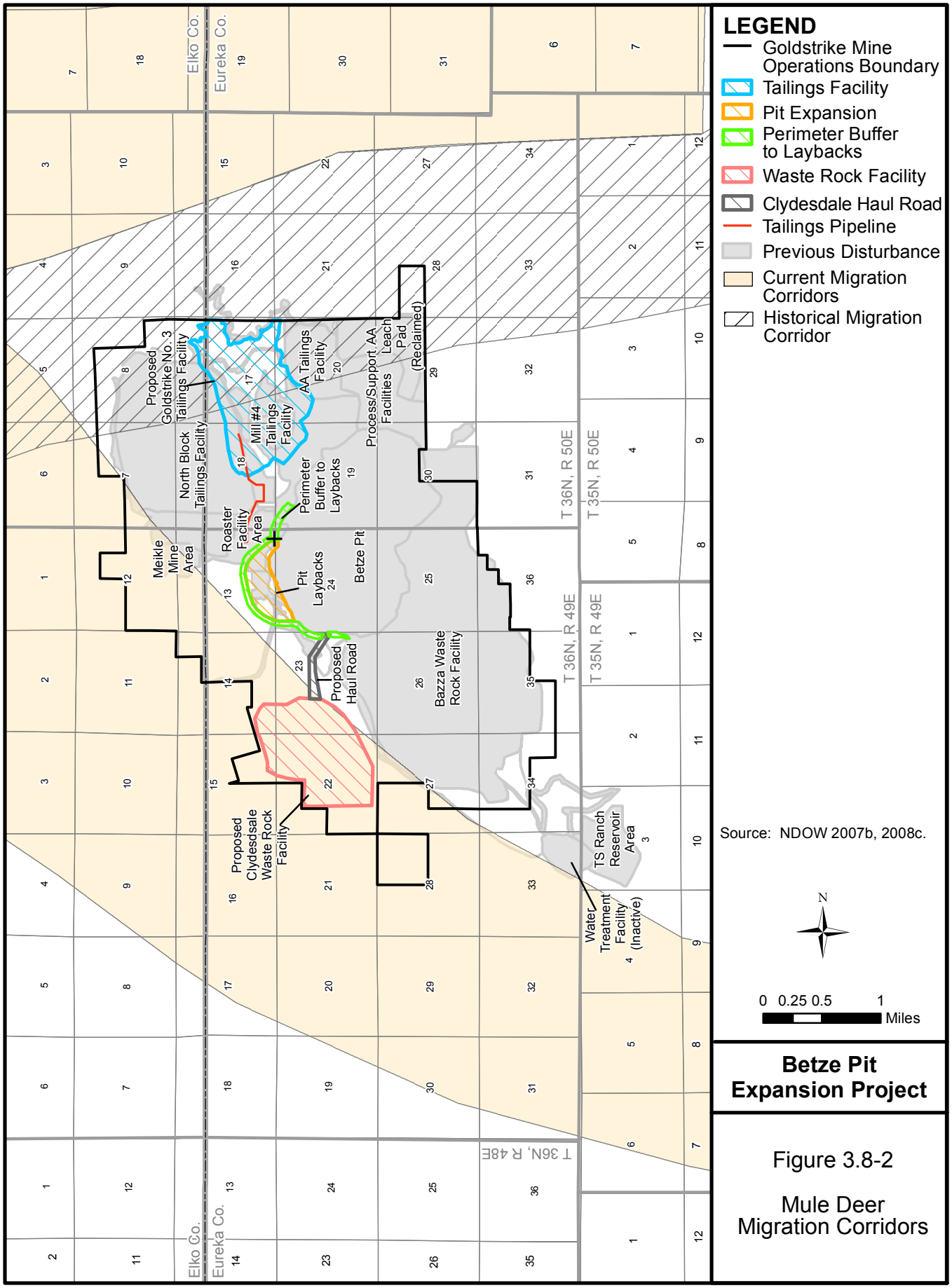
Due to limited habitat, waterfowl or shorebird concentrations are limited to ponds, springs, and perennial streams located in the project region.




**Betze Pit Expansion Project**

Figure 3.8-1

Pronghorn Habitat




**Betze Pit Expansion Project**

Figure 3.8-2

Mule Deer Migration Corridors

### 3.8.1.3 Nongame Species

A diversity of nongame species (e.g., small mammals, passerines, raptors, and reptiles) occupies a wide range of trophic levels and habitat types within the study area. Habitats found within the study area (e.g. salt-desert shrublands, sagebrush shrublands) support a variety of resident and seasonal nongame species. Nongame mammals include the deer mouse, Merriam's shrew, sagebrush vole, golden-mantled ground squirrel, least chipmunk, and woodrat. Rodent populations provide a large prey base for the area's predators.

Nongame birds encompass a variety of passerine and raptor species including migratory bird species that are protected under the Migratory Bird Treaty Act (MBTA) (16 USC 703-711) and Executive Order (EO) 13186 (66 Federal Register [FR] 3853); see Section 3.8.1.4, Migratory Birds, for further details.

Passerine or songbird species occupy the entire range of habitats found within the study area. However, due to the higher level of plant diversity and structure, more abundant potential nest sites, and greater food base, the riparian areas along Bell, Boulder, and Rodeo creeks support the highest diversity of bird species within the study area.

Several raptor species have been documented within the vicinity of the study area including the golden eagle, prairie falcon, American kestrel, red-tailed hawk, great-horned owl, short-eared owl, and western burrowing owl (Lamp 2007b). Details on sensitive raptor species such as golden eagle, bald eagle, and ferruginous hawk are discussed in the Special Status Bird Species section in Section 3.8.1.5, Special Status Species. Information on other raptors is presented below.

No known raptor nests exist within the study area (Lamp 2007b). Golden eagles have been observed within the study area, but no nests have been recorded in the vicinity. Prairie falcons have been recorded approximately 20 miles southwest of the study area along Rock Creek (Lamp 2007b). Burrowing owls have been recorded nesting approximately 15 miles northwest of the study area along Boulder Creek (Lamp 2007b). Red-tailed hawk and great-horned owl nests were observed in the Ren Pit. There also has been red-tailed hawk nesting in the Dee Pit in the past. This nest had to be removed 2 years in a row to allow for mining to occur in that portion of the pit (Lamp 2007b).

Other important nongame species include several bat species. The study area contains suitable foraging habitat for several bat species (Bradley et al. 2006). All of the bats identified for this study are currently BLM sensitive species and/or Nevada protected species (BLM 2007d; NDOW 2007a). These species are presented in detail in Section 3.8.1.5, Special Status Species.

Other nongame species within the study area include amphibians and reptiles such as the Great Basin spadefoot toad, Great Basin whip-tailed lizard, Great Basin rattlesnake, gopher snake, long-nose leopard lizard, and northern sagebrush lizard (BLM 2002a). Amphibian presence is limited within the study area due to intermittent flows in Bell and Rodeo creeks and a lack of other water sources. The northern leopard frog and spotted frog have been recorded in the CESA; details are discussed in Section 3.6, Aquatic Resources.

### 3.8.1.4 Migratory Birds

Pursuant to EO 13186, a draft MOU among the BLM, USFS, and USFWS was drafted in order to promote conservation and protection of migrating birds. Specific measures to protect migratory bird species and their habitats have not been identified within EO 13186, but instead, the EO provides guidance to agencies to promote best management practices for the conservation of migratory birds. As a result, the BLM Nevada State Office prepared Migratory Bird BMPs for the Sagebrush Biome in order to assist BLM field offices in the consideration of migratory birds in land management activities (BLM no date).

A wide variety of migratory birds are found within the study area. These species are associated with a variety of habitat types, and many occur within the project vicinity year-round. Details on sensitive species such as short-eared owl, vesper sparrow, and loggerhead shrike are discussed in the following section.

### 3.8.1.5 Special Status Species

As stated in Section 3.6, Aquatic Resources, special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. A total of 42 special status species were identified as potentially occurring within the study area (BLM 2007d; NDOW 2007a; NNHP 2007; USFWS 2007b). These species, their associated habitats, and their potential for occurrence within the study area are summarized in **Appendix E**. Occurrence potential within the study area and CESA was evaluated for each species based on their habitat requirements and/or known distribution. Based on these evaluations, seven special status wildlife species have been eliminated from detailed analyses based on their habitat requirements and/or known distributions, as shown in **Appendix E**. These species include silver-haired bat, river otter, northern goshawk, Lewis's woodpecker, pinyon jay, juniper titmouse, and black-rosy finch. The 36 special status wildlife species identified as potentially occurring within the project area or CESA are described below. The two amphibian special status species identified as potentially occurring within the Project area or CESA are discussed in Section 3.6.1.2, Aquatic Resources Special Status Species.

Special Status Mammal Species

Federal and state sensitive bat species that have been identified as potentially occupying appropriate habitat types within or near the study area are presented in **Appendix E**. Bat species that could occur within the study area include pallid bat, Townsend's big-eared bat, big brown bat, hoary bat, California myotis small-footed myotis, long-eared myotis, little brown myotis, long-legged myotis, Yuma myotis, western pipistrelle bat, and Brazilian free-tailed bat (BLM 2007d; Lamp 2007b; NNHP 2007). Suitable foraging habitat is present throughout the study area (Bradley et al. 2006). Potential roosting habitat within the vicinity of the project boundary includes forested habitat and rock outcrops. Higher elevation forest habitats and cliffs are present east of the study area in the Tuscarora Range and may provide potential roosting habitat for area bats.

*Pallid Bat*

The pallid bat is a year-round resident in Nevada. Found primarily at low and middle elevations (1,300 to 8,400 feet), this species occupies a variety of habitats such as piñon-juniper, blackbrush, cresote, sagebrush, and salt desert scrub (Bradley et al. 2006). This species feeds primarily on large ground-dwelling arthropods (e.g., scorpions, centipedes, grasshoppers), but also feeds on large moths (Bradley et al. 2006). The pallid bat is a colonial species, roosting in groups of up to 100 individuals (Arizona Game and Fish Department [AGFD] 1993). Roost sites consist of rock outcrops, mines, caves, hollow trees, buildings, and bridges (AGFD 1993; Bradley et al. 2006). The pallid bat is intolerant of roost sites in excess of 40 degrees Celsius (Bradley et al. 2006). This species has been documented southwest of the study area along Rock Creek (Bradley et al. 2006). Based on its known range and suitable habitat within the study area, the potential for this species to occur within the study area is considered high.

*Townsend's Big-eared Bat*

The Townsend's big-eared bat is a year-round resident found throughout Nevada from low desert to high mountain habitats (700 to 11,400 feet in elevation) (Bradley et al. 2006). The Townsend's big-eared bat primarily occurs in piñon-juniper, mountain mahogany, white fir, blackbrush, sagebrush, salt desert scrub, agricultural lands, and urban habitats (Bradley et al. 2006). This species prefers caves, mines, and buildings that maintain stable temperatures and airflow for nursery colonies, bachelor roosts, and hibernacula (Harvey et al. 1999). It does not make major migrations and appears to be relatively sedentary, not traveling far from summer foraging grounds to winter hibernation sites (Harvey et al. 1999). Its distribution seems to be determined by suitable roost and hibernation sites, primarily caves and mines. This bat is believed to feed entirely on moths (Harvey et al. 1999) and gleans insects from foliage and other surfaces (Bradley et al. 2006). This species has been recorded east of the study area at abandoned mine shafts in the Lynn Creek drainage (BLM 2002b), and NNHP has identified the study area as suitable habitat (NNHP 2007). The potential for this species to occur within the study area is considered high.

*Big Brown Bat*

The big brown bat is a year-round resident in Nevada. This species is found from low to high elevations (1,000 to 9,800 feet) and occupies a variety of habitats including piñon-juniper, blackbrush, cresote, sagebrush, and salt desert scrub (Bradley et al. 2006). This species gleans insects over water and open landscapes, as well as in both forested and edge settings (Bradley et al. 2006). The big brown bat is a colonial species, roosting in groups up to several hundred. Roost sites include caves, mines, buildings, bridges, and trees. This species is known to be more tolerant of human habitation than other bat species. This species has been documented at several locations in the project vicinity including Sugarloaf Butte (BLM 2000a; Lamp 2007b). The potential for this species to occur within the study area is considered high.

*Western Red Bat*

In Nevada, previous to 2004, this species was known only from a few locations in Lincoln and Clark counties (Bradley et al. 2006). Audio data, recorded in 2004, determined the presence of western red bat in the vicinity of Newmont's Proposed Emigrant Project 25 miles south of the Betze Pit Expansion Project. It is typically found in wooded areas and lowland riparian areas. The western red bat roosts under tree bark and leaf litter but also may roost in caves and mines (Bradley et al. 2006). Records of this species in Nevada are inconsistent and this species is generally considered a migrant. Suitable habitat for this species occurs within the study area. The potential for occurrence within the project area is considered moderate.

*Hoary Bat*

The hoary bat is a summer resident in Nevada found at low to middle elevations (1,900 to 8,200 feet) in forest habitats including riparian and upland forests (Bradley et al. 2006). This species also is found in valley basins containing pure stands of Rocky Mountain juniper as well as agricultural areas (Bradley et al. 2006). The hoary bat forages primarily at high altitudes over the tree canopy and follows watercourses for foraging and drinking (Bradley et al. 2006). This species roosts in trees within foliage but may roost in caves and beneath rock ledges (Bradley et al. 2006). This species has not been documented within the project vicinity. Marginal foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered low.

*California Myotis*

The California myotis is a year-round resident found throughout Nevada at low and middle elevations (700 to 9,000 feet) (Bradley et al. 2006). This species occurs in a variety of habitats from Lower Sonoran desert scrub to forests. The California myotis gleans insects above open habitat. This species typically roosts singly or in small groups, although some mines are known to shelter colonies of over 100 individuals. Roost sites include mines, caves, buildings, rock crevices, hollow trees, and under exfoliating bark (Bradley et al. 2006). This species is known to forage throughout the winter. This species has not been documented within the project vicinity. However, suitable foraging habitat occurs within the project region. The potential for this species to occur within the study area is considered high.

*Small-footed Myotis*

The small-footed myotis is found throughout Nevada from approximately 3,500 to 5,900 feet in elevation (Bradley et al. 2006). This species inhabits a variety of habitats including desert scrub, grassland, sagebrush steppe, blackbrush, greasewood, piñon-juniper woodlands, pine-fir forests, agricultural lands, and urban areas (Bradley et al. 2006). Day and maternity roosts of western small footed myotis have been found in crevices in cliffs, boulders, and on talus slopes. Summer roosts are highly variable and include buildings, mines, under the bark on trees, and crevices in cliffs and boulders (AGFD 1993; Harvey et al. 1999). This species prefers small protected dry crevices. Night and hibernation roosts are located in small caves and abandoned mine adits. Buildings also are used as temporary night roosts between flights. Western small-footed myotis forage for insects over the edge of rocky bluffs, in clearings, near rocks, and over forests (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). This species has been documented within the Newmont Operations Area south of the study area (Lamp 2007b). Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Long-eared Myotis*

The long-eared myotis is found throughout Nevada from approximately 2,300 to 6,800 feet in elevation but primarily is found at higher elevations (Bradley et al. 2006). The long-eared myotis primarily is associated with coniferous forests, including piñon-juniper woodlands, however, the species also utilizes sagebrush and desert scrub habitats. Day roosts include hollow trees; under loose tree bark; crevices in rock cliffs and fissures in the ground; and occasionally in caves, abandoned mines, and buildings. Night roosts primarily occur in caves, mines, and abandoned buildings (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). This species is known to roost singly or in small groups. This species gleans insects (primarily small moths) over vegetation and open water (e.g., rivers, streams, and ponds) (Bradley et al. 2006). This species has been documented within the project vicinity at Sugarloaf Butte and along Rock Creek (BLM 2000b; Bradley et al. 2006; Lamp 2007b). Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Little Brown Myotis*

The little brown bat is probably a year-round resident primarily found in northern Nevada at higher elevations. This species often is associated with coniferous forests. Foraging occurs in open areas among vegetation, along water margins, and above open water. Roost sites include hollow trees, rock outcrops, buildings, and occasionally in mines and caves (Bradley et al. 2006). This species has not been documented within the project vicinity. Marginal foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered low.

*Long-legged Myotis*

The long-legged myotis occupies piñon-juniper and montane coniferous forest habitats from approximately 3,000 to 11,200 feet in elevation in Nevada (Bradley et al. 2006). Individuals typically day roost singly or in small groups in buildings, rock crevices, caves, abandoned mines, or in hollow trees, particularly large diameter snags or live trees with lightning scars (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). Night roosts and hibernacula are often in caves and mines. Foraging typically occurs in open areas, often at canopy height (Bradley et al. 2006). This species has been documented within the project vicinity at Sugarloaf Butte (Lamp 2007a). Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Yuma Myotis*

The Yuma myotis is a year-round resident found primarily in the southern and western half of Nevada at low to middle elevations (1,500 to 7,700 feet). This species occurs in a wide variety of habitats, including sagebrush, salt desert scrub, agriculture, playa, and riparian habitats. This species gleans aquatic insects over open water and above vegetation. Roost sites include buildings, trees, mines, caves, bridges, and rock crevices. Night roosts are usually associated with buildings, bridges, or other man-made structures (Bradley et al. 2006). This species has not been documented within the project vicinity. Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered moderate.

*Western Pipistrelle Bat*

The western pipistrelle is a year-round resident in Nevada, occupying low and middle elevations (700 to 8,200 feet) in desert habitats of blackbrush, creosote, salt desert scrub, and sagebrush, with occasional occurrence in ponderosa pine and piñon-juniper, usually in association with rock features such as granite boulders and canyons (Bradley et al. 2006). This species gleans insects over open habitats. This species roosts both singly or in small groups in mines, caves, or occasionally in buildings and vegetation. This species has been documented within the project region along Rock Creek (BLM 2000a; Bradley et al. 2006). Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Brazilian Free-tailed Bat*

The Brazilian free-tailed bat is found throughout Nevada in a wide variety of habitats ranging from desert scrub to high elevation mountain habitats (700 to 8,200 feet) (Bradley et al. 2006). This species roosts in a variety of structures including cliff faces, caves, mines, buildings, bridges, and hollow trees. Some caves are used as long-term transient stopover roosts during migration (Bradley et al. 2006). The Brazilian free-tailed bat is known to travel long distances to foraging areas and often forages at high altitudes. This species has not been documented within the project vicinity. Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered moderate.

*Preble's Shrew*

The Preble's shrew is found in a wide variety of habitats in Nevada including arid grasslands and shrublands, wetland and forest edges, and alpine tundra. The Preble's shrew is active year-round and may be active at any time throughout the day or night, but is probably most active during morning and evening hours (WAPT 2006). The Preble's shrew resembles other shrews, feeding primarily on insects and other small invertebrates such as worms, mollusks, and centipedes (WAPT 2006). The Preble's shrew has been documented in northern Elko County, and suitable habitat occurs within the study area (BLM 2002b). The potential for this species to occur within the study area is considered high.

*Pygmy Rabbit*

This species has been recorded south of the study area at the Leeville Project (BLM 2002b). The pygmy rabbit is distributed throughout the northern Great Basin, primarily in rocky habitats dominated by dense stands of big sagebrush and rabbitbrush, particularly in floodplain habitats. Pygmy rabbits usually remain near dense cover, where rabbits excavate burrows and create trail systems in the understory. Sagebrush is important forage for this rabbit and is consumed year-round. NNHP (2007) has identified the study area as having suitable sagebrush habitat. Field surveys by BGMI in March 2008, found suitable habitat present in the study area but no evidence of new use (SRK 2008a); therefore, the potential for this species to occur within the study area is considered moderate.

*Fletcher Dark Kangaroo Mouse*

This species is found throughout Nevada in a wide variety of habitats including intermountain desert scrub, sagebrush grasslands, badlands, desert playas, and ephemeral pools (WAPT 2006). This species' primary food source is seeds, but it also may eat insects. It does not appear to utilize free water and is believed to store food in seed caches within burrow systems (WAPT 2006). Activity for this species has been observed March to October with peak nocturnal activity occurring in the first 2 hours after sunset (WAPT 2006). Suitable habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

<u>Special Status Bird Species</u>

*Least Bittern*

The least bittern is found in wetlands, marshes, wet meadows, and lakes from Sheldon National Wildlife Refuge (NWR) to Ruby Lakes NWR south to Mason Valley Wildlife Management Area (WMA) in western Nevada (Neel 1999). This species' preferred habitat is marshes in very fresh water, typically characterized by cattail and/or spikerush (Floyd et al. 2007). The breeding season for this species is April 15 to July 15 depending on water conditions. The potential for this species to occur within the study area is considered low.

*Bald Eagle*

The bald eagle is found throughout Nevada but mainly as a migrant and winter resident (Floyd et al. 2007). This species generally roosts in close proximity to large water bodies including rivers, lakes, and reservoirs (WAPT 2006). Nests are typically very large stick nests located in large trees such as cottonwoods. Bald eagles typically begin nesting in February, and young fledge by July. This species has been documented during winter surveys within the sub-basins of Rock, Boulder, and Maggie Creek (JBR 1996). However, due to

the lack of suitable habitat (i.e., large trees near water bodies), the potential for this species to occur within the study area is considered moderate.

*Swainson's Hawk*

The Swainson's hawk is a summer resident of Nevada and, like the golden eagle, is most abundant in the northern third of the state (Herron et al. 1985). The majority of documented breeding territories in Nevada have been located in agricultural valleys. Swainson's hawks nest in a wide variety of vegetative communities from 4,000 to 6,500 feet in elevation. Nest sites primarily are found in deciduous trees. However, nests also have been documented in other vegetation types such as buffaloberry, serviceberry, and sagebrush (Herron et al. 1985). Swainson's hawks begin nesting in April, and young typically fledge by July. This species has been observed nesting within the project region (BLM 2002b). No known nest sites occur within the study area (Lamp 2007b). Suitable foraging habitat is located within the study area. The potential for this species to occur within the study area is considered high.

*Ferruginous Hawk*

The ferruginous hawk commonly breeds in many areas of Nevada. This species often nests in trees, on promontory points, rocky outcrops, cut banks, or on the ground. Preferred breeding habitat in most of the state is scattered juniper forests at the interface between piñon-juniper and desert shrub communities that overlook broad valleys used for foraging (Herron et al. 1985). Ferruginous hawks begin nesting in March, and young fledge by July. This species has been observed nesting within the project vicinity (BLM 2002b). No known nest sites occur within the study area (Lamp 2007b). Suitable foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Golden Eagle*

The golden eagle is a year-long resident and is considered to be commonly breeding throughout Nevada; however, eagle densities and nesting activity are greatest in the northern third of Nevada (Herron et al. 1985). Nesting golden eagles prefer suitable cliffs that overlook sagebrush flats, piñon-juniper forests, salt desert shrub, or other habitat capable of supporting a suitable prey base. Highest densities of nesting eagles typically are found along river systems where cliffs border the entire length of the river, and lower densities are found in piñon-juniper habitat and salt desert shrub communities (Herron et al. 1985). Golden eagles begin nesting in March, and young fledge by July. Wintering golden eagles tend to congregate in broad valleys interspersed with agricultural croplands or sagebrush and desert shrub communities. This species has been recorded flying over the study area and suitable nesting habitat exists approximately 20 miles southwest of the study area (Lamp 2007b). Suitable foraging habitat exists within the study area. The potential for this species to occur within the study area is considered high.

*Peregrine Falcon*

The peregrine falcon is found in southwestern and extreme southeastern Nevada. This species prefers tall cliffs with an unobstructed view for both nesting and perching. Peregrine falcons nest on cliffs and rock ledges usually in close proximity to a water source (Johnsgard 1990). This species typically migrates south of the U.S. during winter months. Peregrine falcons forage in open areas for birds and occasionally small mammals (Johnsgard 1990). Although previous surveys have not observed this species, there is marginal foraging habitat located within the study area. However, no known nest sites occur within or near the study area. The potential for this species to occur within the study area is considered low.

*Prairie Falcon*

Prairie falcons range throughout the Great Basin and are permanent residents of Nevada. Habitat requirements include steep cliff ledges and outcrops for nesting that border semi-arid valleys (BLM 2005). The highest nesting densities in Nevada occur in northern counties, particularly located in or near the mouth of narrow canyons, overlooking riparian vegetation and agricultural lands (Herron et al. 1985). Prairie falcons begin nesting in March, and young typically fledge by July. This species has been recorded flying over the study area (Lamp 2007b). Suitable foraging habitat occurs within the study area, and nesting habitat occurs

approximately 20 miles southwest of the study area. The potential for this species to occur within the study area is considered high.

*Greater Sage-grouse*

The greater sage-grouse is found throughout Nevada in sagebrush-dominated habitats (Northeastern Nevada Stewardship Group [NNSG] 2004). Sagebrush is a key component of greater sage-grouse habitat on a year-long basis (NNSG 2004; USFWS Mountain Prairie Region [USFWS MPR] 2007). Sagebrush provides forage and nesting, security, and thermal cover for this species. Moist areas that provide succulent herbaceous vegetation during the summer months are used extensively as brood rearing habitat. Open, often elevated areas within sagebrush habitats usually serve as breeding areas (strutting grounds or lek sites) (NNSG 2004; USFWS MPR 2007). During winter, greater sage-grouse often occupy wind exposed areas where sagebrush is available (e.g., drainages, southern or western slopes, or exposed ridges). Historically, three leks occurred immediately within the project vicinity (Lamp 2007b). However, two of these leks have been consumed by the BGMI Goldstrike Mine in recent years. The third lek is 1.5 miles north of the study area and has not been active since 1989 (BLM 2007b). The nearest active lek occurs approximately 5.5 miles north of the study area and is considered in the cumulative effects analyses. Greater sage-grouse males begin displaying on leks in March, and hens typically begin nesting in April and May. NDOW considers the entire project area summer and winter habitat (Lamp 2007b). **Figure 3.8-3** presents designated sage-grouse nesting habitat in the vicinity of the study area. Greater sage-grouse have been observed within the project area and suitable habitat is present. However, surveys conducted in March 2008 found little sign and indicated the project area as low density habitat (SRK 2008b). Considering that the study area encompasses three historic leks and greater sage-grouse have been observed in the study area, the potential for this species to occur within the study area is high.

*Sandhill Crane*

The sandhill crane breeds in the lower river valleys and interior basins of the northeastern and east-central regions of Nevada (Floyd et al. 2007). This species is found in large irrigated hay meadows, flooded pastures, and grasslands (WAPT 2006). Sandhill cranes also are found in agricultural grain fields during certain times of the year. Approximately 90 percent of nesting crane pairs in Nevada are found in Elko County with additional nesting pairs in White Pine, Eureka, Lander, northern Lincoln and Nye, and eastern Humboldt counties (WAPT 2006). The breeding season for this species is April 15 to July 15. Due to the lack of suitable habitat, the potential for this species to occur within the study area is considered low.

*Long-billed Curlew*

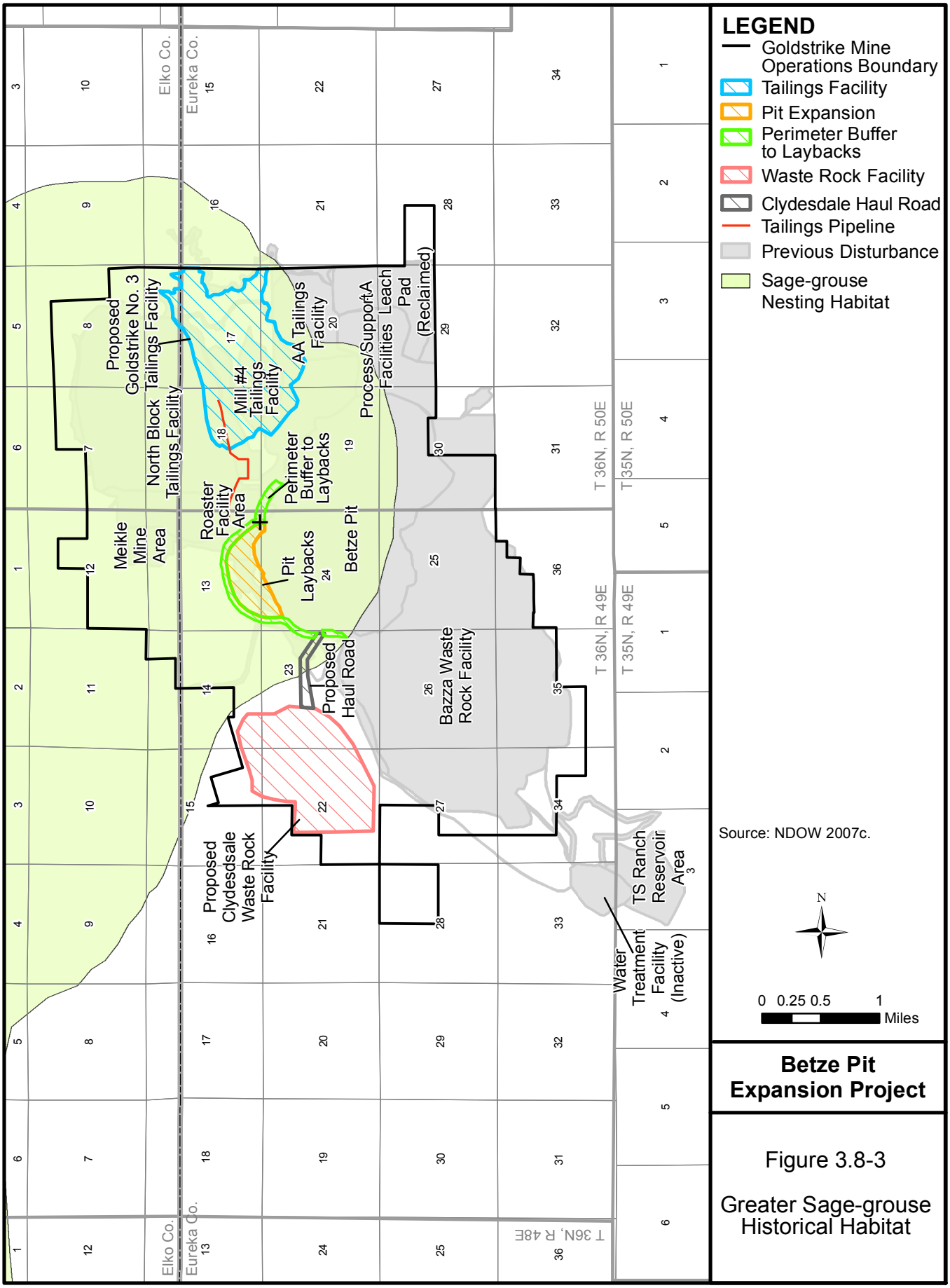
The long-billed curlew is known to breed at Sheldon NWR in northern Washoe County, Ruby Lake NWR in Elko County, Lahontan Valley in Churchill County, and Fish Creek Ranch in Eureka County. This species prefers short grasslands, wet meadows, wetlands, and marshes (Floyd et al. 2007). The breeding season for this species is April 15 to July 15. Due to marginal habitat occurring within the study area, the potential for this species to occur within the study area is considered low.

*Black Tern*

The black tern is found only at a few locations in Nevada including shallow lakes and wetlands from Sheldon NWR to Ruby Lakes NWR south to Mason Valley WMA in western Nevada (Floyd et al. 2007). This species prefers marshes in very fresh water, typically characterized by cattail and/or spikerush. Nesting usually occurs semicolonially with other terns in shallow freshwater marshes with emergent vegetation (Floyd et al. 2007). The breeding season for this species is April 15 to July 15. The potential for this species to occur within the study area is considered low.

*Burrowing Owl*

The burrowing owl is known to breed throughout Nevada. The majority of the breeding population is known to migrate from northern Nevada during the winter months. However, observations of this owl have been recorded throughout Nevada during all months of the year (Herron et al. 1985). Breeding by burrowing owls is




**Betze Pit Expansion Project**

Figure 3.8-3

Greater Sage-grouse Historical Habitat

strongly dependent on the presence of burrows constructed by prairie dogs, ground squirrels, or badgers. Prime burrowing owl habitat must be open, have short vegetation, and contain an abundance of burrows. Burrowing owls begin nesting in April, and young typically fledge by August. This species has been observed nesting approximately 15 miles northwest of the study area (Lamp 2007b). No known nest sites occur within the study area. Suitable foraging habitat exists within the study area. The potential for this species to occur within the study area is considered high.

*Long-eared Owl*

Long-eared owls occur within juniper woodlands, coniferous forests, and riparian areas at higher elevations (Herron et al. 1985). The majority of Nevada's population of long-eared owls is considered non-migratory, although individuals occurring outside of Nevada have been known to winter in Nevada (Herron et al. 1985). Long-eared owls begin nesting in February, and young typically fledge by July. This species has been documented within the project region south of the study area in Boulder Valley. Suitable foraging habitat occurs within the study area. Due to a lack of roosting and nesting habitat, the potential for this species to occur within the study area is considered low.

*Short-Eared Owl*

Short-eared owls are year-round residents of Nevada, although few nest sites have been identified. The species tend to nest in meadow and wetland habitats (Herron et al. 1985). Short-eared owls forage in open areas and are known to nest and roost on the ground. This species begins nesting in February, and young typically fledge by July. This species has been documented within the project region south of the study area in Boulder Valley and in Squaw Valley at the northern end of the Carlin Trend (JBR 1996). Suitable nesting and foraging habitat occurs within the study area. The potential for this species to occur within the study area is considered high.

*Loggerhead Shrike*

The loggerhead shrike is a common resident throughout Nevada. This species is found in open grasslands along valley floors and foothills of the Great Basin. In Nevada, it is commonly found in scrub habitat types such as sagebrush and greasewood. Loggerhead shrikes prefer shrubs or small trees for nesting, but nesting also can occur in piñon-juniper woodlands. The breeding season for this species is April 15 to July 15. This species can be found perching on wire, fences, or poles (National Geographic Society 1983). This species has been observed within the project region (BLM 2002b). There is suitable nesting and foraging habitat within the study area. The potential for this species to occur within the study area is considered high.

*Yellow-breasted Chat*

The yellow-breasted chat is found throughout Nevada, although it is more common in the eastern portion of the state (Floyd et al. 2007). This species is found in cottonwood, willow, riparian and other woodland habitats with dense understories. The breeding season for this species is April 15 to July 15. Due to the lack of suitable habitat, the potential for this species to occur within the study area is considered low.

*Vesper Sparrow*

The vesper sparrow is a summer resident that occurs in various open shrub habitats from high elevation valleys to higher mountain slopes and basins (Floyd et al. 2007). This species occurs from approximately 5,500 feet in elevation in the foothills of northern Nevada to approximately 9,000 feet in elevation in surrounding mountain ranges. Open areas with a scattered canopy of big sagebrush and a minimum ground cover of 20 percent grasses, forbs, and young shrubs appear to be the preferred nesting habitat for this species (Floyd et al. 2007). Nests normally are placed on the ground under or near shrubs. The breeding season for this species is April 15 to July 15. Diet consists of seeds and insects (Neel 1999). There is suitable nesting and foraging habitat within the study area. The potential for this species to occur within the study area is considered high.

### 3.8.2 Environmental Consequences

Wildlife, special status species, and related issues addressed by this analysis were determined through consultation with the BLM, NDOW, and USFWS. The primary issues related to wildlife and special status species include: disruption of big game movements and cumulative loss of habitat, loss or alteration of native habitats, increased habitat fragmentation, animal displacement, direct loss of wildlife, and impacts associated with water management. In addition, primary issues related to special status species, especially pygmy rabbit and greater sage-grouse, include impacts that could contribute to their being listed as federally threatened or endangered.

The potential impacts of the proposed project on terrestrial wildlife can be classified as short-term and long-term. Short-term impacts arise from habitat removal and disturbance as well as from activities associated with mine operation; these impacts would cease upon mine closure and completion of successful reclamation. Long-term impacts consist of permanent changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success. Direct impacts to wildlife populations could include limited direct mortalities from mine development, habitat loss or alteration, incremental habitat fragmentation, and animal displacement. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities.

The riparian habitat within the region supports a greater number of species than other habitat types. As a result, project-related effects may be greater for species closely associated with riparian corridors. The degree of the effects on terrestrial wildlife species and their upland habitats would depend on factors such as the sensitivity of the species, seasonal use patterns, type and timing of project activity, and physical parameters (e.g., topography, cover, forage, and climate).

#### 3.8.2.1 No Action Alternative

Under the No Action Alternative, the Goldstrike Mine would continue to operate under existing authorizations. No native wildlife habitat would be disturbed or lost. Additional habitat fragmentation and animal displacement would not occur. The level of human use would remain the same as the current levels.

<u>Surface Disturbance</u>

Impacts to wildlife from currently authorized mine-related surface disturbance include the temporary (short-term and long-term) and permanent reduction or loss of habitat (BLM 1991b). Habitat loss or alteration results in direct losses of smaller, less mobile species of wildlife, such as small mammals and reptiles, and the displacement of more mobile species into adjacent habitats. In areas where habitats are at, or near, carrying capacity, animal displacement could result in some unquantifiable reductions in local wildlife populations (BLM 1991b). Mine-related surface disturbance also results in an incremental increase in habitat fragmentation at the mine site until reclamation has been completed and vegetation has been re-established (BLM 1991b). It is assumed that mine-related displacement and habitat fragmentation effects are highest for wildlife species that use riparian corridors (BLM 1991b).

*Game Species*

Direct impacts to mule deer include the long-term reduction of potential forage and the increase of habitat fragmentation from vegetation removal associated with mine construction and development activities (BLM 1991b). This loss of habitat has resulted in an overall reduction in the amount of available habitat in the project region. In addition, an important big game migration corridor located along the west side of the Tuscarora Range has been directly impacted from the construction of several large mining facilities including the Goldstrike Mine (Lamp 2007b). These facilities have severely decreased the width of the migration corridor and further fragmented mule deer habitat along the Carlin Trend (Lamp 2007b).

Impacts to pronghorn would be similar to those discussed above for mule deer, although not as severe based on pronghorn population trends and use within the study area.

Impacts to mountain lions are minimal, based on the infrequent occurrence of the species within the study area.

Direct impacts to small game species (e.g., greater sage-grouse, chukar, mourning dove, pygmy rabbit, and black-tailed rabbit) include the long-term reduction of potentially suitable habitat and the permanent loss of potential habitat (BLM 1991b). Existing impacts also include displacement from the disturbance areas and increased habitat fragmentation, until reclamation has been completed and vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas is available for use by these species. However, displacement increases competition and could include some local reductions in wildlife populations if adjacent habitats are at carrying capacity (BLM 1991b).

*Nongame Species*

Impacts to nongame species are similar to those discussed above for small game species. Existing direct impacts to nongame species (e.g., small mammals, passerine, raptors, and reptiles) include the long-term reduction of suitable habitat, permanent loss of habitat, and the direct loss of less mobile species (BLM 1991b). Existing impacts also include displacement from the disturbance areas and increased habitat fragmentation until vegetation is re-established. However, displacement increases competition and results in some local reductions in wildlife populations if adjacent habitats are at carrying capacity (BLM 1991b). Existing impacts also include nest and burrow abandonment or loss of eggs or young.

*Human Presence and Noise*

Under currently authorized disturbance, impacts resulting from human presence and noise include avoidance or accommodation. Avoidance results in displacement of animals from an area larger than the actual disturbance area. The total extent of habitat loss as a result of the wildlife avoidance response is impossible to predict since the degree of this response varies from species to species and can even vary between different individuals of the same species. In addition to avoidance response, increased human presence has intensified the potential for wildlife/human interactions ranging from harassment of wildlife to poaching and legal harvest. No additional impacts would be expected under this alternative.

Water Quality and Quantity

Species likely affected by reductions in available water sources and associated habitats would include big game, upland game birds and small game mammals, nongame birds (e.g., raptors and passerines), nongame mammals (e.g., bats), reptiles, amphibians, and fish. The impacts to these species are included within the area that was disclosed and mitigated for in the 2000/2003 Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48** and described in Section 3.3.3.1 and 3.3.4.2.

The CIA (BLM 2000b) and Betze Project Draft SEIS (BLM 2000a) summarized the impacts associated with future reduction in mine discharges on the artificially created wetlands in Boulder Valley. As mine discharges diminish in the future, the level of free water that has surfaced within the valley, in addition to the associated riparian and wetland vegetation, would be reduced. Waterfowl/shorebirds use of these artificial communities could also decline as drier habitats begin to reestablish in the valley. Based on anecdotal observations of the soils and vegetation in this area, it appears that saturated soils are increasing the leaching of minerals and salts into the soil surface and subsurface layers, thereby modifying the associated plant communities (BLM 2000a, 2000b). The leaching of minerals and salts also may be occurring on irrigated lands in Boulder Valley. As mine dewatering diminishes and artificial wetlands dry out, other impacts may occur such as an increase in: 1) noxious and invasive plant species, 2) susceptibility to wildfire, 3) eolian erosion and fugitive dust emissions if upland plants do not become reestablished, and 4) saline or alkaline runoff.

These potential impacts would affect private land in Boulder Flat primarily within the TS Ranch controlled by ELLCO, a subsidiary of Newmont Gold Corporation. These lands are not under BLM jurisdiction or BGMI's control. Irrigated lands within Boulder Flat may continue to be irrigated after mine dewatering diminishes. ELLCO has water rights to allow for pumping groundwater for irrigation to supplement or replace the water supply provided by BGMI after mine dewatering ceases at the Goldstrike Mine.

The BLM cannot enforce mitigation for potential impacts on private land; however, the BLM recommends the following voluntary measures for private landowners to implement should they choose to mitigate for potential impacts on artificial wetland sites and irrigated areas that have dried out due to cessation of mine dewatering in Boulder Flat:

- Conduct vegetation monitoring at affected sites to determine vegetative cover, species density, and diversity and compare results to suitable reference areas in Boulder Flat.
- Implement a noxious and invasive weed control program, including weed surveys, to minimize their spread and reduce wildfires associated with cheatgrass infestations.
- Mitigation of soil salinity in affected areas by:
  - Reclamation (removal of salts from the root zone that requires large quantities of freshwater and effective soil drainage); or
  - Scraping and removal of surface soils that contain salt buildup; or
  - Incorporation of organic matter to improve soil structure and water infiltration; or
  - Deep tillage to mix salts present in the surface zone with deeper soils to reduce surface concentrations.
- Conduct vegetation reseeding with appropriate plant species in affected areas to minimize wind and water erosion as well as fugitive dust. Plant appropriate salt-tolerant vegetation in areas that have salt or alkali buildup in soils.

#### 3.8.2.2 Proposed Action

Terrestrial Wildlife

*Surface Disturbance*

The Proposed Action would result in the long-term reduction of approximately 943 acres of native vegetation, including approximately 867 acres of sagebrush shrubland. Woody species such as sagebrush would require up to 25 years to reach maturity. The disturbance associated with the Proposed Action would be reclaimed following completion of mining activities. BGMI would conduct reclamation monitoring in the same manner as the AA Leach Pad and Bazza Waste Rock Facility as it has been confirmed to be successful reclamation as compared to adjacent undisturbed sites (Cedar Creek Associates 2007a).

Impacts to wildlife from mine-related surface disturbance would include the temporary (short-term and long-term) and permanent reduction or loss of habitat. Habitat loss or alteration would result in direct losses of smaller, less mobile species of wildlife, such as small mammals and reptiles, and the displacement of more mobile species into adjacent habitats. In areas where habitats are at, or near, carrying capacity, animal displacement could result in some unquantifiable reductions in local wildlife populations. Mine-related surface disturbance also would result in an incremental increase in habitat fragmentation at the mine site until reclamation has been completed and vegetation has been re-established. It is anticipated that the potential mine-related displacement and habitat fragmentation effects would be highest for wildlife species that use the riparian corridors along Bell, Boulder, and Rodeo creeks. However, BGMI proposes to implement a 100-foot setback from Bell and Rodeo creeks when constructing the Clydesdale Waste Rock Facility, therefore, limiting impacts to species associated with this riparian corridor.

Game Species

Potential direct impacts to mule deer would include the incremental long-term reduction of potential forage and the incremental increase of habitat fragmentation from vegetation removal associated with mine construction and development activities. The project would disturb approximately 943 acres of low density mule deer habitat, consisting primarily of sagebrush shrublands habitat. This anticipated loss of habitat would result in an incremental reduction in the amount of available habitat in the project region. In addition, NDOW has indicated

that an important historic big game migration corridor located along Bell Creek would be directly impacted from the construction of the proposed Clydesdale Waste Rock Facility (Lamp 2007b; NDOW 2007b). This waste rock facility would decrease the width of the migration corridor and would further fragment mule deer habitat along the Carlin Trend. Therefore, significant impacts to mule deer populations that continue to use this important historic migration corridor could occur as a result of the Proposed Action (Lamp 2007c).

In order to minimize continuing impacts to the transition range for the resident mule deer herd, BGMI is committed to minimizing disturbance where possible within the remaining corridors that are utilized by the deer herd for passage through the Carlin Trend area. Surface disturbance would be staged in such a way, where possible, as to be sequential in nature; if one part of an open corridor is disturbed it would be completed and reclaimed before a subsequent section is started. The corridor would be maintained at a width of 600 feet. **Figure 2-15** shows the reclamation schedule for the Clydesdale Waste Rock Facility along the corridor.

Construction of the Clydesdale Waste Rock Facility and associated haulage road would progress using the following protective measures:

- The footprint of the entire facility and haul road would be surveyed in the field. Appropriate storm water controls would be designed and installed on the downstream side of the facilities with particular attention being paid to areas adjacent to drainages. An interceptor berm or ditch may be installed on the upstream side of the footprint to minimize the run-on of meteoric water from the adjacent area to the disturbed footprint.
- Disturbance within remaining corridors would be reclaimed as soon as possible to allow the least amount of time for disruption to herd movement.
- Following the construction of the storm water controls, the entire footprint would be stripped of topsoil which would either be staged in a topsoil stockpile or at the toe of the designed facility.
- Culverts would be installed in the Bell Creek Drainage and an engineered fill would be placed to contain and support them.
- The haul road sub base and capping material would be placed by end-dumping material with the mine haulage fleet. Once the haul road is completed, waste rock would be placed within the footprint of the facility, progressing from the entry point of the haul road, building the facility generally to the west and south. The haul road would be constructed with two strategically placed breaks/gaps to allow for wildlife movement to help minimize wildlife/vehicle collisions along the haul road.
- Re-sloping and reclamation of the faces shown in **Figure 2-15** would commence as soon as is practical from a sequencing and worker safety standpoint.
- Facility reclamation would generally be performed once the initial lift of material is placed, which would range from 0 feet at the topographic catch point to approximately 50 feet in height to the south. There would be no irreversible topography changes that would block or hinder movement after mining activities are completed. Reclaimed topography would support north/south deer patterns of migration.
- The Bazza Waste Rock Facility has been partially reclaimed in previous years along its western margin closest to the Bell Creek Drainage. Subsequent reclamation on the Bazza Waste Rock facility would concentrate on continuing to expand this western margin to allow the migration corridor to widen in the least amount of time possible.

BGMI has committed to assisting NDOW and the BLM in the collection of big game migration data in the project vicinity. BGMI has contributed approximately $31,849 for the purchase of 5 radio collars to monitor how mining, fire, and other influences are impacting the Area 6 deer herd. The use of these radio collars will help NDOW ascertain the continued use of this historic migration corridor and project how it may be used in the future. If the data collected by these collars indicates a reduced use and/or probable abandonment of this corridor than restrictions and commitments imposed upon BGMI for the maintenance of this migration route may be eased or removed.

Impacts to pronghorn would be similar to those discussed above for mule deer. Potential direct impacts would include the incremental long-term reduction of approximately 66 acres of summer range and 360 acres of very important winter range. Although impacts to the pronghorn population would be anticipated from the construction of the Clydesdale Waste Rock Facility, it is anticipated that impacts would not be as severe as those discussed above for mule deer, as pronghorn are able to adjust their migration habits more readily than mule deer.

Impacts to mountain lions are expected not to be significant, as this species occurs at a low density in and around the project area.

Direct impacts to small game species (e.g., chukar, mourning dove, and black-tailed rabbit) would include the incremental long-term reduction of approximately 943 acres of potentially suitable habitat, and the permanent loss of approximately 101 acres of potential habitat. Impacts also would include displacement from the disturbance areas and increased habitat fragmentation, until reclamation has been completed and vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas would be available for use by these species. However, displacement would increase competition and could include some local reductions in wildlife populations if adjacent habitats are at carrying capacity. Potential impacts also could include nest and burrow abandonment or loss of eggs or young. However, potential effects to small game from mine development are expected to be low. These temporary losses would reduce productivity for that breeding season. Potential impacts to the pygmy rabbit and greater sage-grouse are discussed below.

#### Nongame Species

Impacts to nongame species would be similar to those discussed above for small game species. Direct impacts to nongame species (e.g., small mammals, passerine, raptors, and reptiles) would include the incremental long-term reduction of approximately 943 acres of potentially suitable habitat, and the permanent loss of approximately 101 acres of potential habitat. Impacts also would include displacement from the disturbance areas and increased habitat fragmentation, until vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas would be available for use by these species. However, displacement would increase competition and could result in some local reductions in wildlife populations if adjacent habitats are at carrying capacity. Potential impacts also could include nest and burrow abandonment or loss of eggs or young. However, potential effects to nongame species from mine development are expected to be low. These temporary losses would reduce productivity for that breeding season.

#### Migratory Birds

A variety of resident and migratory bird species (e.g., raptors and songbirds) have been identified as potentially occurring within the study area. Potential direct adverse impacts to bird species would include the temporary loss of approximately 943 acres and permanent loss of approximately 101 acres of potentially suitable breeding, roosting, and foraging habitat. However, this temporary loss is expected to have little effect on local bird populations based on the amount of suitable breeding and foraging habitat in the surrounding area. If construction or development of the proposed facilities was to occur during the breeding season (approximately April 15 through July 15, depending on species), direct impacts to breeding birds could include the possible direct loss of nests or indirect effects (e.g., abandonment) from increased human noise and human presence within close proximity of an active nest site. In order to minimize impacts to breeding raptors, BGMI has committed to conducting breeding raptor surveys and implementing appropriate mitigation measures, as needed, in the event that project construction would occur during the raptor breeding season. In addition, for the protection of breeding songbirds, BGMI has committed to avoiding habitat removal, to the extent possible, between April 15 and July 15 or, alternately, conducting breeding bird surveys and implementing appropriate mitigation in coordination with the BLM and NDOW. With implementation of these measures, residual impacts to nesting bird species within the study area would be limited primarily to temporary habitat loss. This loss is anticipated to have little effect given the extent of native habitats in the surrounding region.

A short segment (<2 miles) of an existing 120-kV transmission line would be re-routed around the proposed Clydesdale Waste Rock Facility (as described in 2.3.5.5). This short, rerouted power line segment is 9,500 feet long and potentially could pose an electrocution hazard for raptor species attempting to perch on the structures. To minimize this potential impact, BGMI has committed to using raptor-deterring design measures which may include, but would not be limited to, a 60-inch separation between conductors and/or grounded hardware in eagle-use areas as well as the use of insulating or cover up materials for perch management depending on line configuration, pole type, and associated biological risk factors. The rerouted power line segment also would incrementally increase the collision potential for migrating and foraging bird species. However, collision potential typically is dependent on variables such as the location in relation to high-use habitat areas (e.g., nesting, foraging, and roosting), line orientation to flight patterns and movement corridors, species composition, visibility, and line design (APLIC 2006). To minimize potential collision impacts to migrating and foraging bird species, BGMI has committed to using standard raptor-proofing designs as discussed in Section 2.2.1.13, Applicant-committed Environmental Protection Measures.

*Human Presence and Noise*

The most common wildlife responses to noise and human presence are avoidance or accommodation. Avoidance would result in displacement of animals from an area larger than the actual disturbance area. The total extent of habitat loss as a result of the wildlife avoidance response is impossible to predict since the degree of this response varies from species to species and can even vary between individuals of the same species. Also, after initial avoidance of human activity and noise-producing areas, certain wildlife species may acclimate to the activity and begin to reoccupy areas formerly avoided. For example, during the initial development phases, it is likely that big game (i.e., pronghorn and deer) would be displaced from a larger area than the actual disturbance sites due to the avoidance response. However, these big game species have demonstrated the ability to acclimate to a variety of activities as long as human harassment levels do not increase substantially (Ward 1976). Therefore, it is possible that the extent of displacement would approximate the actual disturbance area after the first few years of mine operation (Ward 1976). In addition to avoidance response, increased human presence intensifies the potential for wildlife/human interactions ranging from harassment of wildlife to poaching and legal harvest.

Three factors would combine to help minimize the potential effects related to increased human presence in the study area. First, the Proposed Action is an expansion of an existing mine site where human activity associated with processing operations continues to date. Second, the location of the mine site is in close proximity to a number of other mining operations in the project vicinity (e.g., Newmont's Blue Star/Genesis, Deep Star, Lantern, Section 36, North Lantern, Leeville, and the Bootstrap Mine) that currently experience relatively high human presence and noise levels. Third, BGMI has developed an environmental awareness course for employee orientation that was implemented in association with the existing mine and would continue to be implemented under the Proposed Action. Under the Proposed Action, this program would be required for all construction and operations personnel to inform them of applicable federal and state laws, caution against animal harassment, and develop an awareness of, and sensitivity to, wildlife issues and concerns specific to the mine site.

The number of personnel traveling to and from the mine site would not change from existing levels, and the potential for increased wildlife mortalities from mine-related vehicles along the mine access roads is expected to remain negligible, due to mine-regulated speed limits on mine roads, and bus transportation to and from the mine site for mine employees.

*Water Quality and Quantity*

Wildlife populations within the study area could be affected by exposure to mine-related process solutions, which could contain potentially toxic levels of cyanide. Potential sources for wildlife exposure to these solutions would include the proposed Goldstrike No. 3 Tailings Facility. The proposed tailings facility would be designed and constructed as a zero discharge facility to minimize the potential release of process solutions outside of the protected containment area.

To minimize impacts to wildlife from exposure to adverse cyanide concentrations at the tailings impoundment, BGMI has committed to maintaining WAD cyanide concentrations at non-lethal levels, less than 50 ppm (Donato et al. 2007) and generally less than 20 ppm. Cyanide concentrations are in compliance with the Industrial Artificial Pond permit issued from NDOW. Based on BGMI's committed environmental protection measures, potential impacts to wildlife resources from cyanide ingestion would be low.

*Pit Lake Ecological Risk Assessment*

Based on guidance in BLM IM NV-2004-031, Ecological Risk Assessment Guidelines for Open Pit Mine Lakes in Nevada (BLM 2004), "ERAs should normally be used for additional analysis when the predicted pit water chemistry identifies a potential problem with the future pit lake." The BLM is directed to consider the applicable water quality standards in determining the need for an ecological risk assessment (ERA).

BGMI chose to conduct a screening-level ERA for the project to evaluate potential adverse effects to wildlife and aquatic life that could be exposed to the post-mining Betze Pit Lake. Standardized USEPA procedures were followed using USEPA and Nevada BLM guidance (Hunter 2008), applied to the pit conditions expected based on the Betze Pit Lake Water Quality Prediction Report (Schafer 2007) data.

The screening-level ERA therefore prospectively quantified anticipated risk for chemical exposures of ecological receptors selected on the basis of the ecological site conceptual model. The surface water chemical concentrations are those predicted to be present in the Betze Pit Lake from the Proposed Action when dewatering ceases as detailed in Schafer (2007). The screening level ERA compared standard ecological screening benchmarks against predicted concentrations in pit lake water at Year 50 in order to identify the ecological constituents of potential concern.

It should be noted that the screening level ERA discussed here (Hunter 2008) only considers, prospectively, the Proposed Action. It does not consider the ecological risk associated with the No Action Alternative. The Betze Project SEIS (BLM 2000a) conducted a screening level evaluation of pit water (see Section 3.4.2.4 of the Draft SEIS), comparing predicted water quality against standard screening benchmarks for wildlife (Sample et al. 1996). That evaluation did not consider potential risk to aquatic life.

The evaluation in the Betze Project SEIS (BLM 2000a) concluded that the pit lake may over time develop an aquatic community of aquatic plants and aquatic invertebrates. However, the inaccessibility of the pit water limits its use by terrestrial wildlife, and the limited amount of aquatic resources likely to develop limits its use as a substantial food source for avian and bat wildlife. The evaluation concluded that the anticipated concentrations of metals would not result in reported ecological risk to the three selected wildlife species (rough-winged swallow, red-tailed hawk, and little brown bat).

An ERA is directed towards evaluating if there is potential for ecological risk (i.e., adverse effects to biota from exposure to the stressor). It is by nature conservative, utilizing conservative screening level assumptions and benchmarks in order to allow elimination of those exposures which have no potential for adverse effects. Reporting of a potential risk does not necessarily imply that an adverse effect is actually present or likely to occur, but triggers additional evaluation of site-specific factors to further consider the potential for adverse risks.

The prospective screening level risk assessment conducted by Hunter (2008) sets out a conceptual site model for the pit lake where the pit lake develops a littoral zone, and could be attractive to a variety of birds and mammals, and possibly livestock. Even fish are considered possible, if fish are deliberately introduced, or immigrate spontaneously from the Rodeo Creek Diversion into the pit at the end of mining or by occasional bird transport. The risk assessment considered various species that could conceivably use resources in the pit lake, including birds (cliff swallow, bald eagle, mallard duck, killdeer, and western grebe); mammals (mule deer, little brown bat, and livestock); and fish (introduced bluegill sunfish and bass were noted). arsenic, selenium, cadmium, and nickel were identified for further quantitative risk analysis in the screening level ERA when compared against standard screening benchmarks.

Betze Pit Lake Water conditions from Year 50 (Schafer 2007) were chosen for the ERA because rapid infilling, erosion, and wall sloughing during the years prior to Year 50 are expected to create an unstable pit lake, thus prohibiting substantial development of biological activity (Hunter 2008). The pit lake water constituent of potential concern (COPC) concentrations are expected to be higher without the Rodeo Creek Diversion into the pit after closure (Shafer 2007). These higher COPC concentrations were used for the ERA in order to predict the impacts to wildlife using the most conservative model.

To assess the potential exposure of the selected species, a conservative deterministic dose model (USEPA 1993) was applied to the birds and mammals, applying conservative biota-sediment bioaccumulation factors and bioaccumulation factors to account for biotransfer of COPCs via food sources to the wildlife species, in addition to direct contact and ingestion of sediment and surface water. This approach yields conservative estimates, as it is assumed that a large portion (or all) of the resources the population needs are derived from the pit lake, an unlikely scenario in view of the limited habitat expected to develop and the general inaccessibility of the area.

In an additional step, the effects analysis, potentially toxic doses, or toxicity reference values (TRVs), were derived for the wildlife species to compare to the doses calculated in the exposure analysis. This evaluation, based on literature data, uses toxicity data from the species of concern or taxonomically similar species to derive the threshold for “safe” doses to calculate. Upper bound and lower bound TRVs were derived, representing the highest dose that will not result in an adverse effect and the lowest dose that may result in an adverse effect, per standard risk assessment practice.

For the fish evaluation, development of TRVs as noted above were not used, and toxicity tests were instead conducted using fathead minnows (*Pimephales promelas*) exposed to water conditions simulating the anticipated concentrations in the pit lake at Year 50 (Hunter 2008; Schafer 2007). This species is commonly used as a surrogate for native fish species, as standard, accepted protocols exist, and its universal use allow comparative analysis. However, the use of the fathead minnow may not necessarily be representative of all fish species, and the evaluation needs to consider its representativeness to local conditions on a case-by-case basis.

The screening level risk assessment concluded that ecological risk to the wildlife receptors is not likely from pit water exposure. The potential risk is expressed as a Hazard Quotient (HQ) equal to the exposure dose divided by the TRV, where a HQ<1 indicates that there is no potential for adverse effects, while a HQ>1 indicates such risk cannot be excluded. Even under the conservative input assumptions, there was no potential for adverse effects (“risk”) for any of the wildlife or livestock species under lower or upper bound estimate conditions, except for the lower bound estimates for a few cases (the swallow and the bat). In both of these cases the conservative assumptions required that the level of exposure be much higher than realistically expected (for example, the swallow is assumed to gather all the mud needed for its nest from the pit lake, and the bat consumes insects that all emerged from larval stages spent in the pit lake). Considering that such assumptions are unrealistically conservative, the risk assessment concluded that the Betze Pit Lake is not likely to result in adverse effects to wildlife or livestock under anticipated future conditions at Year 50.

While a fish community is not anticipated for the pit lake under the Proposed Action or alternatives, it is possible that fish may end up present in the pit lake either through spontaneous immigration of fish possibly present in local watercourses (e.g., dace, minnow, or chub species), or the deliberate stocking of fish (e.g., sunfish, bass, or even trout). Introduction of fish to the pit lake is not planned by BGMI and any such introduction would need to consider the potential for success in view of the physical and chemical conditions in the pit lake.

The ERA considered potential risk to any fish, and concluded, based on literature toxicity data, that exposure to anticipated concentrations of arsenic in the pit lake, particularly in consideration of the elevated sulfate levels (>1,000 mg/L) that risk to fish from exposure to arsenic concentrations was unlikely. High sulfate lowers the toxicity of arsenic. Selenium has highly site-specific toxicity characteristics. Based on comparative data from other pit lake data in Nevada it appears that bioaccumulation of selenium would be lower than the default

assumed in the National Ambient Water Quality Criteria calculations, and adverse effects from selenium would not be anticipated to fish or to piscivorous wildlife.

Cadmium and nickel concentrations are anticipated to be elevated to levels above screening levels, and ecological risk to fish was evaluated with additional testing. Laboratory toxicity tests were conducted on the fathead minnow (*Pimephales promelas*) to evaluate potential toxicity from nickel and cadmium. Results show that acute toxicity is not expected from nickel or cadmium concentrations up to at least 4 mg/L nickel and 0.09 mg/L cadmium. Survival of fish populations at the anticipated concentrations would not be adversely impacted.

The fathead minnow is considered relatively tolerant of nickel and cadmium relative to more sensitive species such as trout, and possibly bass. However, the fathead minnow is likely a good surrogate for the taxonomically and ecologically related fish species in the area, which permits the conclusion that adverse ecological effects to spontaneously immigrating fish is not likely.

A further consideration is that the anticipated hardness of the pit water is expected to be elevated (1,270 mg/L as $CaCO_3$). While in general metal toxicity decreases with increasing hardness, the anticipated levels are considerably above the upper bound of hardness values that are considered in standard toxicity screening. It is true that the elevated hardness may affect the applicability of hardness data. However, the use of empirical toxicity tests showed that even the most sensitive parameters, nickel and cadmium, did not result in toxicity under simulated ambient conditions, reinforcing the conclusion of no anticipated toxic effects.

*Hazardous Materials Spill*

The probability of a transportation-related spill of process chemicals along the transportation route is discussed in Section 3.14, Hazardous Materials and Solid Waste. The potential for wildlife exposure to toxic chemicals as a result of a transportation-related spill would be greatest if an accident were to occur near aquatic habitats. Spills in dryland habitat would pose only minimal risk to most wildlife species since these spills would be adjacent to highways and could be rapidly contained and cleaned up.

In general, the materials of greatest concern would be sodium cyanide, sodium hydroxide, and diesel fuel. The effects of a sodium cyanide release would be highly variable and would depend on the quantity released, the location of the release (e.g., dry upland area, wet meadow area, or flowing stream area), the species exposed, and the chemical conditions at the release location. The most likely effect of a potential release of sodium cyanide would be the poisoning of terrestrial or aquatic species. Animal species that drink contaminated water could suffer severe effects or death depending on the concentration of cyanide and the volume of the water consumed. Sodium cyanide solution decomposes rapidly when in contact with the atmosphere into poisonous and flammable hydrogen cyanide gas. Animal species that breathe this gas could suffer severe effects or death depending on the concentration of cyanide gas and the duration of exposure. Environmental effects of a cyanide spill or leak would be limited in extent and time of contamination, due to the rapid degradation of cyanide into benign elements when exposed to direct sunlight or oxygen.

Sodium hydroxide spilled onto the ground or into a water body has the potential to cause short-term damage to localized terrestrial and aquatic habitats. A sodium hydroxide release into a stream or other water body has the potential to raise the pH of the water and temporarily reduce populations of aquatic invertebrates, amphibians, and fish.

A diesel spill has the potential to contaminate soil, surface water, and groundwater in addition to harming aquatic life and vegetation. Although unlikely, such a spill also could ignite from the accident and cause a range fire. Since cleanup actions would take place immediately, diesel contamination has a low potential to result in long-term impacts to soil, surface water, and possibly groundwater.

The risk of wildlife exposure associated with accidental spills into aquatic habitats would be highly unlikely for several reasons. The probability of an accident and the resulting release of process chemicals would be low as discussed in Section 3.14, Hazardous Materials and Solid Waste, and areas of aquatic habitat adjacent to the

proposed transportation route are limited. Hazardous chemicals would be transported via U.S. Department of Transportation (USDOT)-certified containers and transporters, and transportation of sodium cyanide and other chemical reagents would be in accordance with all applicable rules and regulations. Goldstrike Mine was certified May 17, 2007 by International Cyanide Management Code (ICMC) for the mining industry (ICMC 2008). In the event of a spill, a carrier would be required to implement appropriate emergency response measures as stipulated by state and federal regulations. In addition, as discussed in Section 3.14, Hazardous Materials and Solid Waste, BGMI would implement the existing Environmental Incident Response Manual that establishes procedures for responding to accidental spills or releases of hazardous materials to minimize environmental risks.

Special Status Species

The Proposed Action would result in the long-term reduction of approximately 943 acres of native vegetation, including approximately 867 acres of sagebrush shrubland habitat. Woody species such as sagebrush would require up to 25 years to reach maturity. The disturbance associated with the proposed project would be reclaimed following completion of mining activities.

Impacts to special status species from mine-related surface disturbance would include the temporary (short-term and long-term) and permanent reduction or loss of habitat. This impact would result from construction and operation of the proposed project facilities that include expansion of the Betze Pit, and development of the Clydesdale Waste Rock Facility and haul road and Goldstrike No. 3 Tailings Facility. Habitat loss or alteration would result in direct losses of smaller, less mobile species of wildlife, such as small mammals and reptiles, and the displacement of more mobile species into adjacent habitats. In areas where habitats are at, or near, carrying capacity, animal displacement could result in some unquantifiable reductions in local wildlife populations. Mine-related surface disturbance also would result in an incremental increase in habitat fragmentation at the mine site until vegetation has been re-established. It is anticipated that the potential mine-related displacement and habitat fragmentation effects would be highest for special status species that may use the Bell Creek corridor.

*Mammals*

Bats

Of the 14 bat species that could occur in the study area, 9 species (western red bat, pallid bat, Townsend's big-eared bat, big brown bat, small-footed myotis, long-eared myotis, long-legged myotis, western pipistrelle bat, and Brazilian free-tailed bat) have been documented within the project region (BLM 2000a; Bradley et al. 2006; Lamp 2007c). Potentially suitable habitat for the remaining five species (hoary bat, little brown myotis, California myotis, and Yuma myotis) exists within the study area. Implementation of the Proposed Action could result in direct and indirect impacts to local bat species and their habitat. Direct impacts would include the long-term disturbance of foraging habitat, including approximately 867 acres of sagebrush shrublands habitat. Impacts also would result in the permanent loss of approximately 101 acres of potentially suitable habitat from the development of the proposed facilities.

Preble's Shrew

Implementation of the Proposed Action would result in the long-term reduction of approximately 943 acres, and permanent loss of approximately 101 acres of potentially suitable habitat for this species. This impact would be considered low, considering the large amount of suitable habitat located within the study area. However, project construction likely would result in the direct mortality of individual shrews, if present. The loss of individual Preble's shrews would not result in population-level effects.

Pygmy Rabbit

Implementation of the Proposed Action would result in the long-term reduction of approximately 867 acres, and permanent loss of approximately 101 acres of potentially suitable sagebrush habitat (sagebrush-

dominated habitats) for this species (see **Table 3.7-3**). This impact would be considered low, considering the small amount preferred habitat (i.e., big sagebrush) located within the study area. However, project construction likely would result in the direct mortalities of individual rabbits, if present. The loss of individual pygmy rabbits (a game species in Nevada) would not result in population-level effects.

Fletcher Dark Kangaroo Mouse

Implementation of the Proposed Action would result in the long-term reduction of approximately 943 acres, and permanent loss of approximately 101 acres of potentially suitable habitat for this species. This impact would be considered low, considering the large amount of suitable habitat located within the study area. However, project construction likely would result in the direct mortalities of individual mice, if present. The loss of individual Fletcher dark kangaroo mice would not result in population-level effects.

*Birds*

Based on implementation of applicant-committed environmental protection measures, no adverse effects to sensitive raptor species have been identified in association with rerouting power distribution lines around the proposed pit layback areas, and the potential for impacts to sensitive bird species related to exposure to process solutions would be considered low. Other potential species-specific impacts are discussed below.

Bald Eagle

No bald eagle nest sites occur within the project boundary. Occurrence by this species would be limited to migrating and wintering individuals. Impacts would include the long-term reduction of approximately 943 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of potential foraging habitat associated with development of the proposed facilities. Indirect impacts associated with mine-related noise and human presence currently occurs at the site and would continue under the proposed project. Based on implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within the project boundary, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Swainson's Hawk

No Swainson's hawk nests have been identified in the study area. In addition, no suitable nesting habitat occurs within the project boundary. Direct impacts would include the long-term reduction of approximately 943 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of potential foraging habitat associated with development of the proposed facilities. However, this impact would be considered negligible based on the overall availability of suitable foraging habitat in the vicinity of the study area. Indirect impacts would continue to result from mine-related noise and human presence. Based on implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within the project vicinity, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Ferruginous Hawk

As discussed above, no ferruginous hawk nests have been identified in the vicinity of the study area. In addition, no suitable nesting habitat occurs within the project boundary. Direct impacts would include the long-term reduction of approximately 943 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of potential foraging habitat associated with development of the proposed facilities. However, this impact would be considered negligible based on the overall availability of suitable foraging habitat in the vicinity of the study area. Indirect impacts would continue to result from mine-related noise and human presence. Based on implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within

the project vicinity, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Golden Eagle

No golden eagle nest sites occur within the project boundary. In addition, no suitable nesting habitat (e.g., exposed rocky outcrops) occurs within the project boundary. Direct impacts would include the long-term reduction of approximately 943 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of potential foraging habitat associated with development of the proposed facilities. Indirect impacts associated with mine-related noise and human presence currently occurs at the site and would continue under the proposed project. Based on implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within the project boundary, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Peregrine Falcon

No peregrine falcon nests have been identified in the vicinity of the study area. However, no impacts to breeding birds as a result of proposed mine-related activities would be anticipated based on the lack of potentially suitable breeding habitat (e.g., tall cliffs) in the proposed disturbance areas. Direct impacts to this species would result from the long-term reduction of approximately 943 acres of potential foraging habitat and the permanent loss of approximately 101 acres of potential foraging habitat in association with the development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. Based on the implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within the project boundary, and the existing level of mining activity at the site, potential impacts to this species as a result of the proposed project would be considered low.

Prairie Falcon

No prairie falcon nest sites have been documented within the project vicinity. In addition, no suitable nesting habitat (e.g., cliffs) occurs within the project boundary. Direct impacts to migrating and foraging falcons would include the long-term reduction of approximately 943 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of habitat associated with development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. Based on the implementation of BGMI's committed environmental protection measures, the lack of existing nest sites within the project boundary, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Greater Sage-grouse

No active greater sage-grouse lek sites have been identified within the project boundary. As discussed in Section 3.8.1.5, the nearest active lek site occurs approximately 5.5 miles north of the project boundary. As a result no impacts to breeding greater sage-grouse would be anticipated from project activities. Although greater sage-grouse could nest in upland habitats within the project boundary, it is anticipated that brooding activity would be low, due to the limited availability of surface water and riparian vegetation in the study area. Potential direct impacts would include the incremental long-term reduction of approximately 943 acres of nesting habitat, summer range, and winter range. Direct impacts to this species would include the long-term reduction of approximately 867 acres of sagebrush shrublands habitat and the permanent loss of approximately 101 acres of sagebrush shrublands habitat in association with the development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. This impact would be considered negligible based on the overall availability of suitable habitat in the vicinity of the project. Refer to Section 3.1 for a list of conservation projects currently implemented in the region.

Burrowing Owl

Although no burrowing owl nest sites have been documented within the project boundary, sagebrush shrubland and grassland vegetation that would be disturbed as a result of the Proposed Action would be suitable habitat for foraging birds within the study area. However, based on BGMI's committed environmental protection measures, including nesting raptor surveys and implementation of mitigation measures, as applicable, impacts to breeding birds would be minimized. Direct impacts to this species would include the short-term reduction of approximately 943 acres of potential breeding and foraging habitat, until reclamation has been completed and vegetation has been re-established, and the permanent loss of approximately 101 acres of habitat associated with development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. Based on implementation of BGMI's committed environmental protection measures and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Long-eared Owl

This species has not been documented breeding within the study area, and no suitable breeding habitat is present within the study area. Therefore, impacts to breeding birds as a result of proposed mine-related activities would not be anticipated. Direct impacts to this species would result from the long-term reduction of approximately 943 acres of potential foraging habitat and the permanent loss of approximately 101 acres of potential foraging habitat in association with the development of the proposed facilities. These impacts would be considered negligible based on the overall availability of suitable habitat in the vicinity of the project. Indirect impacts would continue to result from mine-related noise and human presence. Based on the implementation of BGMI's committed environmental protection measures, the overall availability of suitable habitat in the vicinity of the project, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Short-eared Owl

This species has not been documented breeding within the study area, although suitable nesting habitat is present. Impacts to breeding birds as a result of proposed mine-related activities would be anticipated based on potentially suitable breeding habitat (e.g., open shrublands) in the proposed disturbance areas. Direct impacts to this species would result from the long-term reduction of approximately 943 acres of potential foraging habitat and the permanent loss of approximately 101 acres of potential foraging habitat in association with the development of the proposed facilities. These impacts would be considered negligible based on the overall availability of suitable habitat in the vicinity of the project. Indirect impacts would continue to result from mine-related noise and human presence. Based on the implementation of BGMI's committed environmental protection measures, the overall availability of suitable habitat in the vicinity of the project, and the existing level of mining activity at the site, potential impacts to this species as a result of the Proposed Action would be considered low.

Loggerhead Shrike

Based on the presence of potentially suitable breeding habitat, direct impacts to breeding pairs as a result of proposed mine-related activities and the applicable environmental protection measures to minimize these impacts would parallel those described above for the short-eared owl. Direct impacts to this species would include the long-term reduction of approximately 943 acres of potential breeding and foraging habitat, until reclamation has been completed and vegetation has re-established, and the permanent loss of approximately 101 acres of breeding and foraging habitat in association with the development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. These impacts would be considered negligible based on implementation of BGMI's committed environmental protection measures, the overall availability of suitable habitat in the vicinity of the project, and the existing level of mining activity at the site.

Yellow-breasted Chat

Based on the presence of potentially suitable breeding habitat in the project region, direct impacts to breeding pairs as a result of proposed mine-related activities and the applicable environmental protection measures to minimize these impacts would parallel those described above for the short-eared owl. These impacts would be considered negligible based on implementation of BGMI's committed environmental protection measures, the overall availability of suitable habitat in the vicinity of the project, and the existing level of mining activity at the site.

Vesper Sparrow

Based on the presence of potentially suitable breeding habitat, direct impacts to breeding pairs as a result of proposed mine-related activities and the applicable environmental protection measures to minimize these impacts would parallel those described above for the short-eared owl. Direct impacts to this species would include the long-term reduction of approximately 943 acres of potential breeding and foraging habitat, until reclamation has been completed and vegetation has re-established, and the permanent loss of approximately 101 acres of breeding and foraging habitat in association with the development of the proposed facilities. Indirect impacts would continue to result from mine-related noise and human presence. These impacts would be considered negligible based on implementation of BGMI's committed environmental protection measures, the overall availability of suitable habitat in the vicinity of the project, and the existing level of mining activity at the site.

#### 3.8.2.3 Bazza Waste Rock Facility Alternative

Wildlife

Under this Alternative, approximately 565 acres of native wildlife habitat associated with the Clydesdale Waste Rock Facility and associated haul road would not be disturbed or lost, as compared to the Proposed Action. As a result, impacts to the designated big game migration corridor and associated habitat for big game, small game, and nongame (including migratory birds) would not occur. In addition, habitat fragmentation and animal displacement associated with the Clydesdale Waste Rock Facility would not occur. Reclamation of the Bazza Waste Rock Facility would not be completed until 2018, as compared to 2011 for the Proposed Action, and the level of human activity would increase due to increased waste rock haulage until the facility is fully reclaimed. However, currently reclaimed areas of the Bazza Waste Rock Facility would not be disturbed and suitable wildlife habitat would remain on reclaimed portions of the Bazza Waste Rock Facility.

Special Status Species

Impacts to special status species would parallel those described above for wildlife.

#### 3.8.2.4 West Nile Virus

Background

The potential for the proposed project to increase the likelihood of BGMI employees, contractors, and visitors to the Goldstrike Mine to contract West Nile Virus (WNV) was evaluated based on a scoping comment received. WNV is a flavivirus that is spread by mosquitoes, typically *Culex pipiens*, and can infect humans, birds, horses, and some other mammals. **Table 3.8-1** indicates the human WNV incident rates for Eureka and Elko counties, as well as, the State of Nevada. During the past 3 years, there were 164 human cases of WNV reported in Nevada, 25 cases reported in Elko, and 0 cases reported in Eureka counties (Nevada State Health Division [NSHD] 2007). During the past 3 years in the entire U.S., there were 10,673 cases of WNV reported. People become infected with WNV by the bite of a mosquito infected with WNV. The basic transmission cycle is via mosquitoes becoming infected when they feed on infected birds. Infected mosquitoes can then transmit WNV to humans and animals. The virus may cause West Nile Fever—usually a mild disease in humans, characterized by flu-like symptoms. West Nile Fever typically lasts only a few days and does not appear to cause any long-term health effects. More severe diseases resulting from a person being infected with this virus

can be West Nile Encephalitis (an inflammation of the brain), West Nile Meningitis (an inflammation of the membrane around the brain and the spinal cord), or West Nile Meningoencephalitis (inflammation of the brain and the membrane surrounding it).

**Table 3.8-1 Human West Nile Cases in Elko County, Eureka County, and Nevada, 2005 to 2007**

| | 2007 | 2006 | 2005 | To Date (total) |
|---|---|---|---|---|
| Elko County | 2 | 23 | 0 | 25 |
| Eureka County | 0 | 0 | 0 | 0 |
| State of Nevada | 10 | 124 | 30 | 164 |

Source: NSHD 2007.

All residents of areas where virus activity has been identified are at risk of getting West Nile encephalitis; however, many people who are infected with WNV experience no symptoms. One in five will develop symptoms, typically headaches and flu-like illness. Only 1 in 150 will develop serious complications. Others may experience mild symptoms, such as low-grade fever, headache and body aches, skin rash or swollen lymph nodes, or nausea within 3 to 15 days. Symptoms may appear suddenly with the onset of severe headache, high fever, stiff neck, and muscle weakness. Among those with severe illness due to WNV, case-fatality rates range from 3 percent to 15 percent and are highest among the elderly. Persons over 50 years of age have the highest risk of severe symptoms.

Although the *Culex pipiens* mosquito is typically a canopy-feeder, it can and does bite humans. The mosquito breeds in shallow, stagnant, or slow moving water, thus these types of habitats at the Goldstrike Mine potentially could contribute to an increased number of mosquitoes, depending upon the location and nature of deposited surface water. Steep banks and moving water would mitigate against this; shallow, stagnant reservoirs would contribute to it.

No Action Alternative

The occurrence of *Culex pipiens* is not prevalent in northeastern Nevada due to the arid climate where evaporation greatly exceeds precipitation and due to lack of suitable habitat. At the Goldstrike Mine, arid conditions and rapid run-off and infiltration of infrequent storm events limits the occurrence of standing water and habitat for *Culex pipiens* to breed. Storm water detention ponds and intermittent drainages within the mine site are typically dry within a few days of precipitation events. The North Block and AA Tailings facilities decant pools would likely provide marginal mosquito breeding habitat due to open water conditions exposed to wind turbulence, and lack of protected areas along the shoreline. The risk of workers or visitors contracting WNV at the Goldstrike Mine is low.

The post-mining pit lake could provide habitat for mosquitoes to breed; however, the habitat is anticipated to be marginal due to the generally steep slopes and open water habitat (Schafer 2007).

Proposed Action

Under the Proposed Action the risk of workers, contractors, or visitors contracting WNV at the mine site would be similar to the No Action Alternative. The decant pool from the Goldstrike No. 3 Tailings facility would be much smaller than the existing North Block Tailings Facility decant pool due to the higher solids-to-water ratio of the tailings slurry. Mosquito breeding habitat also would be marginal for the proposed facility. The post-mining pit lake at equilibrium under the Proposed Action would result in a slightly larger surface area (115 percent) of the No Action Alternative pit lake and a slightly smaller volume (90 percent) (Schafer 2007).

The risk of people contracting WNV at the Goldstrike Mine is low under the Proposed Action. No additional mitigation measures are proposed over current mine practices.

Bazza Waste Rock Facility Alternative

This alternative would result in the same impacts as discussed in the Proposed Action.

## 3.8.3 Cumulative Impacts

The CESAs for wildlife and special status species encompass a portion of NDOW's WMA 6 as depicted in **Figures 3.8-4** through **3.8-7**. The CESAs were determined by BLM and NDOW and include a contiguous area that provides very important seasonal habitat for mule deer, pronghorn, and greater sage-grouse. Generally, the CESAs extend from the northern end of the Independence Range in the North to the Humboldt River and northern end of the Piñon Range to the South.

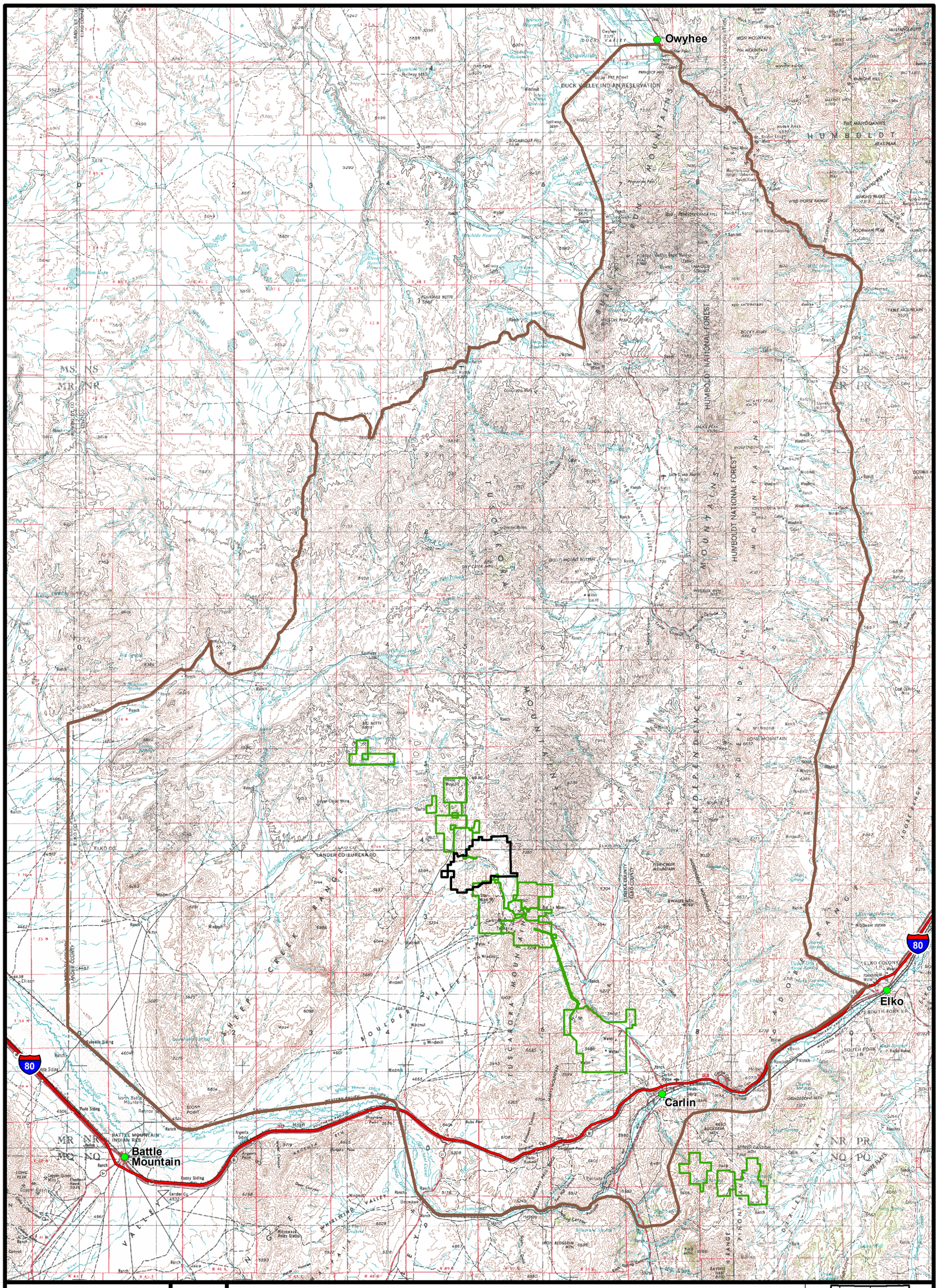
Cumulative effects on wildlife in the CESAs have resulted primarily from wildfires, mineral exploration, mining activities, non-native invasive weeds, livestock grazing, drought, urbanization, and seeding of native range with introduced herbaceous species (BLM 2007b). Other industrial development activities in the area such as a power plant, transmission lines, and roads also contribute to impacts to wildlife (BLM 2007b). Development of reasonably foreseeable mine projects and the TS Power Plant will continue to impact big game in their respective CESA. However, mine areas proposed for development have been the site of human activity including exploration drilling and environmental monitoring programs within or adjacent to existing mine areas (BLM 2007b).

### 3.8.3.1 No Action Alternative

Terrestrial Wildlife

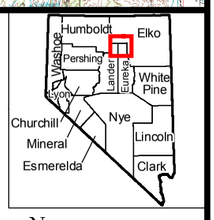
Cumulative impacts to wildlife resources primarily would be directly related to habitat loss, habitat fragmentation, and animal displacement. Big game, especially mule deer, would be most susceptible to these cumulative impacts since encroaching human activities along the foothills of the Tuscarora Range and the Carlin Trend have resulted in animal displacement and habitat fragmentation in areas that are utilized as migration corridors between summer and winter ranges. The population of migrating mule deer has declined from 30,000 to about 8,000 animals due to effects of fire and development on important seasonal ranges (NDOW 2007b). The mild winter of 2006, which caused few mule deer to migrate, also made it difficult to determine accurate populations (Lamp 2007b). Displacement of mule deer and pronghorn from wildfire, mining activities, and other land uses increases demands on adjacent habitats. Most habitats in the immediate area are at carrying capacities and can not support additional animals (Lamp 2007b). Displaced animals would be lost from the population until habitats are rehabilitated, restored, or mitigated, allowing populations to expand into affected areas. Many of the local wildlife populations (e.g., big game, raptors, migratory birds) that occur in the CESAs would continue to occupy their respective ranges and breed successfully, although population numbers may decrease relative to the amount of cumulative habitat loss and disturbance from incremental development.

Within the wildlife, mule deer, and pronghorn CESAs (**Figures 3.8-4** through **3.8-6**), mining has removed wildlife habitat, primarily as a function of fencing and/or land disturbance associated with mining operations. In addition, wildfire has created one of the primary cumulative effects on these species. As shown in **Table 3.8-2**, from 1999 to early August 2007 thousands of acres of wildlife habitat has been impacted by large-scale wildfires (NDOW 2007b). Wildfire has resulted in the temporary to long-term loss of shrubs that provide forage and cover as habitat components, which has caused reductions in mule deer and pronghorn herds throughout their respective CESAs. Effects of wildfires to terrestrial wildlife species include loss of habitat (forage and cover) which can lead to die-offs of mule deer and pronghorn as well as other species. The loss of canopy cover and forb and grass diversity is prevalent across the burned areas and the recovery of these plant communities will vary in terms of time and cover. In many areas, native shrub communities have been replaced by cheatgrass-dominated grasslands (BLM 2007b). A breakdown of disturbance by mining operations and wildfire is presented in **Table 3.8-2**.




**LEGEND**

- Wildlife Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundary




N

0 5 10 Miles

Source: BLM 2007b,c.

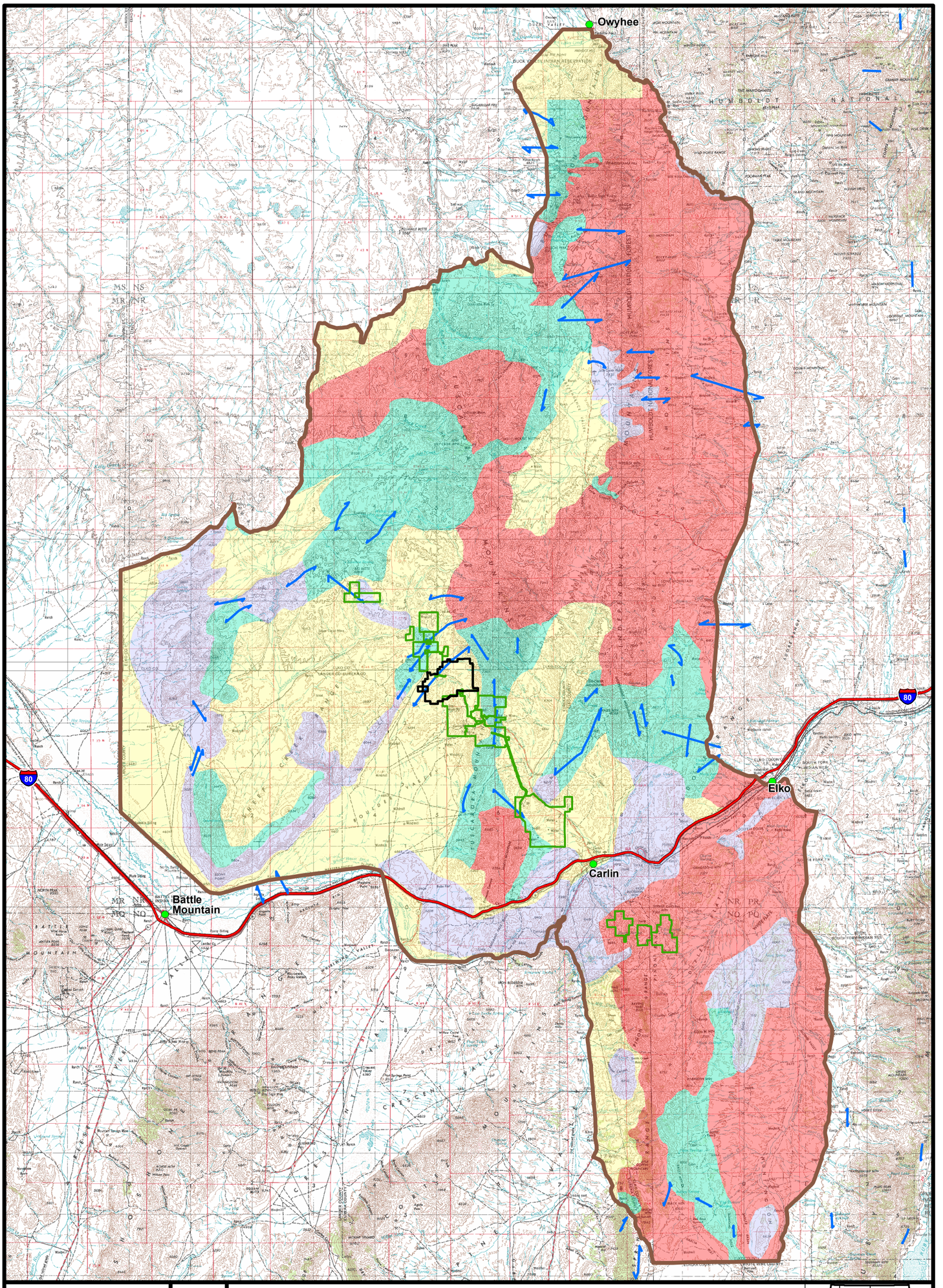
**Betze Pit Expansion Project**

Figure 3.8-4

Wildlife Cumulative Effects Study Area

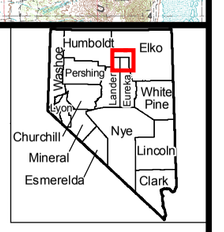


06/05/2008




**LEGEND**

- Mule Deer Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundary
- Crucial Winter Habitat
- Transitional Habitat
- Low Density
- Summer Habitat
- Migration Corridors




N

0 5 10 Miles

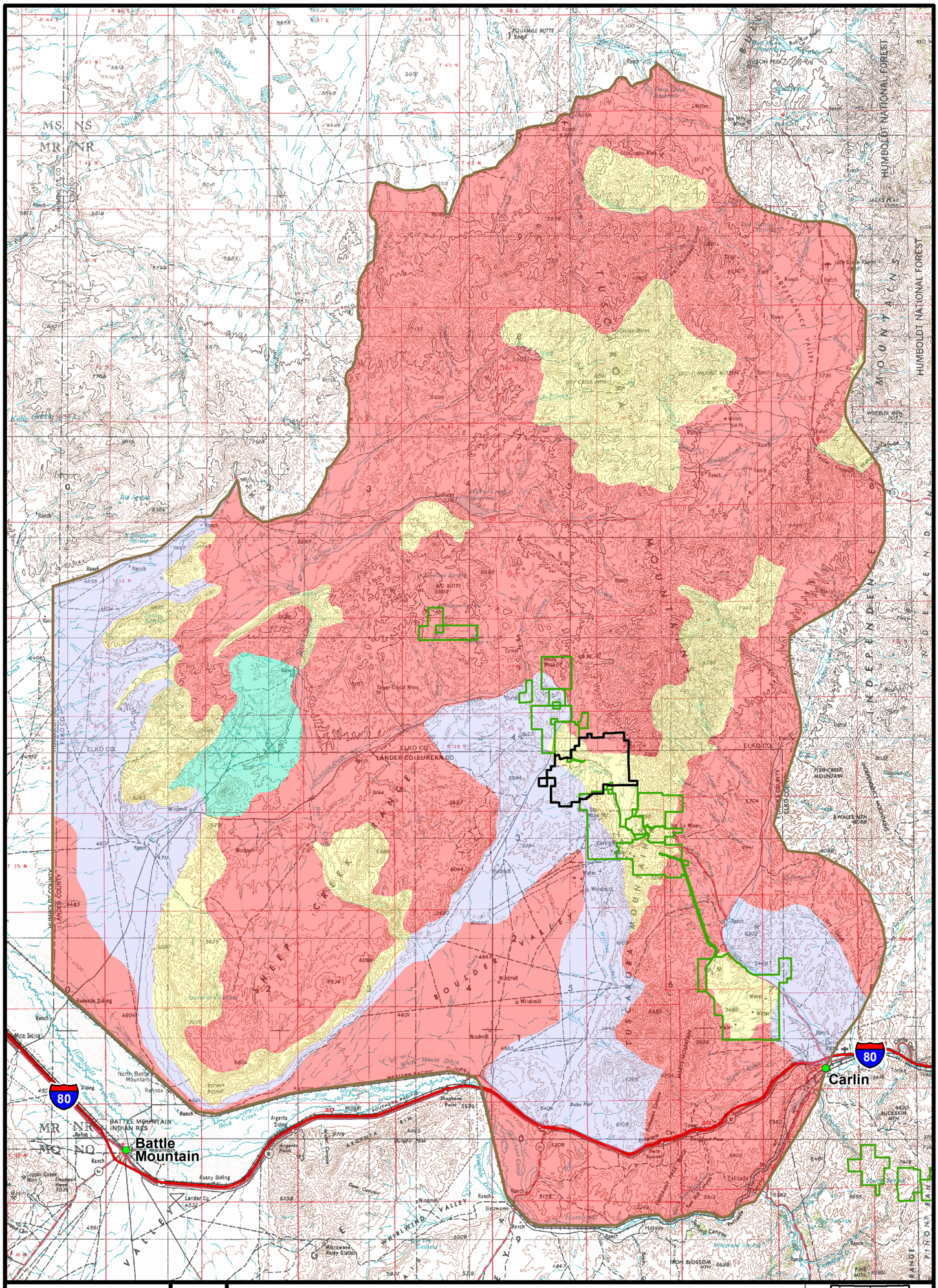
Source: BLM 2007b,c.

Figure 3.8-5
Mule Deer Cumulative Effects Study Area

**Betze Pit Expansion Project**

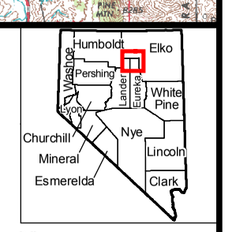


08/05/2008




**LEGEND**

- Pronghorn Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundary
- Crucial Winter Habitat
- Transitional Habitat
- Low Density
- Summer Habitat




N

0 5 10 Miles

Source: BLM 2008a.

Figure 3.8-6

Pronghorn Cumulative Effects Study Area

**Betze Pit Expansion Project**

07/25/2008

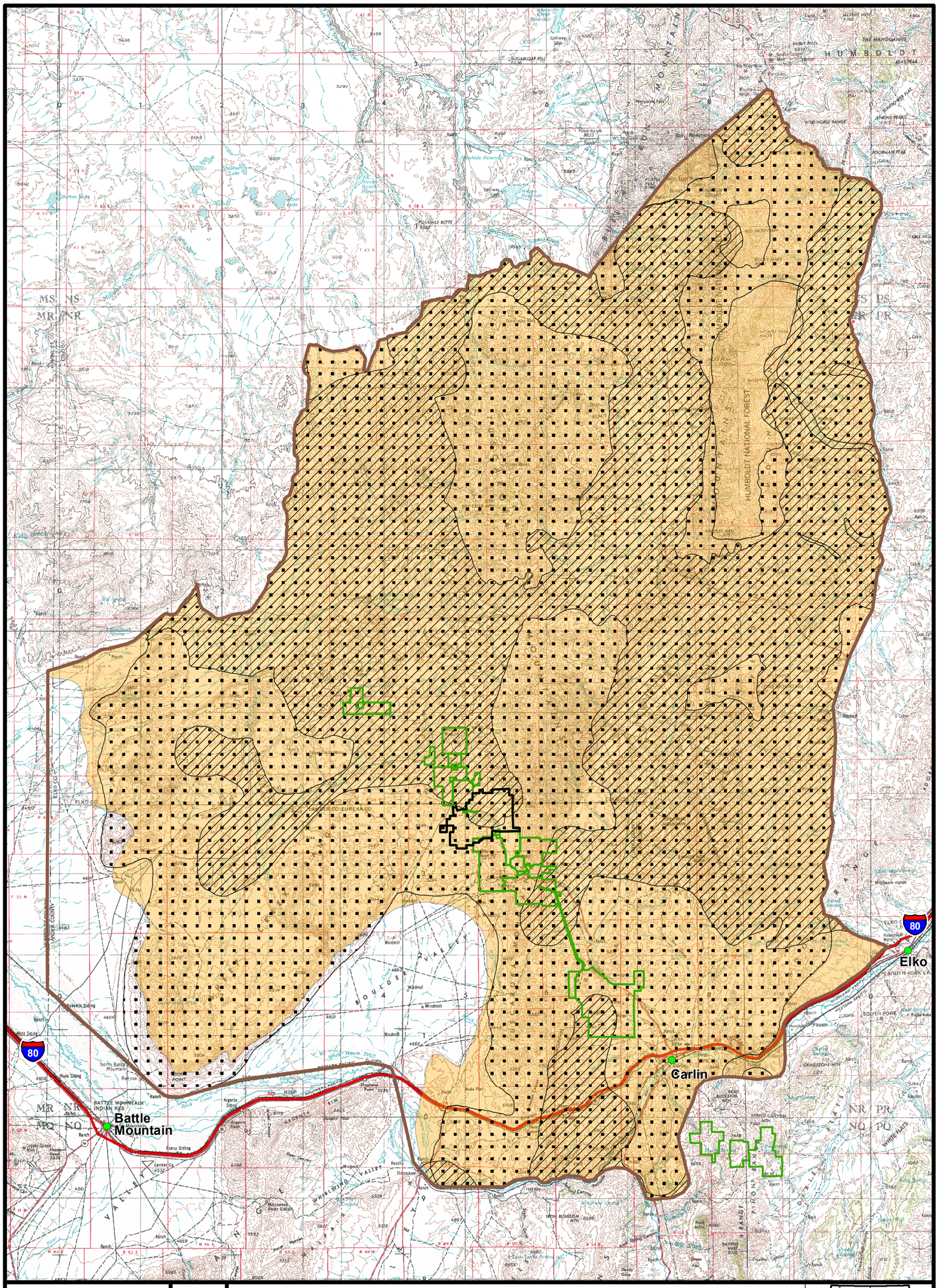


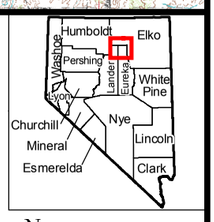

Figure 3.8-7

Greater Sage-grouse Cumulative Effects Study Area

**Betze Pit Expansion Project**

**LEGEND**

- Greater Sage-grouse Cumulative Effects Study Area
- Nesting and Early Brood Habitat
- Winter Habitat
- Late Summer Habitat
- Goldstrike Mine Operations Boundary
- Mine Plan Boundary




N

0 5 10 Miles

Source: BLM 2008a; NDOW 2007c.

06/05/2008

**Table 3.8-2 Wildlife, Mule Deer, Pronghorn, and Greater Sage-grouse Habitat Disturbance**

| CESA | Total Acres of Habitat | Acres Disturbed by Mining Operations (Past, Present, RFFAs)[1] | Acres Disturbed by Fire | % of Total Habitat Acres Disturbed |
|---|---|---|---|---|
| Wildlife[2] | 2,389,957 | 37,453 | 958,586 | 42 |
| Mule Deer | 2,119,638 | 38,700 | 627,058 | 31 |
| Pronghorn | 1,590,750 | 37,453 | 745,821 | 49 |
| Greater Sage-grouse | 2,090,081 | 37,453 | 880,537 | 44 |

[1]The special status CESA is identical to the wildlife CESA, excluding greater sage-grouse.

[2]See **Table 3.1-1** for breakdown of mining projects.

Source: NDOW 2007c; USGS 2004.

Mine dewatering operations could result in reduction or loss of flow in springs and seeps that support wildlife. Reductions or elimination of flow in springs, seeps, and streams from dewatering could impact wildlife species dependent on these sites (e.g., amphibians and birds) and may affect distribution of other species (e.g., bats, mule deer and pronghorn) that use these sites as part of a larger habitat complex. These impacts are within the area that was disclosed and mitigated for in the 2000/2003 Betze SEIS (BLM 2000a, 2003a) as shown in **Figure 3.3-48** and described in Section 3.3.3.1.

Nesting raptor species also would be susceptible to these cumulative impacts since encroaching human activities along the foothills of the Tuscarora Range and the Carlin Trend have resulted in bird displacement and habitat fragmentation in areas that may be at their relative carrying capacity for these resident species. Many of the local wildlife populations (e.g., small game, migratory birds) that occur in the cumulative effects study area would continue to occupy their respective ranges and breed successfully, although population numbers may decrease relative to the amount of cumulative habitat loss and disturbance from incremental development.

Past and present actions and RFFAs in the wildlife, mule deer, and pronghorn cumulative effects study areas have resulted, or would result, in the direct disturbance of habitat (**Table 3.8-2**). Future underground mining, if it should occur, likely would not result in additional habitat disturbance. A portion of the cumulative disturbance areas have been, or would be, reclaimed or has recovered materially (i.e., wildfire areas). The reclaimed areas, and areas associated with habitat conversion, would be capable of supporting wildlife use; however, species composition and densities would change.

Under currently authorized disturbance, indirect cumulative impacts include increased noise, additional human presence, and the potential for increased vehicle-related mortalities.

Groundwater drawdown associated with existing dewatering operations could result in a long-term reduction in the amount and extent of available surface water (e.g., perennial seeps, springs, streams) and associated riparian habitats for area wildlife within the cumulative 10-foot groundwater drawdown area (**Figure 3.3-26**). The potential cumulative impacts from dewatering have been addressed in the CIA (BLM 2000b) and Betze SEIS (2000a, 2003a) and were mitigated (**Figure 3.3-48** and Section 3.3.4.2).

Special Status Species

The CESA for special-status species is the same as the wildlife CESA (**Figure 3.8-4**) except for greater sage-grouse which is presented in **Figure 3.8-7**. The special status species CESA encompasses habitat that

would have potential to be affected by drawdown from mine dewatering and therefore, potentially impact special status species. **Table 3.8-2** presents the disturbance of special status species habitat by mining operations and wildfire. The CESA for greater sage-grouse encompasses areas that are utilized by greater sage-grouse in relation to past and present actions and RFFAs. **Table 3.8-2** presents the disturbance of greater sage-grouse habitat by mining operations and wildfire. Several thousand acres of cultivated alfalfa in Boulder Valley and the Humboldt River Valley (area north of Battle Mountain) may potentially provide late summer/brood-rearing habitat for greater sage grouse (NDOW 2008a). These areas provide succulent forbs sought by grouse including alfalfa and other annual or perennial forbs. The current extent of potential use of these cultivated areas by greater sage-grouse is unknown since cover provided by sagebrush habitats adjacent to these fields have been impacted by wildfires in many areas over the last 20 to 30 years (NDOW 2008a).

Studies have shown that development can negatively impact sage grouse populations as a result of habitat loss and increased human disturbance (Holloran 2005; Walker et al. 2007). Sage grouse have been observed to abandon lek sites in areas with increased road development (Braun 1986; Holloran 2005; Walker et al. 2007). Compared to hens in undisturbed leks, sage grouse hens that used breeding leks within approximately 2 miles from development moved further away from breeding leks to nesting areas and had lower nest initiation rates (Lyon and Anderson 2003). Furthermore, sage grouse hens that utilized habitats farthest from roads had greater brood survivorship than those hens utilizing habitat near roads (Lyon and Anderson 2003). Connelly et al. (2000) recommends that facilities be located more than 2 miles (3.2 km) from active lek sites under ideal habitat conditions, 3 miles (5 km) when habitat conditions are not ideal, and 11 miles (18 km) when sage grouse populations are migratory. It is assumed that habitat conditions within the project area are not ideal, based on the current level of human disturbance and noise levels, as well as the current activity level (inactive) at the lek site located north of the project area.

Under the current authorized disturbance, potential cumulative impacts to other special status wildlife species would parallel those described above for terrestrial wildlife.

#### 3.8.3.2 Proposed Action

Terrestrial Wildlife

Cumulative impacts to terrestrial wildlife would be similar to those described above under the No Action Alternative cumulative effects, except there would be an additional 943 acres of habitat disturbance associated with the Proposed Action, including the loss of 565 acres of undisturbed sagebrush vegetation in the Little Boulder Valley. NDOW classifies this undisturbed habitat as an important big game migration corridor, especially for mule deer (NDOW 2007b). If the proposed Clydesdale Waste Rock Facility is constructed, there will be no sizeable undisturbed habitat along this portion of the migration corridor (NDOW 2007b). As a result, habitat fragmentation, habitat loss, and animal displacement associated with the construction of the Clydesdale Waste Rock Facility would occur. Indirect impacts such as human presence and noise would incrementally increase and would continue until the facility is fully reclaimed.

Special Status Species

Cumulative impacts to special status species would parallel those described above under the No Action Alternative cumulative impacts except for an additional 943 acres of habitat disturbance associated with the Proposed Action.

#### 3.8.3.3 Bazaa Waste Rock Facility Alternative

Terrestrial Wildlife

Under this alternative, cumulative impacts would be similar to those described above under the No Action Alternative cumulative effects, except that 565 acres of habitat disturbance associated with construction of the Clydesdale Waste Rock Facility and associated haul road would not occur. However, cumulative impacts such

as habitat fragmentation, habitat loss, and animal displacement associated with the Bazaa Waste Rock Facility Alternative would continue to occur as a result of the facility not being fully reclaimed until 2018.

Special Status Species

Cumulative impacts to special status species would parallel those described above for terrestrial wildlife.

### 3.8.4 Mitigation Measures and Monitoring

All mitigation measures proposed during the course of this review and analysis have been adopted by BGMI and have become operator commitments to reduce impacts to wildlife resources.

Riparian habitat mitigation measures have been provided for with the long-term monitoring and mitigation fund associated with the 1991 Betze EIS and 2003 Betze SEIS and are described in Section 2.2.1.13, Applicant-committed Environmental Protection Measures.

### 3.8.5 Residual Impacts

Residual impacts to wildlife resources from the proposed project would include the permanent loss of approximately 101 acres of sagebrush habitat associated with the pit expansion. The Bazza Waste Rock Facility Alternative would result in the long-term loss of 301 acres of sagebrush habitat.

## 3.9 Cultural Resources

### 3.9.1 Affected Environment

The study area for cultural resources encompasses the project boundary. The CESA encompasses the Carlin Trend extending north to the Bootstrap Mine and south to the Gold Quarry South Operations (**Figure 3.9-1**). The CESA includes those mines and related facilities encompassing the core area of the Carlin Trend. The CESA was determined based on consultation with BLM resource specialists.

#### 3.9.1.1 Regulatory Framework

Federal historic preservation laws provide a legal environment for documentation, evaluation, and protection of cultural resources that may be affected by federal undertakings, or by private undertakings operating under federal license, or on federally managed lands. NEPA states that federal undertakings shall take into consideration impacts to the natural environment with respect to an array of resources, and that alternatives must be considered. The courts have made clear that cultural resources are regarded as part of the natural environment. The National Historic Preservation Act of 1966 (NHPA), as amended, established the Advisory Council on Historic Preservation (ACHP) and the NRHP. The NHPA mandates that federal agencies consider an undertaking's effects on cultural resources that are listed on or eligible for listing on the NRHP, and Section 106 of the NHPA establishes a review process by which these resources are given consideration during the conduct of federal undertakings. Cultural resources that are listed on or eligible for listing on the NRHP are referred to as historic properties.

Regulations in 36 CFR 800 outline the process through which historic preservation legislation under the NHPA is administered; 36 CFR 800.14 allows federal agencies to adopt program alternatives to 36 CFR 800 and to tailor the Section 106 process to better fit agency procedures. The most common program alternative is a PA negotiated among the agency, SHPO, and ACHP.

In June 1991, a PA among the BLM Elko District Office, Nevada SHPO, ACHP, and BGMI was finalized (PA 1991). The PA defines general and specific measures to be undertaken by the BLM, SHPO, and BGMI to ensure that the BLM's objectives and responsibilities regarding the protection of historic properties under the NHPA are fulfilled. Specifically, the PA outlines the steps to be taken to: 1) identify prehistoric and historic sites; 2) evaluate them for eligibility for listing on the NRHP; 3) identify potential adverse effects; 4) develop measures to avoid, reduce, or mitigate adverse effects; and 5) address inadvertent discoveries. Additionally, the PA assigns roles and responsibilities for implementation of the PA, which ensures that all interested parties are given an opportunity to comment on the effects of an undertaking to historic properties and any mitigation for such effects.

#### 3.9.1.2 Eligibility Criteria for Listing Properties on the NRHP

The NRHP, maintained by the National Park Service (NPS) on behalf of the Secretary of the Interior, is the nation's inventory of historic properties. The NPS has established three main standards that a resource must meet to qualify for listing on the NRHP: age, integrity, and significance. To meet the age criteria, a resource generally must be at least 50 years old. To meet the integrity criteria, a resource must "possess integrity of location, design, setting, materials, workmanship, feeling, and association" (36 CFR 60.4). Finally, a resource must be significant according to one or more of the following criteria:

- Criterion A – Be associated with events that have made a significant contribution to the broad patterns of U.S. history; or
- Criterion B – Be associated with the lives of persons significant in U.S. history; or

- Criterion C – Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D – Have yielded, or may likely yield, information important in prehistory or history.

#### 3.9.1.3 Investigations in the Study Area

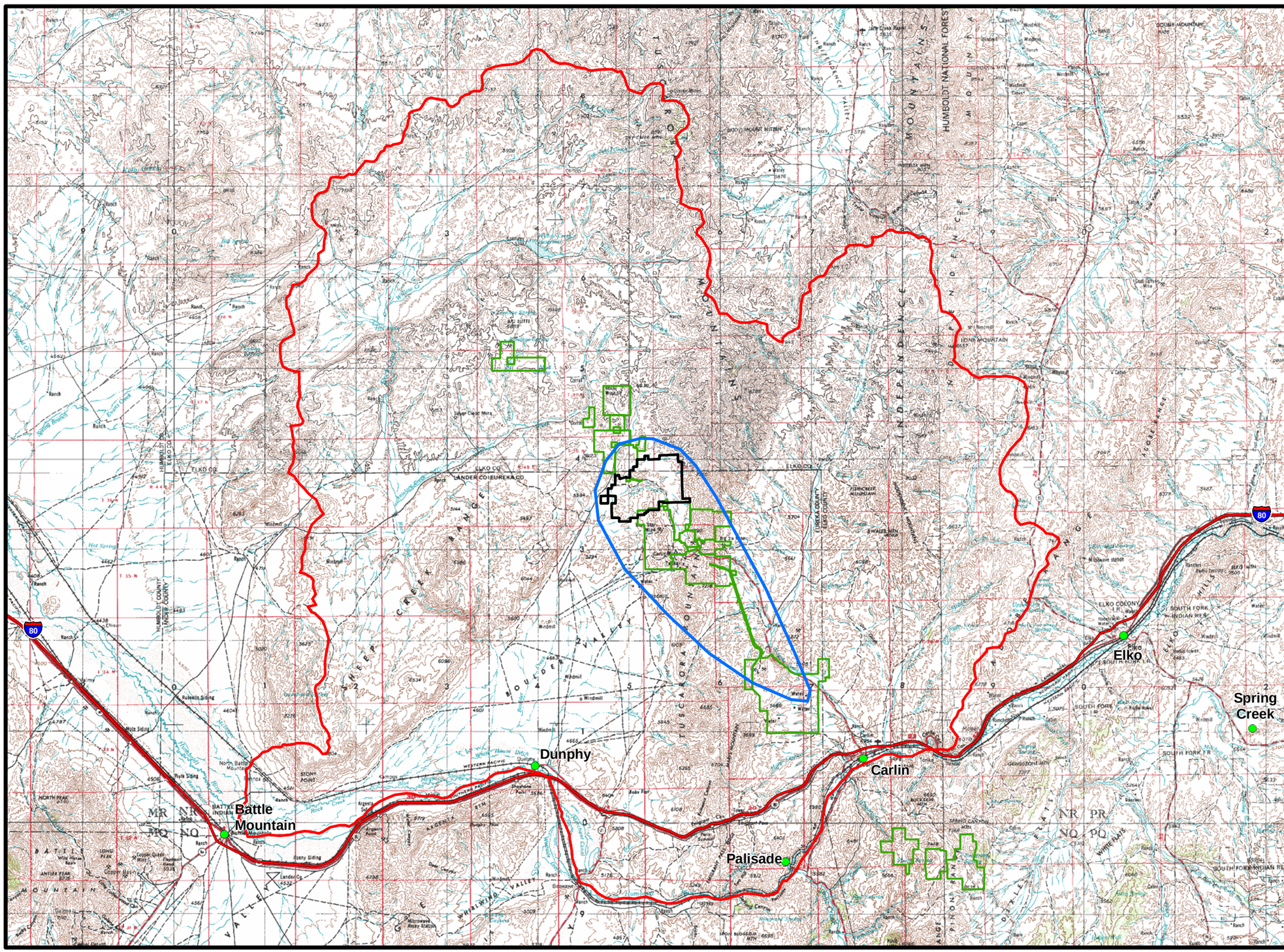
Numerous cultural resource investigations have been conducted in or near the study area. These have included Class I and Class III inventories. Class I inventories are a review of reports containing the results of previously conducted inventories in the study area, as well as library and archival sources for regional prehistory and history. Class III inventories are intensive field surveys in which the archaeologists record and document all sites and isolates encountered on the surface, and evaluate the sites for eligibility to the NRHP. Nearly all of the area within the BGMI property boundary has been inventoried for cultural resources, and the documented sites evaluated for the NRHP. Under the PA, potentially eligible sites or eligible sites were to be avoided until they were threatened with destruction or damage.

The results of the inventories have been documented in survey reports that have been submitted to the BLM and SHPO for review. The reports contain the cultural and historical overview of the area; the location, type, and significance of identified sites; archaeological field methods; artifact analysis; eligibility recommendations for each identified site; and proposed mitigation for historic properties that would be affected by proposed disturbance. Contents of the survey reports, in particular the description and location of recorded sites, are confidential and are not accessible for public review.

As a result of previous cultural resources investigations in the analysis area, five NRHP-eligible prehistoric sites were located within the study area (26EU1533, 26EU1539, 26EU1548, 26EU2064, and 26EU2126). These five sites are eligible for inclusion to the NRHP under Criterion D based on their potential to yield information important in prehistory or history. Subsequently, a data recovery plan was developed by SWCA Environmental Consultants Inc. (SWCA) to mitigate potential adverse effects to the sites (Cannon and Stettler 2007). Data recovery at the five sites was completed in fall 2007. In addition, eight prehistoric sites previously recommended as eligible for the NRHP were located near the study area (26EU1903, 26EU2452, 26EU1549, 26EU1506, 26EU1484, 26EU1486, 26EU1786, and 26EU1528); however, no data recovery or other forms of mitigation are planned for these sites since seven of the sites would be avoided by enclosing the sites within protective fencing during project construction, and one of the sites was destroyed by previous mining disturbance. Data recovery at the five NRHP-eligible prehistoric sites has occurred in three stages: 1) surface artifact collection and remote sensing survey, 2) excavation, and 3) mechanical stripping. The process focuses on locating buried archaeological deposits that could provide answers to project research questions and information that can be added to the local and regional archaeological database. Site descriptions for the five prehistoric sites are provided below.

<u>Site 26EU1533</u>

Site 26EU1533 was originally recorded by the Desert Research Institute (DRI) as a sparse chipped stone scatter (Hicks 1989). P-III Associates, Inc. (P-III) revisited the site in 1992 (Newsome 1992) and recorded a central concentration of debitage surrounded by a diffuse scatter of flakes. In September 2005, SWCA revisited the site and noted that the site appeared to have experienced a range fire and subsequent erosion since the time of P-III's visit in 1992 (Cannon and Stettler 2007). In October 2006, SWCA returned to the site to conduct limited probing, which consisted of two shovel tests and one 1- x 1-meter (m) test unit dug to a depth of 10 cm (Cannon and Stettler 2007). The limited probing resulted in the discovery of an Elko corner-notched point.




**LEGEND**

- Native American Traditional Values Cumulative Effects Study Area
- Cultural Resources Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries
- Towns

Source: BLM 2007b,c.

N W E S

0 5 10 Miles

**Betze Pit Expansion Project**

Figure 3.9-1

Native American Traditional Values and Cultural Resources Cumulative Effects Study Area

Site 26EU1539

Site 26EU1539 was first documented by DRI as a low-density lithic scatter with some ground stone (Hicks 1989). In 1992 and 1993, P-III revisited the site and identified additional artifacts and artifact concentrations (Schroedl 1993). SWCA revisited the site in September 2005 and recorded two artifact concentrations and noted previously unrecorded artifacts (Cannon and Stettler 2007). One of the previously unrecorded artifacts included a small side-notched point. In September 2006, SWCA returned to the site and conducted limited probing, which included three 10-cm-deep shovel tests and one 20-cm-deep 1- x 1-m test unit. The limited probing revealed buried lithic artifacts, but no features.

Site 26EU1548

Site 26EU1548 was originally recorded by DRI as a low-to-moderate density lithic scatter with five localized concentrations (Hicks 1989). In 1993, P-III revisited the site and made no changes to the site description; however, they did identify a large biface (Newsome et al. 1993). SWCA revisited the site in September 2005 and found two artifact concentrations (Cannon and Stettler 2007). In September 2006, SWCA returned to the site to conduct limited probing, which consisted of five 10-cm-deep shovel tests and one 30-cm-deep 1- x 1-m test unit. The limited probing revealed buried lithic artifacts, but no features.

Site 26EU2064

Site 26EU2064 was originally recorded by P-III as a dispersed lithic scatter, which included a Humboldt projectile point (Tipps and Popek 1992). In September 2005, SWCA revisited the site and found four artifact concentrations within the originally recorded dispersed lithic scatter (Cannon and Stettler 2007). The following year, SWCA returned to the site to conduct limited probing, which consisted of 27 shovel tests and ten 1-x 1-m test units excavated to a depth of 35 cm below the surface. The limited probing revealed buried lithic artifacts, but no features.

Site 26EU2126

Site 26EU2126 was originally documented by P-III as two lithic concentrations surrounded by a discrete scatter of debitage, which included a Cottonwood point fragment (Tipps and Popek 1992). In September 2005, SWCA revisited the site and found the two originally recorded artifact concentrations (Cannon and Stettler 2007). SWCA returned to the site in September 2006 to conduct limited probing, which consisted of three 10-cm-deep shovel tests and one 30-cm-deep 1- x 1-m test unit. The limited probing revealed buried lithic artifacts and burned artiodactyl bone. (Artiodactyl bones come from a group of even-toed hoofed mammals such as camels, cattle, pigs, and deer.)

Data recovery at the five NRHP-eligible sites proceeded as follows: 1) controlled collection of all artifacts visible on the surface; 2) mechanical mowing of the vegetation; 3) geophysical remote sensing using multiple kinds of techniques (e.g., resistivity, magnetometer, conductivity) with sub-meter resolution necessary for locating small cultural features (e.g., hearths, artifact concentrations, pits); 4) hand excavation of small 1-m square units to confirm and evaluate the remote sensing results and surface indicators of human activities; and 5) mechanical scraping to confirm the absence of additional, undetected cultural features. The field work was completed in fall of 2007. Data analysis and report writing will continue through spring 2008, with a draft report submitted to BLM by July 11, 2008.

### 3.9.2 Environmental Consequences

The NHPA requires that federal agencies take into account the effect of a proposed undertaking on historic properties. Historic property, as defined by the regulations implementing Section 106, means “any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP maintained by the NPS.” Potential effects to historic properties are assessed using the “criteria of adverse effect” (36 CFR 800.5[a][1]), as defined in the implementing regulations for the NHPA. “An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the

property's location, design, setting, materials, workmanship, feeling, or association." The analysis of effects using these criteria is limited to those resources that are listed in the NRHP or have been recommended as eligible.

#### 3.9.2.1 No Action Alternative

Under the No Action Alternative, the proposed facilities that would comprise the Betze Pit Expansion Project would not be developed. The mining and ore processing activities associated with the existing Goldstrike Mine would continue under the terms of current permits and approvals as authorized by the BLM and State of Nevada. No additional ground-disturbing activities beyond those currently authorized would occur at the mine site. Prior to construction of the authorized facilities, adverse effects to NRHP eligible properties located in the area of the facilities were, or would be, fully mitigated in accordance with Section 106 of the NHPA, the 1991 PA, and NEPA. Therefore, no adverse effects to historic properties are anticipated under the No Action Alternative.

#### 3.9.2.2 Proposed Action

Data recovery was completed at five historic properties located in the project area; therefore, under Section 106 of the NHPA, there would be no adverse effects to these properties as a result of the Proposed Action. However, although Section 106 provides for findings of no adverse effect through mitigation, mitigation means lessening of effects to historic properties, not that the properties are not damaged by an undertaking. Even with data recovery, some data about the site, and the site itself, are lost. A principal disadvantage of this form of mitigation is that the recovery process itself is destructive, preventing future opportunities for scientific research, preservation, or public appreciation.

In addition, eight prehistoric sites previously recommended as eligible for the NRHP were located near the project area; however, no data recovery or other forms of mitigation are planned for these sites since seven of the sites would be avoided by enclosing the sites within protective fencing during project construction, and one of the sites was destroyed by previous mining disturbance.

The potential for the discovery of previously unidentified cultural resources during construction activities exists within proposed disturbance areas and could result in direct effects to these unanticipated discoveries. However, if any previously unknown cultural resources are discovered during construction on BLM-administered lands, all construction activities would cease within the vicinity of the discovery, and the BLM Authorized Officer and SHPO would be notified of the find. Steps would be taken to protect the site from vandalism or further damage until the BLM Authorized Officer can evaluate the nature of the discovery as outlined in the PA. Construction would not resume in the area of the discovery until the BLM Authorized Officer has issued a notice to proceed.

If construction or other project personnel discover what may be human remains, funerary objects, or items of cultural patrimony on BLM-administered land, construction would cease within the vicinity of the discovery, and the BLM Authorized Officer would be notified of the find. Any discovered Native American human remains, funerary objects, or items of cultural patrimony found on federal land would be handled in accordance with Native American Grave Protection and Repatriation Act (NAGPRA). Non-Native American human remains would be handled in accordance with Nevada law. Construction would not resume in the area of the discovery until the BLM Authorized Officer has issued a notice to proceed.

If human remains and associated funerary objects are discovered on private land during construction activities, construction would cease within the vicinity of the discovery and the county coroner or sheriff would be notified of the find. Treatment of any discovered human remains and associated funerary objects found on private land would be handled in accordance with the provisions of applicable Nevada law.

An increase in the number of workers during construction could increase the potential for indirect effects at archaeological sites. Indirect effects are difficult to quantify and control. However, they can include the loss of

surface artifacts due to illegal collection and inadvertent destruction, and increased erosion due to soil disturbance associated with construction activities. In accordance with the applicant-committed environmental protection measures and the PA, BGMI would train all of its personnel, and all personnel of its contractors, in their responsibilities to protect cultural resources and enforce BGMI's policy against off-road cross-country travel and the removal of artifacts. Some BGMI personnel have been trained as Nevada Site Stewards who work with other personnel and cultural resource consultants in developing and implementing a program of site stewardship that includes regular monitoring and site visits to assess their condition.

Indirect effects to archaeological resources from modifications to erosion/sedimentation rates during construction activities could occur as a result of the Proposed Action. The development of waste rock piles and other facilities, which alter runoff may indirectly impact surrounding archaeological sites by altering patterns of erosion and groundwater. The development of dryer, wetter, or even more importantly fluctuating soil moisture conditions at sites surrounding the proposed expansion may have adverse effects on preservation conditions (especially of organic remains) at surrounding archaeological sites. Long-term monitoring, as part of the site stewardship program, should enable the BLM to evaluate these types of effects and mitigate effects, as appropriate.

To reduce erosion effects to archaeological sites, construction practices would include soil stabilization and temporary controls to minimize erosion, encourage infiltration, and control sediment discharges (see Section 2.2.1.13, Applicant-committed Environmental Protection Measures). Where necessary, temporary erosion controls would be installed prior to, or immediately following, initial disturbance of the soil and would be maintained until the soil has been stabilized.

#### 3.9.2.3 Bazza Waste Rock Facility Alternative

This alternative would result in the continued use of the existing Bazza Waste Rock Facility and the proposed Clydesdale Waste Rock Facility would not be constructed. Two of the five NRHP-eligible prehistoric sites that have undergone data recovery are located in the area of the proposed Clydesdale Waste Rock Facility. Therefore, under this alternative, two of the five NRHP-eligible sites would not be lost through project construction compared to all five under the Proposed Action.

### 3.9.3 Cumulative Impacts

The CESA for cultural resources is shown in **Figure 3.9-1.** The CESA boundary was determined by the BLM to include those mines and related facilities that encompass the core area of the Carlin Trend, including areas currently subjected to open pit and underground mining activities. Past, present, and RFFAs are identified in Section 3.1.

#### 3.9.3.1 No Action Alternative

As directed by law, cultural resource inventories were completed for mining and mining exploration involving federal lands within the CESA. A summary of the cultural resource inventories can be found in **Table D-1**, **Appendix D**. Compliance with Section 106 of the NHPA has minimized impacts to cultural resources; however, past and present mining and mining exploration have resulted in cumulative impacts to these resources. Although cultural resource inventories are done in advance of mining exploration and development with the intent of avoiding historic properties, impacts these properties have occurred. Recent re-evaluation of many of the remaining cultural resources within the BGMI operations boundary have shown that some of the historic properties that should have been avoided under the PA have been damaged, and a few completely destroyed (**Table D-2**, **Appendix D**). Once the re-evaluation is completed, site treatment and data recovery plans will be developed and implemented to mitigate the damage and loss.

The development and implementation of treatment plans at historic properties that cannot be avoided or protected typically involves archaeological excavation and other forms of data recovery. Cultural resources represent non-renewable, finite resources that cannot be replaced. Even with data recovery, some data about

the site is lost, especially to future generations of archaeologists who will have new questions and theories to investigate, and new means or methods of doing so. A principal disadvantage of this form of mitigation is that the recovery process itself is destructive, preventing future opportunities for scientific research, preservation, or public appreciation. A list of mitigated sites located within the CESA is included **Table D-3**, **Appendix D**.

#### 3.9.3.2 Proposed Action

Cumulative effects to cultural resources under the Proposed Action would be similar to the No Action Alternative cumulative impacts discussed above.

#### 3.9.3.3 Bazza Waste Rock Facility Alternative

This alternative would have similar cumulative impacts to cultural resources as discussed above for the No Action Alternative.

### 3.9.4 Mitigation Measures and Monitoring

All known historic properties identified within the area of potential effect (APE) have been mitigated in accordance with the 1991 PA and data recovery plan prepared for the project. The eight sites to be enclosed within protective fences and the other remaining historic properties that have not undergone data recovery within the POO will be monitored to ensure that additional damage or adverse effects do not occur in any of them. Any previously unknown historic properties that may be discovered during construction activities would be mitigated in accordance with the PA. Therefore, no additional mitigation or monitoring is recommended.

### 3.9.5 Residual Impacts

The Proposed Action would result in the loss of cultural resources that are not eligible for the NRHP. Although these sites have been recorded to BLM standards and the information has been integrated into local and statewide databases, the sites ultimately are destroyed by project construction. Adverse effects to five NRHP-eligible properties have been mitigated through implementation of data recovery. However, since some of the cultural value associated with these sites cannot be fully mitigated, the Proposed Action and Bazza Waste Rock Facility Alternative would result in a residual impact to these resources. No residual adverse effects to cultural resources, including NRHP eligible properties are anticipated under the No Action Alternative.

## 3.10 Native American Traditional Values

### 3.10.1 Affected Environment

The analysis area for Native American Traditional Values encompasses the project boundary. The CESA encompasses the hydrologic study area (**Figure 3.9-1**). The boundary for the CESA includes water sources important to the Western Shoshone, as well as edible/medicinal plants, minerals, wildlife, and traditional/cultural/religious use sites.

#### 3.10.1.1 Regulatory Framework

Federal law and agency guidance require BLM to consult with Native American tribes concerning the identification of cultural values, religious beliefs, and traditional practices of Native American people that may be affected by actions on BLM-administered lands. This consultation includes the identification of places (i.e., physical locations) of traditional cultural importance to Native American tribes. Places that may be of traditional cultural importance to Native American people include, but are not limited to:

- Locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world;
- Locations where religious practitioners go, either in the past or the present, to perform ceremonial activities based on traditional cultural rules or practice;
- Ancestral habitation sites;
- Trails, burial sites; and
- Places from which plants, animals, minerals, and waters possessing healing powers or used for other subsistence purposes, may be taken.

Some of these locations may be considered sacred to particular Native American individuals or tribes.

In 1992, the NHPA was amended to explicitly allow that “properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization may be determined to be eligible for inclusion on the NRHP.” If a resource has been identified as having importance in traditional cultural practices and the continuing cultural identity of a community, it may be considered a traditional cultural property (TCP). The term “traditional cultural property” first came into use within the federal legal framework for historic preservation and cultural resource management in an attempt to categorize historic properties containing traditional cultural significance. To qualify for nomination to the NRHP, a TCP must:

- Be more than 50 years old;
- Be a place with definable boundaries;
- Retain integrity; and
- Meet certain eligibility criteria as outlined for cultural resources in the NHPA (see Section 3.9, Cultural Resources).

In addition to NRHP eligibility, some places of cultural and religious importance also must be evaluated to determine if they should be considered under other federal laws, regulations, directives, or policies. These include, but are not limited to, the NAGPRA of 1990, American Indian Religious Freedom Act (AIRFA) of 1978, Archaeological Resources Protection Act (ARPA) of 1979, and EO 13007 of 1996.

NAGPRA established a means for Native Americans, including Indian Tribes, to request the return of human remains and other sensitive cultural items held by federal agencies or federally assisted museums or institutions. NAGPRA also contains provisions regarding the intentional excavation and removal of, inadvertent

discovery of, and illegal trafficking in Native American human remains and sensitive cultural items located on federal lands.

AIRFA established a federal policy of protecting and preserving the inherent right of individual Native Americans to believe, express, and exercise their traditional religions including, but not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremonial, and traditional rites.

ARPA requires notification of the appropriate Indian tribe before approving a cultural resource use permit for the excavation (testing and data recovery) of archaeological resources, if the responsible federal land manager determines that a location having cultural or religious importance to the tribe may be harmed or destroyed.

EO 13007 defines a sacred site as any specific, discrete, narrowly delineated location on federal land that is identified by an Indian tribe, or Indian individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion, provided that the tribe or appropriate authoritative representative has informed the federal agency of the existence of such a site.

EO 13007 requires federal agencies "to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, to "(1) accommodate access to and ceremonial use of such sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites." To implement these requirements, federal agencies must, "where practicable and appropriate," . . . "implement procedures, . . . to ensure reasonable notice is provided of proposed actions or land management policies that may restrict future access to or ceremonial use of, or adversely affect the physical integrity of, sacred sites."

#### 3.10.1.2 Native American Consultation

In compliance with the NHPA, as amended, the BLM initiated government-to-government consultation for the Betze Pit Expansion Project SEIS on April 24, 2007, by sending letters to the following federally recognized tribes/bands: Te-Moak Tribe of Western Shoshone, Duckwater Shoshone Tribe, Ely Shoshone Tribe, Yomba Shoshone Tribe, Duck Valley Sho-Pai Tribes of Idaho and Nevada, Battle Mountain Band Council, Wells Band Council, South Fork Band Council, and Elko Band Council. Letters were sent to inform the various tribes of the proposed undertaking and to inquire whether the tribes:

- Wish to arrange a meeting;
- Require more information about the project;
- Want to enter into formal consultation; or
- Want to attend a field tour of the proposed project area.

In addition, the BLM sent letters to the Western Shoshone Defense Project and the Western Shoshone Committee of Duck Valley to inform them of the project. **Table 3.10-1** lists the tribes and groups that have been contacted and summarizes the current status of consultation and the concerns they have identified regarding the proposed project. BLM organized two tours for Native American elders to visit the project area including the five sites under-going data recovery, but no elders showed up for the tours. The field work was completed before the tours could be rescheduled.

**Table 3.10-1 Summary of Native American Consultation**

| Name of Tribe | Date of Contact | Follow-up Contact | Status |
|---|---|---|---|
| Te-Moak Tribe of Western Shoshone | April 24, 2007 | July 25, 2007 | Tribal representative asked for and received a second copy of the 4/24/07 introduction letter to present again to the Council along with a date for a meeting or field visit. |
| Duckwater Shoshone Tribe | April 24, 2007 | July 24, 2007 | No response to date. |
| Ely Shoshone Tribe | April 24, 2007 | July 24, 2007 | Tribe declined to participate in consultation. No issues or concerns were identified. |
| Yomba Shoshone Tribe | April 24, 2007 | July 24, 2007 | Tribal representative recommended that BLM contact the tribal Chairperson. No response to date. |
| Duck Valley Sho-Pai Tribes of Idaho and Nevada | April 24, 2007 | May 1, 2007<br>July 25, 2007<br>Sept. 19, 2007<br>October 1, 2007 | BLM requested a meeting with tribal representatives. A field visit was arranged for 10/1/07. The field visit was cancelled when none of the representatives were able to attend. At this time, the visit has not been rescheduled. |
| Battle Mountain Band Council | April 24, 2007 | July 25, 2007<br>July 27, 2007 | No response to date. |
| Wells Band Council | April 24, 2007 | July 24, 2007 | No response to date. |
| South Fork Band Council | April 24, 2007 | July 24, 2007 | No response to date. |
| Elko Band Council | April 24, 2007 | July 25, 2007<br>August 7, 2007<br>August 8, 2007<br>August 10, 2007<br>August 23, 2007<br>August 27, 2007<br>Sept. 17, 2007<br>Sept. 19, 2007<br>October 1, 2007 | Tribal representatives requested tribal monitor/observer participation in data recovery at five historic properties in the APE. The qualified observer was not available.<br><br>Tribal representatives requested a field visit. Field visit was arranged for 10/1/07. The field visit was cancelled when none of the representatives were able to attend. At this time, the visit has not been rescheduled. |
| Western Shoshone Defense Project (WSDP) | April 24, 2007 | | No response to date. |
| Western Shoshone Committee of Duck Valley | April 24, 2007 | | No response to date. |

Source: Dixon 2007.

## 3.10.2 Environmental Consequences

The effects of federal undertakings on TCPs or places of religious or cultural importance to contemporary Native Americans are given consideration under the provisions of EO 13007, AIRFA, NAGPRA, and recent amendments to the NHPA. As amended, the NHPA now integrates Indian tribes into the Section 106 compliance process, and also strives to make the NHPA and NEPA processes procedurally compatible. Furthermore, under NAGPRA, culturally affiliated Indian tribes and federal agencies jointly may develop procedures to be taken when Native American human remains are discovered on federal lands.

### 3.10.2.1 No Action Alternative

Under the No Action Alternative, the proposed facilities that would comprise the Betze Pit Expansion Project would not be developed. The mining and ore processing activities associated with the existing Goldstrike Mine would continue under the terms of current permits and approvals as authorized by the BLM and State of Nevada. No additional ground-disturbing activities beyond those currently authorized would occur at the mine site. Prior to construction of the authorized facilities any adverse effects to TCPs and places of cultural or religious importance located in the area of the facilities would be, fully mitigated in accordance with Section 106 of the NHPA and other appropriate laws that protect these resources. To date, no other tribes have responded to the letters, and no TCP or place of cultural or religious importance has been identified through inventory or by the contacted tribes. Therefore, no adverse effects to Native American Traditional Values are anticipated under the No Action Alternative.

### 3.10.2.2 Proposed Action

Government-to-government consultation between the BLM Elko District Office and tribal representatives was initiated on April 24, 2007, and currently is ongoing. The Duck Valley Sho-Pai Tribes of Idaho and Nevada and the Elko Band Council requested a field visit to the project area. A visit was scheduled for October 1, 2007; however, the field visit was cancelled after none of the tribal representatives were able to attend. At this time, the field visit has not been rescheduled. The ElkoBand Council proposed a monitor/observer be present, but a qualified server was not available. To date, no other tribes have responded to the letters, and no TCP or place of cultural or religious importance has been identified through inventory or by the contacted tribes.

If a TCP or place of cultural or religious importance is identified by tribal representatives, no surface disturbance would occur within or immediately adjacent to the boundary of the property prior to completion of all consultation required by law. If data recovery or other form of mitigation is required at a TCP or place of cultural or religious importance, a data recovery or mitigation plan would be reviewed and approved by the BLM and SHPO. Tribal representatives would be asked to participate in the development of any such data recovery or mitigation plan. Therefore, no adverse effects to Native American traditional values are anticipated as a result of the Proposed Action.

### 3.10.2.3 Bazza Waste Rock Facility Alternative

This alternative would result in the continued use of the existing Bazza Waste Rock Facility and the proposed Clydesdale Waste Rock Facility would not be constructed. For this alternative, potential impacts to Native American traditional values would be the same as those described for the Proposed Action. To date, no TCPs or places of cultural or religious importance to Native Americans have been identified through inventory or by the tribes participating in the government-to-government consultation process.

## 3.10.3 Cumulative Impacts

The CESA for Native American Traditional Values is shown in **Figure 3.9-1**. Past, present, and RFFAs are identified in Section 3.1.

### 3.10.3.1 No Action Alternative

Tribal consultation and research conducted for previous EAs and EISs resulted in the identification of general issues that require consideration as part of the cumulative impacts assessment. Those general issues include water, sage-grouse, and cultural sites, including NRHP-eligible sites, TCPs, and places of cultural or religious importance. Potential cumulative impacts to these resources are discussed below.

Impacts to Water Resources

Although it is not possible to conclusively identify specific springs and seeps that would or would not be impacted by future mine-induced drawdown or to predict the areal extent of the cumulative drawdown area resulting from the various mine activities in the CESA, it is anticipated that cumulative effects to water sources would be most likely to occur within the cumulative mine-related 10-foot groundwater drawdown contour. The degree to which mine-related impacts to perennial waters in the regional cumulative effects study area have affected, or would affect, Native American traditional values cannot be specifically quantified. However, it is most likely that impacts to perennial streamflows and flows from springs would be within the area of the cumulative predicted 10-foot drawdown contour, as shown on **Figures 3.3-26** and **3.3-48** in the discussion for water resources. This figure indicates spring locations and the extent of perennial streams within the most probable area of cumulative effects. Impacts would include reductions in the amount of flow, as well as in the seasonal duration of flow, from springs and in perennial streams.

Western Shoshone religion is based on the belief that all life is interdependent. Human beings are recognized to have kin ties with other life forms and with the earth itself. This belief system is very important to the Western Shoshone in the Great Basin where a delicate balance must be maintained between human subsistence and an unpredictable, sometimes harsh environment (Rusco 2000). The scarcity and unpredictability of water in this semi-arid region may account for the importance of water in Western Shoshone religion. Water is the keystone of Western Shoshone religion because power (Puha), with its affinity for life, is strongly attracted to water (Rusco 2000). As a result, it is assumed that Western Shoshone traditional lifeways as they relate to perennial waters have been, and would continue to be, cumulatively affected by mine-related activity that has occurred, and would occur, in the regional cumulative effects study area.

The potential cumulative impacts from dewatering have been addressed in the CIA (BLM 2000b) and Betze SEIS (BLM 2000a, 2003b) and were previously mitigated (**Figure 3.3-48** and Section 3.3.4.2). This mitigation may not address impacts to Native American values as they relate to water resources. However, no impacts have been identified to date. For an expanded discussion on impacts to water resources in the cumulative effects study area, the reader is referred to Section 3.3, Water Resources and Geochemistry.

Impacts to Sage-grouse

Animals are of particular importance to the Western Shoshone. Many species continue to be an important subsistence resource. Actions addressed by the cumulative effects analysis could impact the abundance and distribution of animal species and their habitat. Of particular concern to the Western Shoshone is the ongoing regional decline of sage-grouse and their habitat (BLM 2000a). Sage-grouse are considered sacred, and the hunting of these birds is important in preserving Western Shoshone cultural identity and traditions.

A total of 14 greater sage-grouse leks have been identified within the Native American CESA. Nesting habitat for sage-grouse is known to occur in valley bottoms and foothill areas. Nesting habitat is found throughout the CESA, but is mainly concentrated in the northern portion. Summer and winter range occurs throughout the CESA, excluding lower portions of Boulder Valley.

Cumulative impacts to greater sage-grouse primarily would be directly related to habitat loss, habitat fragmentation, and animal displacement. Many of the greater sage-grouse populations that occur in the CESA would continue to occupy their respective ranges and breed successfully, although population numbers may decrease relative to the amount of cumulative habitat loss and disturbance from incremental development.

Indirect impacts associated with human presence and noise incrementally would increase in the CESA during the life of the proposed mine expansion. The contribution of the Proposed Action and Bazza Waste Rock Facility Alternative to these impacts would be short-term and temporary and would cease following completion of operations and final reclamation.

Impacts to Cultural Sites

As a result of previous cultural resource inventories conducted throughout the CESA, a large number of cultural sites have been documented. The sites primarily consist of lithic debitage, tool scatters, and debitage scatters. The lithic debitage and tool scatters contain fragments of stone implements, while debitage scatters contain stone waste flakes, which are a byproduct of tool making. Other cultural sites or resources include (and are not limited to) red and white clay sources, rock shelters, village sites, projectile points, ground stone, and TCPs (e.g., Tosawihi Quarry, Rock Creek). According to the Western Shoshone, cultural sites are associated with the ancestors and considered "physical proof of Shoshone existence" or physical expressions of cultural identity.

The impact analysis of the Proposed Action and Bazza Waste Rock Facility Alternative indicates no adverse impacts to cultural sites based on compliance with the NHPA, the PA, and implementation of mitigating measures involving data recovery (i.e., archaeological excavation), along with collection of all important artifacts with detailed recording of their context. Therefore, under NEPA, no cumulative effects to cultural sites would occur as a result of the Proposed Action. However, archaeological excavation is perceived by some Western Shoshone as part of a destructive process that permanently removes Western Shoshone heritage and the ancestors themselves (Rucks 2004). Therefore, within the context of Native American concerns, it is anticipated that cumulative effects to cultural sites as a result of mining and other human activity would continue as cultural sites are excavated.

#### 3.10.3.2 Proposed Action

At this time, none of the tribes participating in the ongoing government-to-government consultation process have identified any issues specific to the Proposed Action; however, impacts to water resources, to sage-grouse, and to cultural sites are likely to be of concern to tribes. Cumulative effects to Native American Traditional Values for this alternative are similar to the cumulative impacts discussed for the No Action Alternative.

#### 3.10.3.3 Bazza Waste Rock Facility

Cumulative impacts to Native American Traditional Values for this alternative are similar to the Proposed Action as discussed in Section 3.10.3.2.

#### 3.10.3.4 Mitigation Measures and Monitoring

At this time, no TCP or place of cultural or religious importance has been identified by tribal representatives participating in the ongoing Native American consultation. If tribal representatives were to identify sites of tribal importance, these resources would be protected in compliance with Section 106 of the NHPA and NEPA. Therefore, no additional monitoring or mitigation measures are recommended.

### 3.10.4 Residual Impacts

No residual adverse effects to Native American Traditional Values are anticipated for the Proposed Action or alternatives. At this time, no TCP or place cultural or religious importance has been identified by the tribes participating in government-to-government consultation or through cultural resources inventories conducted in the study area. If any TCP or place of cultural or religious importance were identified in the study area, the resource would be protected in compliance with Section 106 of the NHPA and other appropriate laws that protect these resources.

## 3.11 Air Quality

### 3.11.1 Affected Environment

The Goldstrike Mine is located entirely within the Boulder Flat Air Quality Basin (No. 61 - Upper). The study area for air quality encompasses the proposed project boundary and the area within 6 miles of the proposed project. The CESA encompasses the 100-km radius from the Goldstrike Mine (**Figure 3.11-1**).

Nevada has great climatic diversity, ranging from scorching lowland desert in the south to cool mountain forests in the north. Its varied and rugged topography, mountain ranges, and narrow valleys range in elevation from approximately 1,500 to more than 10,000 feet amsl. Large local variations of temperature and rainfall are common.

Nevada lies on the eastern, lee side of the Sierra Nevada Range, a massive mountain barrier that markedly influences the climate. One of the greatest contrasts in precipitation found within a short distance in the U.S. occurs between the western slopes of the Sierras in California and the valleys just to the east of this range. The prevailing winds are from the west. As the warm moist air from the Pacific Ocean ascends the western slopes of the Sierra Range, the air cools, condensation takes place, and most of the available moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt throughout the state, with the result that the lowlands of Nevada are largely desert or steppes. The principal climatic features are bright sunshine; low annual precipitation (averaging 9 inches in the valleys and deserts), heavy snowfall in the higher mountains; clean, dry air; and exceptionally large daily temperature ranges.

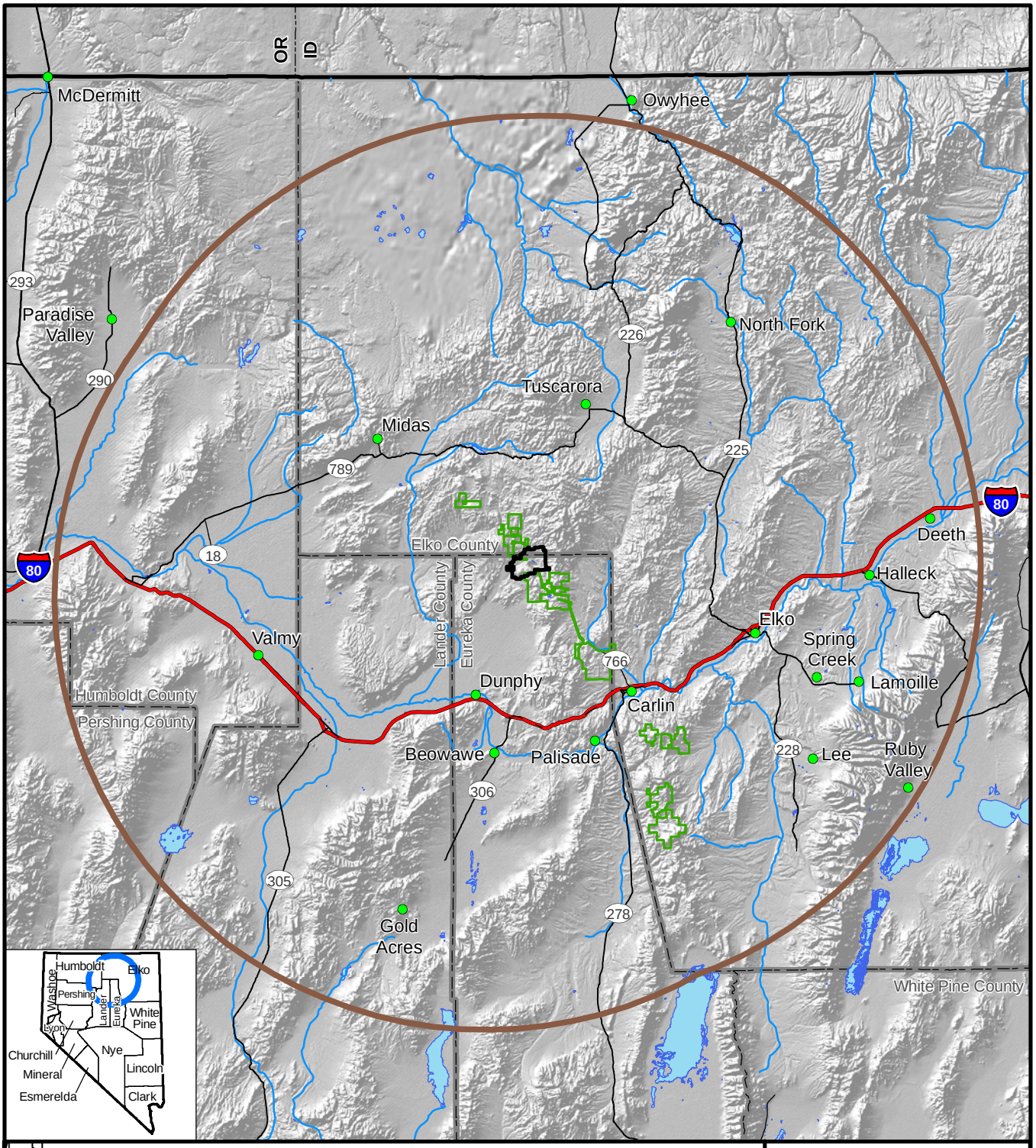
The Betze Pit Expansion Project area is located near the north-central portion of the Great Basin. The surrounding terrain consists of alternating mountain ranges and sagebrush-covered valleys, with the mine site situated in the Basin and Range physiographic province. Elevations at the project location range from approximately 6,000 feet to 7,000 feet amsl.

Regional meteorology, air quality, and dispersion conditions at the project site are characterized from data records from the closest climate monitoring station at Elko, Nevada, which is approximately 45 miles southeast of the proposed project. The climate in the project region is classified as arid, with elevations below 6,500 feet receiving approximately 5 to 9 inches per year of precipitation, while the mountainous areas typically receive approximately 11 to over 16 inches of precipitation annually.

#### 3.11.1.1 Climatology and Meteorology

Three important meteorological factors influence the dispersion of pollutants in the atmosphere: mixing height, wind (speed and direction), and stability. Mixing height is the height aboveground within which rising warm air from the surface will mix by convection and turbulence. Local atmospheric conditions, terrain configuration, and source location determine dilution of pollutants in this mixed layer. Mixing heights vary diurnally, with the passage of weather systems and season. For the project area, the mean annual morning mixing height is estimated to be approximately 300 m. However, during the winter months the mean morning mixing height is approximately 220 m (Holzworth 1972). The mean annual afternoon mixing height exceeds 2,400 m.

Morning atmospheric stability conditions tend to be stable because of the cooling of the air layers nearest the ground. Afternoon conditions, especially during the warmer months, tend to be neutral to unstable because of the rapid heating of the surface under clear skies. During the winter, periods of stable afternoon conditions may persist for several days in the absence of synoptic (continental-scale) storm systems to generate higher winds with more turbulence and mixing. A high frequency of inversions at lower elevations during the winter




## LEGEND

- Air Quality Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries
- Towns
- Lakes and Reservoirs
- Rivers

N

0 6.25 12.5 25 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.11-1

Air Quality Cumulative Effects Study Area

06/20/2008

can be attributed to the nighttime cooling and sinking air flowing from higher elevations to the low lying areas in the basins. Although winter inversions are generally quite shallow, they tend to be more stable because of reduced surface heating.

The proposed project is located at a latitude that places it within the belt of prevailing westerly winds that circle the globe around the earth's northern hemisphere. However, the Goldstrike Mine is located in complex terrain where the winds are affected by local topographic features.

Due to the typically dry atmosphere, bright sunny days and clear nights frequently occur. This in turn allows rapid heating of the ground surface during daylight hours and rapid cooling at night. Because heated air rises, and cooled air sinks, winds tend to blow uphill during the daytime and down slope at night. The complexity of terrain features causes complex movements in the cyclic air patterns, with thin layers of moving air embedded within the larger scale movements. The lower level, thermally driven winds also are embedded within larger scale upper wind systems (synoptic winds). Synoptic winds in the region are predominantly west to east, are characterized by daily weather variations that enhance or diminish the boundary layer winds, and are channeled by regional and local topography.

The wind rose for Elko (**Figure 3.11-2**) is representative of the regional wind climatology. The Elko wind rose indicates that winds are predominantly from the west to southwest, but it also shows that there is a secondary maximum of wind occurrences from the northeast. Wind speed has an important effect on area ventilation and the dilution of pollutant concentrations from individual sources. Light winds, in conjunction with large source emissions, may lead to an accumulation of pollutants that can stagnate or move slowly to downwind areas. During stable conditions, downwind usually means down valley or toward lower elevations. Climate data from Elko indicate that the potential for air pollution episodes to last 5 or more days is nearly zero (Holzworth 1972). A potential air pollution episode is defined as a period of time with wind speeds less than 2 m per second and mixing heights less than 1,000 m.

**Table 3.11-1** shows the monthly climate summary data for temperature and precipitation for Elko during the 117-year period from January 1890 through June 2007. Summers are typically hot and dry. Precipitation falls throughout the year with much of it occurring as snowfall during the winter. The average annual precipitation at Elko is approximately 9.6 inches.

**Table 3.11-1 Monthly Climate Summary Elko WB Airport, Nevada[1]**

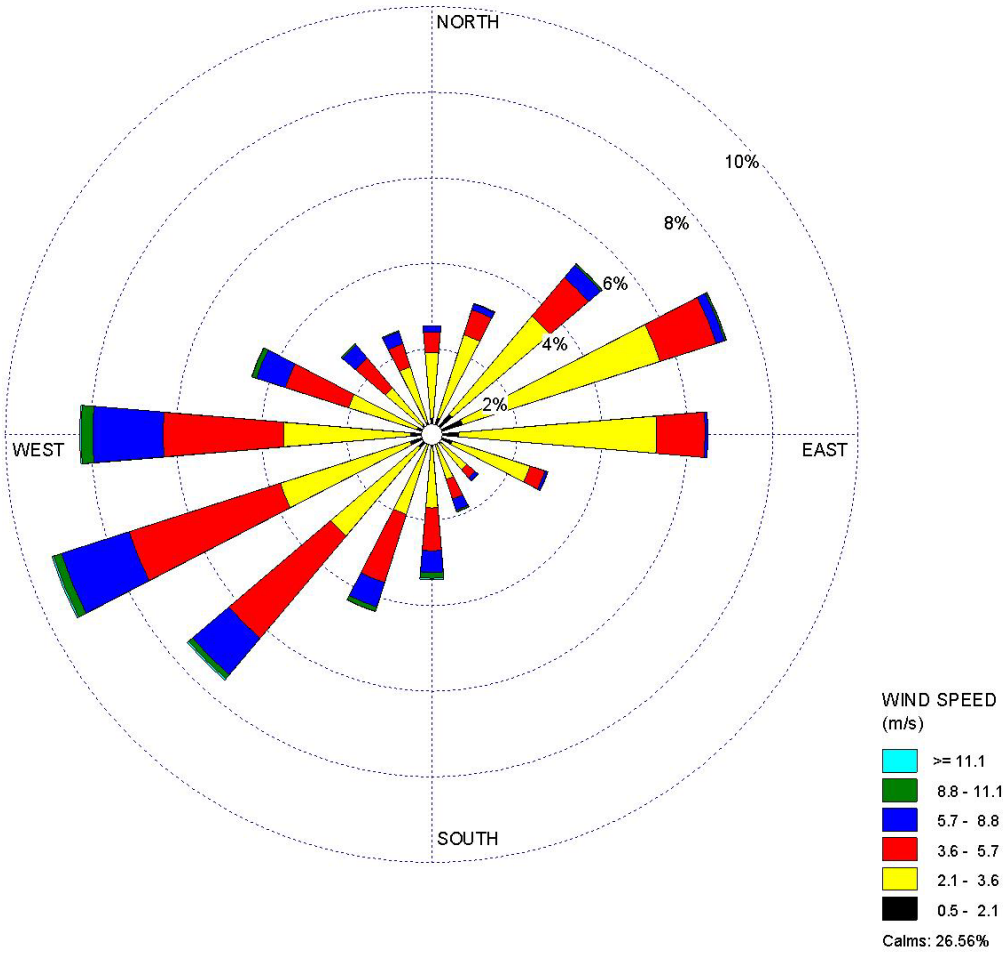
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Max. Temperature (°F) | 36.7 | 42.5 | 51.0 | 60.0 | 69.5 | 80.1 | 91.0 | 88.8 | 78.7 | 65.9 | 50.2 | 39.0 | 62.8 |
| Average Min. Temperature (°F) | 10.8 | 17.3 | 23.6 | 29.1 | 35.6 | 42.2 | 48.1 | 45.6 | 36.6 | 27.9 | 20.4 | 13.2 | 29.2 |
| Average Total Precipitation (in.) | 1.18 | 0.94 | 0.92 | 0.84 | 0.98 | 0.77 | 0.38 | 0.41 | 0.45 | 0.71 | 0.93 | 1.09 | 9.59 |
| Average Total Snow Fall (in.) | 7.8 | 4.5 | 3.7 | 1.6 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 3.2 | 6.2 | 28.0 |
| Average Snow Depth (in.) | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

[1]Period of Record: 1/1/1890 to 6/30/2007.

Source: National Climatic Data Center – National Weather Service Cooperative Network 2007.

WIND ROSE PLOT:

**Station #: 24121 -- Elko / Municipal Airport, NV**




| COMMENTS: | DATA PERIOD: | | |
|---|---|---|---|
| **5-Year Composite Wind Rose Plot for Elko, NV: 1988,1989,1990,1991,1992** | **1988-1992**<br>**Jan 1 - Dec 31**<br>**00:00 - 23:00** | | |
| | CALM WINDS:<br>**26.56%** | TOTAL COUNT:<br>**43824 hrs.** | |
| | AVG. WIND SPEED:<br>**2.58 m/s** | | PROJECT NO.: |

WRPLOT View - Lakes Environmental Software

**Figure 3.11-2 Elko Wind Rose Diagram**

One year of on-site data from the Goldstrike Mine North Block meteorology station is in close agreement with the long-term record at Elko. Goldstrike maximum temperatures and precipitation are very similar to Elko records. Average minimum temperatures at the mine are somewhat higher than at the Elko site. **Table 3.11-2** shows data from the North Block meteorology station for the period December 2006 through November 2007.

**Table 3.11-2 Goldstrike Mine North Block Meteorology Station Data**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average Max. Temperature (°F) | 29.8 | 40.5 | 53.4 | 54.2 | 68.9 | 79.6 | 91.0 | 86.1 | 72.7 | 58.6 | 50.0 | 38.0 | 60.3 |
| Average Min. Temperature (°F) | 16.3 | 27.2 | 34.9 | 35.6 | 45.7 | 53.9 | 67.3 | 61.9 | 50.1 | 39.4 | 32.1 | 24.9 | 40.8 |
| Average Total Precipitation (in.) | 0.3 | 1.9 | 0.8 | 1.6 | 0.4 | 0.5 | 0.4 | 0.0 | 0.7 | 0.6 | 0.8 | 1.1 | 9.1 |

Source: BGMI 2007a.

### 3.11.1.2 Air Quality

Air quality is defined by the concentration of various pollutants and their interactions in the atmosphere. Pollution effects on receptors have been used to establish a definition of air quality. Measurement of pollutants in the atmosphere is expressed in units of ppm or micrograms per cubic meter ($\mu g/m^3$). Both long-term climatic factors and short-term weather fluctuations are considered air quality conditions because they control dispersion and affect concentrations. Physical effects of air quality depend on the characteristics of the receptors and the type, amount, and duration of exposure. Air quality standards specify acceptable upper limits of pollutant concentrations and duration of exposure. Air pollutant concentrations within the standards generally are not considered to be detrimental to public health and welfare.

The relative importance of pollutant concentrations can be determined by comparison with appropriate national and/or state Ambient Air Quality Standards (AAQS). National and state AAQS are presented in **Table 3.11-3**. An area is designated by the USEPA as being in attainment for a pollutant if ambient concentrations of that pollutant are below the national AAQS. An area is not in attainment if violations of national AAQS for that pollutant occur. Areas where insufficient data are available to make an attainment status designation are listed as unclassifiable and are treated as being in attainment for regulatory purposes.

The existing air quality of the project area is typical of the largely undeveloped regions of the western U.S. For the purposes of statewide regulatory planning, this area has been designated as in attainment (not exceeding NAAQS for criteria pollutants) for all pollutants that have an AAQS. Current sources of air pollutants in the region include several precious metals mines that are sources for particulate matter (PM) with aerodynamic diameters (in micrometers) designated as $PM_{10}$ and $PM_{2.5}$.

<u>Global Mercury</u>

Mercury is a naturally occurring element in many soils, volcanic rocks, and marine and geothermal water sources. It assumes many forms and can be found naturally in the environment as free metallic mercury, chemically combined with other elements in a number of soil or rock types, and in the form of methylmercury in plants and animals. Mercury is generally present in the atmosphere in one of three chemical forms: gaseous elemental mercury, reactive gaseous mercury, or particulate mercury. Reactive gaseous mercury and particulate mercury account for less than 2 percent of the total concentration in air, with elemental mercury accounting for more than 98 percent of the total (Fitzgerald et al. 1991).

**Table 3.11-3 National and State of Nevada Ambient Air Quality Standards**

| | Nevada Standards | | National Standards | |
|---|---|---|---|---|
| **Pollutant** | **Averaging Time** | **Concentration ($\mu g/m^3$)** | **Primary ($\mu g/m^3$)** | **Secondary ($\mu g/m^3$)** |
| $O_3$ | 8-Hour | 157 | 157 | 157 |
| CO | 1-Hour | 40,000 | 40,000 | 40,000 |
| CO less than 5,000 feet amsl | 8-Hour | 10,000 | 10,000 | 10,000 |
| CO at or greater than 5,000 feet amsl | 8-Hour | 6,670 | | |
| $SO_2$ | 3-Hour | 1,300 | None | 1,300 |
| $SO_2$ | 24-Hour | 365 | 365 | None |
| $SO_2$ | Annual Average | 80 | 80 | None |
| Nitrogen Dioxide ($NO_2$) | Annual Average | 100 | 100 | 100 |
| $PM_{10}$ | 24-Hour | 150 | 150 | 150 |
| $PM_{10}$ | Annual Average | 50 | 50 | 50 |
| $PM_{2.5}$ | 24-Hour | 35 | 35 | 35 |
| $PM_{2.5}$ | Annual Average | 15 | 15 | 15 |
| Lead | Quarterly Arithmetic Mean | 1.5 | 1.5 | 1.5 |
| Hydrogen Sulfide | 1-Hour | 112 | -- | -- |
| Visibility | Observation | Insufficient amount to reduce the prevailing visibility to less than 30 miles when humidity is less than 70 percent. | -- | -- |

Source: NAC 445B.22097 Standards of Quality for Ambient Air (NRS 445B.210, 445B.300).

Mercury emissions to the atmosphere come from both background and man-made or anthropogenic sources. Background sources of mercury include natural sources such as naturally enriched soils and volcanoes. There are both global and local anthropogenic sources of mercury. The fate of mercury emissions follows a progression from the emission source to transport, deposition, exposure, and potential human risks. From a single source such as a power plant or a mine, a portion of the emissions are deposited locally near the source while the remaining portion of the mercury is dispersed regionally and globally.

Understanding mercury speciation is important in understanding the deposition and bioaccumulation of mercury in the environment. Gaseous mercury ($Hg^0$) must be transformed to particulate or oxidized mercury in order to contribute substantially to mercury deposition and subsequent entry into water bodies where further transformation to methylmercury ($CH_3Hg^+$) can make the mercury available in the aquatic food chain (Porcella 1994). The final pathway to humans for mercury exposure is through the eating of fish with methylmercury stored in their flesh. About 0.3 percent of the total mercury emitted from a point source is deposited in lakes and streams to form a methylmercury compound (Porcella 1994).

Gaseous elemental mercury is a relatively non-reactive chemical form that is not very soluble in water. This form of mercury travels the farthest and can be transported on wind currents for months to years if not oxidized, providing an opportunity for global transport and dispersion. Concentrations of mercury in the air are usually low and of little direct concern. However, atmospheric mercury falls to earth through rain or snow and enters lakes, rivers, and estuaries. Once there, it can transform to its most toxic form, methylmercury, and accumulate in fish and animal tissues.

Mercury accumulates most efficiently in aquatic species. Predatory species at the top of the aquatic food chain generally have higher mercury concentrations. Nearly all of the mercury that accumulates in fish tissue is methylmercury. Inorganic mercury, which is less efficiently absorbed and more readily eliminated from the body than methylmercury, does not tend to bio-accumulate.

Oxidized or reactive gaseous mercury has an average atmospheric residence time of days to weeks (less in the presence of precipitation or bromine compounds often present in saline water bodies). It is not easily volatilized and is very water-soluble. It is easily taken up in precipitation or adsorbed on small particles in the atmosphere and falls out as wet or dry deposition. This form of mercury has a higher potential to enter the food chain and result in concerns related to fish and waterfowl consumption.

Particulate mercury has an average atmospheric residence time of hours to days (depending on the presence or absence of precipitation and the particle size). It has low volatility and is easily taken up in precipitation or adsorbed on small particles, falling out relatively close to the emission source in the presence of precipitation, or as dry deposition that may be transported for longer distances if associated with very small particle sizes. Particle-bound mercury is relatively stable and is not easily converted to $CH_3Hg^+$ (USEPA 1997).

Local Mercury

When bound in mineral forms that typically appear in ore (e.g., cinnabar), mercury is a stable compound that remains in solid form. Ore processing has the potential to liberate mercury from these stable minerals by dissolving it in process solutions. Because it has a boiling point of 675°F, mercury has the potential to volatilize into a gaseous form when subjected to thermal processes in a recovery and refining circuit.

## 3.11.2 Environmental Consequences

Issues related to air quality include potential impacts associated with project-generated air emissions.

### 3.11.2.1 Regulatory Framework and Associated Impacts

Ambient air quality and the emission of air pollutants are regulated under both federal and State of Nevada laws and regulations as discussed below.

Federal Clean Air Act

The Federal Clean Air Act (CAA), and the subsequent Federal Clean Air Act Amendments of 1990 (CAAA), require the USEPA to identify NAAQS to protect public health and welfare. The CAA and the CAAA established NAAQS for seven pollutants, known as “criteria” pollutants. The ambient standards set for these pollutants satisfy “criteria” specified in the CAA. A list of the criteria pollutants regulated under the CAA and their currently applicable NAAQS set by the USEPA are listed in **Table 3.11-3**.

In addition to the designations relative to conforming with the NAAQS, the CAA requires the USEPA to place selected areas within the U.S. into one of three classes, which are designed to limit the deterioration of air quality when it is “better than” the NAAQS. Class I is the most restrictive air quality category. It was created by Congress to prevent further deterioration of air quality in national parks and wilderness areas of a given size, which were in existence prior to 1977, or those additional areas that have since been designated Class I under

federal regulations (40 CFR 52.21). All remaining selected areas outside of the designated Class I boundaries were designated Class II areas, which allow a relatively greater deterioration of air quality, although still below NAAQS. No Class III areas have been designated.

Federal Prevention of Significant Deterioration (PSD) regulations limit the maximum allowable increase in ambient particulate matter in a Class I area resulting from a major or minor kind of stationary source to 4 $\mu g/m^3$ (annual geometric mean) and 8 $\mu g/m^3$ (24-hour average). Increases in other criteria pollutants are similarly limited. Specific types of facilities (listed facilities) that emit, or have the potential to emit, 100 tpy or more of total PM, $PM_{10}$, or other criteria air pollutants, or any facility that emits, or has the potential to emit, 250 tpy or more of total PM, $PM_{10}$, or other criteria air pollutants, are considered major stationary sources. Major stationary sources are required to notify federal land managers of Class I areas, which may be affected by the emissions from the source within 100 km (62 miles) of the major stationary source. There are no Class I areas within 100 km of the study area. The nearest Class I planning area to the study area, the Jarbidge Wilderness, is located approximately 190 km (118 miles) northeast of the study area.

Emissions of $PM_{2.5}$ for mining sources are considered a fraction of $PM_{10}$ emissions. $PM_{2.5}$ impacts to local air quality are not modeled due to secondary formation of fine particulates.

The PSD increments are triggered for a planning area when a PSD application for a major source or modification affecting that planning area has been deemed complete by the regulatory authority (40 CFR 52.21[b][14]). The closest triggered planning area (Air Pollution Control Region 61L) is located to the south of the project boundary. The planning area in which the proposed project would be located has not been triggered for any pollutant. New Source Performance Standards (NSPSs), also required under the CAA, are set by the USEPA for specific types of new or modified stationary sources. NSPSs set fixed emission limits for classes of sources to prevent deterioration of air quality from the construction of new sources and to reduce control costs by building pollution controls into the initial design of sources. Certain project components used to process metallic minerals are subject to the NSPSs found in 40 CFR Part 60, Subpart LL (Standards of Performance for Metallic Mineral Processing Plants).

The CAAA introduced a new facility-wide permitting program known as the Federal Operating Permit, or "Title V," program. The program requires facilities with the potential to emit more than 100 tpy of any regulated pollutant (excluding PM), 10 tpy of any single HAP, or 25 tpy or more of any combination of HAPs, to submit a Federal Operating Permit application. The Goldstrike Mine currently has a Title V Federal Operating Permit.

The CAA directs the USEPA to delegate primary responsibility for air pollution control to state governments, which comply with certain minimum requirements. State governments, in turn, sometimes delegate this responsibility to local or regional governmental organizations. The State Implementation Plan (SIP) was originally the mechanism by which a state set emission limits and allocated pollution control responsibility to meet the NAAQS. The function of a SIP broadened after passage of the CAAA and now includes the implementation of specific technology-based emission standards, permitting of sources, collection of fees, coordination of air quality planning, and prevention of significant deterioration of air quality within regional planning areas and statewide. Section 176 of the CAA, as amended, requires that federal agencies must not engage in, approve, or support in any way any action that does not conform to a SIP for the purpose of attaining AAQS (USEPA 2008).

Nevada State Air Quality Program

The BAPC is the agency in the State of Nevada that has been delegated the responsibility for implementing a SIP (excluding Washoe and Clark counties, which have their own SIP). Included in the SIP are the State of Nevada air quality permit programs (NAC 445B.001 through 445B.3497, inclusive). The Nevada AAQS also are part of the SIP. The Nevada AAQS generally are identical to the NAAQS. In addition to establishing the Nevada AAQS, the BAPC is responsible for permit and enforcement activities throughout the State of Nevada.

The BAPC permitting program implements the Title V Federal Operating Permit program, as well as the minor source permitting program for facilities that emit less than 100 tpy of all criteria pollutants and are not a major source of HAPs. The Goldstrike Mine's current operations are regulated by air quality operating permit AP1041-0739.01.

Under its broad statutory authority to regulate air pollution, BAPC also has implemented a mercury control program that applies to all emission units located at precious metals mines that use direct or indirect thermal energy. This program is unique to the state of Nevada and is codified at NAC 445B.3611 to NAC 445B.3689. The program's goal is to ensure that all non-de minimis thermal emission units are controlled to provide the maximum degree of reduction of mercury emissions in accordance with factors enumerated in the rule.

#### 3.11.2.2 No Action Alternative

Under the No Action Alternative, the proposed Betze Pit Expansion Project would not be developed, and the associated air quality impacts would not occur. However, under this alternative, the existing Goldstrike Mine would continue to operate under current authorizations.

An analysis of potential air quality impacts associated with the existing operation was presented in the Betze Project EIS (BLM 1991a,b), and updates are addressed in the recent air permit application submitted to NDEP (BGMI 2007g). Based on these analyses, the modeled concentrations of criteria pollutants are a fraction of the applicable ambient air quality standards.

The Goldstrike Mine currently operates under Class I Air Quality Operating Permit No. 1041-0739.01, issued by NDEP. Emissions from mining include criteria air pollutants such as $PM_{10}$, gaseous emissions (nitrogen oxides [$NO_X$], $SO_2$, and CO), and metal HAPs such as mercury. Background emission sources include traffic on unpaved roads, windblown dust, agricultural activities, and emissions from existing and future power generation facilities. The Goldstrike operations are a source of gaseous air pollutants including $SO_2$, CO, $NO_x$, and volatile organic compounds (VOCs). The Goldstrike Mine is a major source (potential to emit greater than 100 tpy) of $PM_{10}$, $NO_x$, $SO_2$, and CO.

These permits establish air emission levels to meet air quality standards that are protective of human health and the environment. Air quality in the vicinity of the proposed expansion would continue to be better than the NAAQS. Project emissions associated with the proposed expansion would not adversely affect air quality or visibility in any Class I areas.

Trace metal emissions are generated from the mine and processing facilities. Air pollution control technology and work practices are employed in the processing facilities and operations having the potential to generate air emissions. Fugitive dust emissions are controlled using best practical methods as specified in the applicable fugitive dust control plan. Emissions from process sources are controlled in accordance with the requirements of the air quality operating permit issued by the Nevada BAPC. Such requirements include compliance with specified operating and emission limitations and the operation of emission control systems. Additionally, mercury emissions from process sources are controlled in accordance with Nevada's voluntary and regulatory Mercury Control Programs, which require testing, monitoring, recordkeeping, reporting, and the installation and operation of state-of-the-art controls.

<u>$CO_2$ Emissions</u>

Combustion of biomass and all fossil fuels (coal, petroleum, and natural gas) result in emissions of carbon dioxide ($CO_2$), a greenhouse gas (GHG). Mining operations at the Goldstrike Mine involve combustion of coal, diesel, propane, and gasoline, all of which contribute relatively small amounts of $CO_2$ to the atmosphere. In Nevada, the total $CO_2$ emissions from all combustion sources are approximately 48 million metric tons. Industrial sources account for approximately 2.5 million metric tons and, thus, represent approximately 4 percent of the state's emissions of $CO_2$. Since mining is only a fraction of the total industrial sources within

the state, and Goldstrike is one of many mines, it is clear that combustion sources at the Goldstrike Mine represent a small fraction (much less than 1 percent) of the total $CO_2$ emissions from sources within Nevada. Additional information regarding GHG emissions and estimated fuel and electrical power consumption for the alternatives is presented in section 3.15, Energy Requirements.

Mercury Emissions

**Table 3.11-4** describes the Toxic Release Inventory (TRI) for mercury from 1998 through 2006. **Table 3.11-5** summarizes the unit-specific annual mercury emissions reported to BAPC by the Goldstrike Mine for 2006, and provides an estimate of the emissions of each species of mercury based on 2006 speciation testing conducted at the mine.

Under the Nevada Mercury Air Emissions Control Program (NMCP) Nevada Regulation 445B NAC, the Goldstrike Mine is required to equip mercury sources at the existing operation with the Nevada maximum achievable control technology (NvMACT). For Goldstrike mining operations, the Nevada BAPC requires that the technologies to control mercury emissions listed in **Table 3.11-6** be operated until such time as additional or different controls are required by NvMACT.

As described in the No Action Alternative (Chapter 2.0), BGMI transports all ore generated from Goldstrike Mine operations to the existing ore processing facility. BGMI has developed a detailed air toxics inventory for this facility using stack test results, emissions factors, actual processing rates, and hours of operation to estimate actual mercury emissions. Based on BGMI's TRI, total airborne process emissions of mercury from the mine were estimated to be 617 pounds in 2006 (NDEP 2006).

Mercury is included on the federal list of HAPs, which has been adopted by reference in the Nevada air quality regulations. Nevada air quality regulations (NAC 445B.349) prohibit the *"discharge into the atmosphere from any stationary source of any hazardous air pollutant or toxic regulated air pollutant that threatens the health and safety of the general public, as determined by the director."* The USEPA has not established a National Emission Standard for Hazardous Air Pollutants for mercury emissions from gold ore processing facilities. Mercury is not considered a primary pollutant, and no NAAQS have been established under the CAA for mercury.

Mercury Deposition

Relative contributions of mercury deposition from Nevada gold mining operations and other local, regional, and global sources to watersheds located in Nevada are based on USEPA computer simulation modeling using the Regional Modeling System for Aerosols and Deposition (REMSAD). REMSAD results are used to quantify contributions of specific sources and source categories to mercury deposition within each of the lower 48 states (USEPA 2006).

The REMSAD model is designed to calculate the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect the pollutants. The model is designed to simulate the chemical transfer of mercury mass from one form (particulate [$Hg_p$], divalent gaseous [$Hg^2$], and elemental [$Hg^0$]) to another. REMSAD simulates both wet and dry deposition of mercury. Wet deposition occurs as a result of precipitation scavenging. Dry deposition is calculated for each mercury species based on land use characteristics and meteorological parameters. REMSAD also includes re-emission of previously deposited mercury (originating from anthropogenic and natural sources) into the atmosphere from land and water surfaces.

The USEPA REMSAD modeling domain encompassed the continental U.S. and portions of Canada and Mexico, with a 12-km horizontal grid resolution over the entire U.S. portion of the domain. The model utilized 2001 meteorological data files with a 36-km horizontal resolution.

**Table 3.11-4 Reported Annual Mercury Emissions for the Goldstrike Mine from the TRI and Nevada Mercury Control Program**

| TRI Facility Report Year | Mercury Emissions (lbs/year) |
|---|---|
| 1998 | 1,515 |
| 1999 | 1,411 |
| 2000 | 1,514 |
| 2001 | 1,324 |
| 2002 | 1,299 |
| 2003 | 1,452 |
| 2004 | 2,205 |
| 2005 | 1,701 |
| 2006 | 617 |

Source: Environmental Management Associates, Inc. (EMA) 2006.

**Table 3.11-5 Goldstrike Mine 2006 Reported Mercury Emissions and Speciation Estimates**

| Source Description | $Hg^0$ (lb/yr) | $Hg^2$ (lb/yr) | $Hg_p$ (lb/yr) | Total Hg (lb/yr) |
|---|---|---|---|---|
| Autoclave 1 | 9.9 | 0.5 | 0.2 | 10.7 |
| Autoclaves 2 & 3 | 19.6 | 6.5 | 1.9 | 28 |
| Autoclave 4 | 11.3 | 1.2 | 2.0 | 14.5 |
| Autoclaves 5 & 6 | 20.5 | 8.3 | 2.1 | 30.8 |
| Roasters 1 & 2 | 211.0 | 22.2 | 0.8 | 234.1 |
| Retort 1 | 0.7 | 0.4 | 0.0 | 1.13 |
| Retort 2 | 1.1 | 0.0 | 0.0 | 1.13 |
| Retort 3 | 0.5 | 0.4 | 0.2 | 1.13 |
| Mill Furnaces & Electrowinning Cells | 9.1 | 0.1 | 0.0 | 9.2 |
| Electrowinning Cells only | 20.4 | 0.2 | 0.3 | 20.8 |
| Carbon Kiln | 244.0 | 3.8 | 0.4 | 248.3 |
| Lab Assay Furnaces | 7.0 | 5.2 | 4.1 | 16.3 |
| De Minimis Lab Equipment | 0.3 | 0.2 | 0.2 | 0.66 |
| **Facility Total** | **555.4** | **49.0** | **12.2** | **616.8** |

Note: $Hg^0$ is elemental, $Hg^2$ is reactive/oxidized, $Hg_p$ is particulate.

Source: NDEP 2006.

**Table 3.11-6 Mercury Controls on Thermal Processes at the Goldstrike Mine**

| | |
|---|---|
| Autoclave 1 | Wet venturi scrubbers |
| Autoclaves 2 & 3 | Wet venturi scrubbers |
| Autoclave 4 | Wet venturi scrubbers |
| Autoclaves 5 & 6 | Wet venturi scrubbers |
| Roasters 1 & 2 | Gas quenching, wet gas condenser, wet electrostatic precipitator, mercury adsorption tower |
| Retort 1, 2, and 3 | Mercury condensers and scrubbers with carbon filtration canisters |
| Mill Furnaces & Electrowinning Cells | Cyclone and baghouse, sulfur-impregnated carbon filtration scrubber unit |
| Electrowinning Cells only | Sulfur-impregnated carbon filtration scrubber unit |
| Carbon Kiln | Wet venturi scrubber, sulfur-impregnated carbon filtration unit |

Source: BGMI 2007a.

The AggreGATOR program was developed as a tool for overlaying the model output grid from the USEPA REMSAD modeling to any polygon of interest (e.g., a hydrologic boundary or state boundary). The AggreGATOR program allows the results from the USEPA REMSAD modeling to be analyzed in a customized fashion to assess mercury deposition contributions from specific sources and categories of sources at specified areas, such as watersheds, within the model domain. This analysis is based on the 2007 versions of the USEPA REMSAD modeling and AggreGATOR program. The combination of these two data tools provides the best information currently available for modeled mercury deposition rates to watersheds in this region.

The AggreGATOR program incorporates the REMSAD 12-km grid cell output data and aggregates this data so that it can be viewed for an entire watershed or state. The watersheds defined by the AggreGATOR for Nevada typically include 30 to 60 REMSAD grid cells. The AggreGATOR program allows the user to specify:

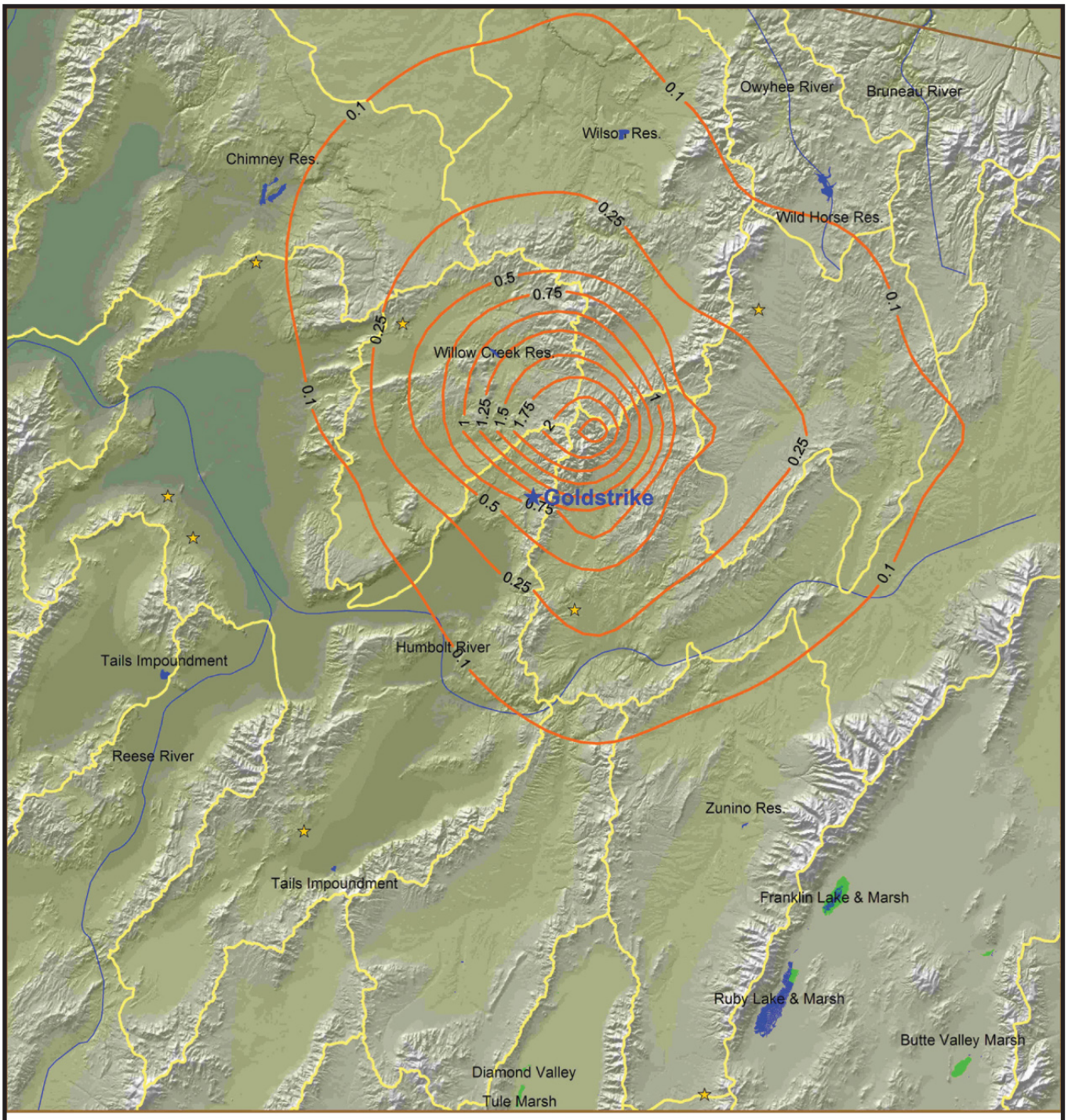
1. The target area (watershed, group of watersheds, entire state, etc.);

2. The source or group of sources for the denominator (usually all the sources including global background are selected); and

3. The source or group of sources for the numerator.

The AggreGATOR program calculates the relative percentage of deposition from the source(s) selected for the numerator to the deposition from the source(s) selected for the denominator within the target area. The USEPA REMSAD modeling and AggreGATOR program results on mercury deposition from Goldstrike Mine operations were presented in Lewis (2007, 2008) and are summarized below.

Database tables within the USEPA AggreGATOR model were accessed to obtain numerical values of Hg deposition based on a 12-km grid cells from the REMSAD model. These data were then analyzed to show isopleths of the annual deposition rates of mercury from Goldstrike's mercury emissions. These isopleths are provided in **Figure 3.11.3**, along with local water bodies, marshes, and major rivers. The maximum deposition from the Goldstrike Mine occurs at the 12-km grid cell immediately northeast of the grid cell containing the Goldstrike Mine (**Figure 3.11-3**). This may be the result of how the model handles plume rise. The plume appears to be carried by winds from the southwest to the next (northeast) grid cell before the model distributes the mercury concentration from the plume across this grid cell (Lewis 2008). **Figure 3.11-3** shows mercury deposition rates decreasing to 0.1 g/km$^2$-yr at a distance of 30 to 100 km. The statewide average global




## Legend

- Goldstrike Mine
- Other Gold Mines
- Hg Deposition (g/km g/km$^2$/yr)
- Lakes, Reservoirs, and Major Rivers
- Wetlands and Marshes

Source: Lewis 2008.

Note: Nevada state-wide global background average deposition is 11.1 g/km2-yr.

N

0 25,000 50,000 Meters

**Betze Pit Expansion Project**

Figure 3.11-3

Mercury Deposition from the Goldstrike Mine

08/05/08

background deposition is 11.1 g/km$^2$-yr as used by the AggreGATOR program, so 0.1 g/km$^2$-yr represents about 1 percent of the global background deposition.

The USEPA REMSAD modeling analyzed all three forms of mercury. The total mercury emissions modeled for the Goldstrike Mine (588 pounds) consisted of 90 percent $Hg^0$ and 10 percent $Hg^2$ and $Hg_p$. These percentages are consistent with Goldstrike's 2006 mercury emissions profile. Emissions of $Hg^2$ and $Hg_p$ are the primary contributors to near-field deposition (Lewis 2008). The fraction of the total mercury emissions does not contribute significantly to near-field mercury deposition.

The Goldstrike Mine's contribution to the mercury deposition in the Willow Creek Reservoir region, approximately 32 km northwest of the Goldstrike Mine, is approximately 1.0 to 1.25 g/km$^2$-yr, or about 10 percent of the total deposition according to the USEPA model (**Figure 3.11-3**). The Wildhorse Reservoir area, approximately 90 km northeast of the Goldstrike Mine, receives less than 0.1 g/km$^2$-year of mercury deposition from the mine, or less than 0.8 percent of the total deposition.

#### 3.11.2.3 Proposed Action

Criteria Pollutant Emissions

Gaseous pollutant emissions associated with the Proposed Action would result from blasting, construction and mining equipment, and vehicle exhaust. These emissions would be minimized by proper equipment maintenance and operation. BGMI would obtain required air quality construction and operating permits from the Nevada BAPC.

Fugitive dust emissions would be generated by expansion of the pit, construction of a waste rock facility and tailings facility, including in-pit and perimeter haul roads and access roads, mining, processing, hauling, stockpiling ore, and disposal of waste rock. Particulate emissions would be mitigated by minimization of drop heights during loading, dust suppression, and procedures outlined in the Barrick Goldstrike Fugitive Dust Control Plan (BGMI 2007h).

The proposed expansion would utilize the existing primary facilities, including ore processing facilities and ancillary support facilities. If approved, the anticipated mine life would be extended approximately 4 years through 2015, followed by an estimated 16 years for ongoing ore processing.

The proposed expansion would extend the operations of the roaster facility by 5 years at its design rate. The pit expansion would not increase the existing levels of production, design capacity, or emission limits, and therefore is not anticipated to increase the emission rates of particulate matter, gaseous materials, or trace metals associated with mineral processing. Particulate emissions comprise the principal impacts to air quality and are primarily associated with mining, transport, and crushing operations. The proposed expansion would extend the period of emissions from mine operations by 5 years.

Mercury Emissions

Ore from the expansion project would be processed at BGMI's existing processing facility, which will continue to operate at existing levels of production, design capacity, etc. Mercury levels in the ore from the expansion project are about the same or less than levels in the previously mined areas. The levels range from about 1 ppm to 5 ppm in the expansion area and from 1 ppm to 10 ppm in the previously authorized mine areas (BGMI 2008a). Based on the 12.4 million tons of ore from the proposed laybacks and similarity in mercury content of the ore from previously mined areas, an estimated total emissions of 625 pounds of mercury would result from 5 years of mineral processing. Therefore, it is not anticipated to increase mercury emission rates. Although emissions will extend over a longer period of time, based on the implementation schedule of the NMCP, process mercury emissions are expected to decrease over that period.

Maximum potential hourly emissions would not increase due to processing of ore, and there would be no projected increases in total annual mercury emissions from the facility. The Proposed Action would result in an extension of operations from the roaster by 5 years with corresponding extension of emissions by 5 years.

HAPs

No individual HAP (including mercury) would be emitted in a quantity greater than the major source limit of 10 tpy, and the combination of HAP emissions would be less than the major source limit of 25 tpy. Therefore, the proposed project would not constitute a major HAP source. The 2006 inventory of HAP emissions for the Goldstrike Mine is listed in **Table 3.11-7**.

#### 3.11.2.4 Bazza Waste Rock Facility Alternative

Under this alternative, the existing Bazza Waste Rock Facility would be expanded vertically and the Clydesdale Waste Rock Facility and haul road would not be constructed. Placement of waste rock in the Bazza facility would result in increased haul distances. All other project facilities would be the same as described under the Proposed Action.

Potential air quality impacts under this alternative would be the same as described for under the Proposed Action with the following exception. The Bazza Waste Rock Facility Alternative would result in additional fugitive dust and haul truck combustion emissions compared to the Proposed Action as a result of the greater haul distance under this alternative. The average total round trip for a haul truck from the Betze Pit to the Bazza Waste Rock Facility is approximately 1.3 miles longer than the roundtrip haul distance from the pit to the proposed Clydesdale Waste Rock Facility. This alternative would result in an additional 58,850 haul truck operating hours and combustion of an additional 5.3 million gallons of fuel over the life of the project, resulting in additional emissions of CO, $SO_2$, $NO_2$, carbon, and other compounds.

### 3.11.3 Cumulative Impacts

The CESA for air resources is shown in **Figure 3.11-1**. Past and present actions and RFFAs are identified in Section 3.1.

Cumulative impacts to air quality would include impacts from the proposed project emission sources in combination with impacts from background emission sources, which reflect emissions associated with the past and present actions, as well as proposed future actions.

#### 3.11.3.1 No Action Alternative

Fugitive Dust and Gaseous Emissions

Fugitive dust and gaseous emissions from nearby mine operations affect air quality in the project area. The existing operations at the Goldstrike Mine will have haul truck traffic as well as extended operation of processing facilities as currently authorized. Ambient air quality data for the region currently reflects impacts of existing mining operations in the airshed. Air quality in the region meets applicable standards and would be expected to remain in compliance under existing Goldstrike operations. Approximately 928 pounds of mercury and mercury compounds were reportedly released annually to the air by mining operations in the Carlin Trend (NDEP 2006). An air quality modeling analysis was conducted for the Leeville SEIS (BLM 2007b) to study potential cumulative effects for other active projects in the region. A summary of the sources of emissions that were included in the modeling are presented in **Table 3.11-8**. The modeling analysis confirmed that there would be no impact to the nearest Class I area, Jarbidge Wilderness.

**Table 3.11-7 HAP Emissions for the Goldstrike Mine**

| Pollutant | Total Emissions (tpy)[1] |
|---|---|
| Arsenic | 0.16 |
| Beryllium | 0.00 |
| Cadmium | 0.01 |
| Cobalt | 0.00 |
| Chromium | 0.03 |
| Mercury | 0.31 |
| Manganese | 0.08 |
| Nickel | 0.02 |
| Phosphorous | 0.00 |
| Lead | 0.04 |
| Antimony | 0.00 |
| Selenium | 0.02 |
| VOC HAPs | |
| 1,3-Butadiene | 0.02 |
| 2,4-Dinitrotoluene | 0.00 |
| 2-Chloroacetophenone | 0.00 |
| Acetaldehyde | 0.23 |
| Acetophenone | 0.00 |
| Acrolein | 0.01 |
| Benzene | 2.24 |
| Benzyl chloride | 0.03 |
| Biphenyl | 0.00 |
| Bis(2-ethylhexyl)phthalate | 0.00 |
| Bromoform | 0.00 |
| Carbon disulfide | 0.01 |
| Chlorobenzene | 0.00 |
| Chloroform | 0.00 |
| Cumene | 0.00 |
| Dimethyl sulfate | 0.00 |
| Dioxins | 0.00 |
| Ethyl benzene | 0.08 |
| Ethyl chloride | 0.00 |
| Ethylene dibromide | 0.00 |

| Pollutant | Total Emissions (tpy) |
|---|---|
| Ethylene dichloride | 0.00 |
| Ethylene glycol | 0.00 |
| Formaldehyde | 0.07 |
| Hexane | 1.57 |
| Isophorone | 0.02 |
| Methyl bromide | 0.01 |
| Methyl chloride | 0.02 |
| Methyl chloroform | 0.00 |
| Methyl ethyl ketone | 0.02 |
| Methyl hydrazine | 0.01 |
| Methyl isobutyl ketone | 0.00 |
| Methyl methacrylate | 0.00 |
| Methyl tert butyl ether | 0.87 |
| Methylene chloride (Dichloromethane) | 0.01 |
| Naphthalene | 0.04 |
| Phenol | 0.00 |
| POM | 0.00 |
| Propionaldehyde | 0.02 |
| Styrene | 0.00 |
| Tetrachloroethylene | 0.00 |
| Toluene | 0.62 |
| Vinyl acetate | 0.00 |
| Xylenes (mixture) | 0.38 |
| Non-Metallic Inorganic HAPs | |
| Hydrogen cyanide | 0.95 |
| Hydrochloric acid | 0.03 |
| Hydrogen fluoride | 0.00 |
| Cyanide compounds (excluding HCN) | 0.00 |
| Chlorine | 0.01 |
| Total HAP[2] Emissions | 7.96 |

[1]tpy = tons per year.

[2]HAP = Hazardous air pollutants.

Source: BGMI 2007a.

**Table 3.11-8 Summary of Emission Sources Included in Leeville Air Quality Modeling**

| Facility | Number of Model Sources | Emissions of $PM_{10}$ (t/y) | Emissions of CO (t/y) | Emissions of $NO_x$ (t/y) | Emissions of $SO_2$ (t/y) |
|---|---|---|---|---|---|
| SOAPA | 84 | 568 | 337 | 354 | 276 |
| Leeville | 7 | 0.5 | 0 | 0 | 0 |
| North Operations Area without Leeville | 40 | 93.8 | 0 | 0 | 0 |
| Goldstrike | 179 | 579 | 400 | 311 | 996 |
| TS Power Plant | 28 | 598 | 744 | 1,170 | 1,546 |
| **Total** | **338** | **1,840** | **1,480** | **1,835** | **2,818** |

Source: EMA 2006.

According to the cumulative air quality analysis performed for the Leeville SEIS, modeling of emission sources at the Goldstrike Mine predicted maximum cumulative annual $PM_{10}$ effects of 10.62 µg/m$^3$ and maximum 24-hour $PM_{10}$ impacts of 16.65 µg/m$^3$. Predicted $PM_{10}$ impacts represent 21 percent of the annual Nevada $PM_{10}$ ambient air quality standard of 50 µg/m$^3$ and 11 percent of the 24-hour $PM_{10}$ ambient air quality standard of 150 µg/m$^3$. Predicted air quality impacts from the Goldstrike Mine indicate that cumulative $PM_{10}$ air impacts would be below applicable criteria in the CESA.

The air quality dispersion modeling study for Goldstrike operations included predicted impacts of gaseous criteria air pollutants $SO_2$, $NO_2$, and CO. This modeling was completed in 2006 (EMA 2006). The dispersion modeling analysis predicted the following maximum cumulative effects:

- 3-hour $SO_2$: 13.03 µg/m$^3$ (ambient air quality standard = 1,300 µg/m$^3$)
- 24-hour $SO_2$: 2.94 µg/m$^3$ (ambient air quality standard = 365 µg/m$^3$)
- Annual $SO_2$: 0.4 µg/m$^3$ (ambient air quality standard = 80 µg/m$^3$)
- Annual $NO_2$: 0.83 µg/m$^3$ (ambient air quality standard = 100 µg/m$^3$)
- 1-hour CO: 216.49 µg/m$^3$ (ambient air quality standard = 40,000 µg/m$^3$)
- 8-hour CO: 38.25 µg/m$^3$ (ambient air quality standard = 10,000 µg/m$^3$)

Background concentrations were not added to these impacts in the analysis, in part because the impacts were low and due to the lack of gaseous air pollutant monitoring data. By applying the ambient air quality standard as significance criteria, it is reasonable to assume that the predicted $SO_2$, $NO_2$, and CO air quality impacts from the Goldstrike operations dispersion modeling demonstrate no significant effects in the CESA (BLM 2007b).

Mercury

Mercury deposition rate data have been collected from two wet deposition monitoring sites in northern Nevada that are part of a national Mercury Deposition Network. These sites are outside of the study area, but they are the nearest source of cumulative mercury monitoring data. The monitoring data presented here (**Table 3.11-9)**, represent cumulative effects from a wider area of influence than the study area, but the data are believed to be

**Table 3.11-9 Cumulative Mercury Monitoring Data**

| Sampling Site | Annual Total Mercury Wet Deposition ($g/km^2$) | |
|---|---|---|
| | 2003 | 2005 |
| Lesperance Ranch NV02 | 30 | 26 |
| Gibbs Ranch NV99 | 43 | 40 |

representative of the trend in environmental impacts from atmospheric releases of mercury involving sources in the study area. The Lesperance Ranch site (NV02) is located approximately 85 miles northwest of the study area, and the Gibbs Ranch site (NV99) is located approximately 73 miles northeast of the study area. These sites began collecting mercury wet deposition data in early 2003, and data are available through 2005. Measured wet deposition for the Mercury Deposition Network sites in northeastern Nevada decreased slightly from 2003 to 2005. Mercury wet deposition at the Lesperance Ranch site decreased by 11 percent from an annual total mercury wet deposition of 30 grams per square kilometer ($g/km^2$) in 2003 to 26 $g/km^2$ in 2005. At the Gibbs Ranch monitoring site, annual mercury wet deposition decreased by 7 percent from a value of 43 $g/km^2$ in 2003 to 40 $g/km^2$ in 2005. Mercury wet deposition decreased from 2003 to 2004, despite a 107 percent increase in precipitation.

According to Lewis (2007), the global background is by far the largest contributor to the state-wide deposition for the USEPA Region 9 states: California, Nevada, and Arizona. The global background contribution percentages for these states as calculated by the AggreGATOR program are provided in **Table 3.11-10**.

**Table 3.11-10 State-Wide Global Background Deposition**

| State | Global Hg Deposition Contribution | Global Hg Deposition ($g/km^2$) |
|---|---|---|
| California | 82.3% | 11.1 |
| Nevada | 92.5% | 11.1 |
| Arizona | 92.4% | 15.4 |

Source: Lewis 2007.

The results from the USEPA REMSAD modeling and AggreGATOR program provide an estimate of the mercury deposition impacts from the Nevada gold mines and global background to Nevada watersheds. **Table 3.11-11** summarizes these impacts for the watersheds on the Nevada-Idaho and Nevada-Utah borders.

The mercury deposition impacts from the Nevada gold mines at the watersheds bordering Nevada with Idaho and Utah are between 0.06 and 6.35 percent of the total impact. The mercury deposition impacts from the Goldstrike Mine range from 0.01 to 2.47 percent at watersheds bordering Nevada with Idaho and Utah.

**Figure 3.11-4** provides the mercury deposition contributions from the Goldstrike Mine's mercury emissions as a percentage of the total deposition (including global background) for each watershed in Nevada. The mercury deposition from the Goldstrike Mine drops off to less than 1 percent at two watersheds distance from the mine, indicating that the deposition of mercury from mines occurs locally.

**Table 3.11-11 Mercury Deposition on Border Watersheds**

| Watershed | Goldstrike Mine Hg Deposition Contribution | All Nevada Gold Mines Hg Deposition Contribution | Global Background Hg Deposition Contribution |
|---|---|---|---|
| **Nevada-Idaho (from west to east)** | | | |
| East Little Owyhee | 0.72% | 3.25% | 92.69% |
| South Fork Owyhee | 2.47% | 6.35% | 89.69% |
| Upper Owyhee | 0.58% | 5.80% | 90.04% |
| Bruneau | 0.46% | 2.77% | 93.05% |
| Salmon Falls Creek | 0.36% | 1.62% | 94.11% |
| Goose Creek | 0.17% | 0.76% | 93.38% |
| **Nevada-Utah (from north to south)** | | | |
| N. Great Salt Lake Desert | 0.12% | 0.51% | 80.91% |
| S. Great Salt Lake Desert | 0.12% | 0.56% | 92.95% |
| Hamlin-Snake Valleys | 0.05% | 0.27% | 94.74% |
| Escalante Desert | 0.01% | 0.07% | 94.26% |
| Lower Virgin | 0.01% | 0.06% | 92.78% |

Source: Lewis 2007.

**Figure 3.11-5** provides the mercury deposition contributions from the global background to each watershed in Nevada. The global background accounts for 66 to 97 percent of the total deposition in each watershed.

### 3.11.3.2 Proposed Action

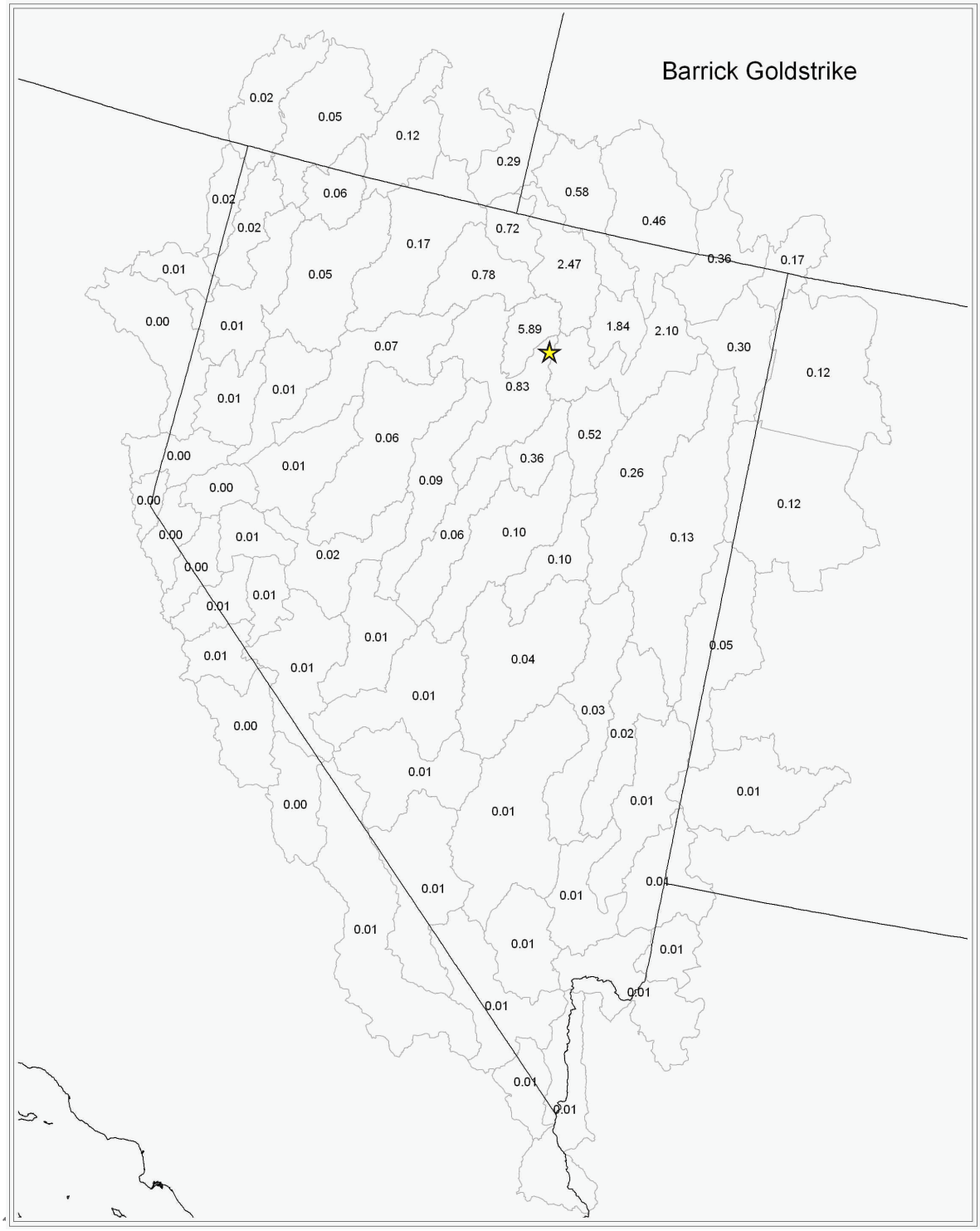
Cumulative impacts to air quality under the Proposed Action would be similar to the impacts described for existing operations (Section 3.11.3.1). Mining and processing activities would extend the timeframe for emissions by 5 years, but annual emission rates would not increase over current activities at the mine site.

### 3.11.3.3 Bazza Waste Rock Facility Alternative

Cumulative effects to air quality under the Bazza Waste Rock Facility Alternative would be similar to the Proposed Action except that there would be an incremental increase in fugitive dust and exhaust emissions due to the longer waste rock haul distances that result in additional operating hours for the haul trucks.

### 3.11.3.4 Mitigation Measures and Monitoring

Air quality emission sources at the Goldstrike Mine would be subject to requirements of federal and Nevada air quality regulations. NDEP Bureau of Air Quality would determine whether air quality construction and operating permits would be required for the proposed action. The air quality permitting process could require that BGMI submit a permit application, including a complete inventory of potential criteria air pollutant emissions from the proposed action. No additional monitoring or mitigation measures have been identified, as no significant impacts to air quality would be anticipated as a result of the proposed action.




**LEGEND**

★ Location of Goldstrike Mine

N

Source: Lewis 2007.

**Betze Pit Expansion Project**

Figure 3.11-4

Goldstrike Mine's Mercury Deposition Contributions as a Percent of Total

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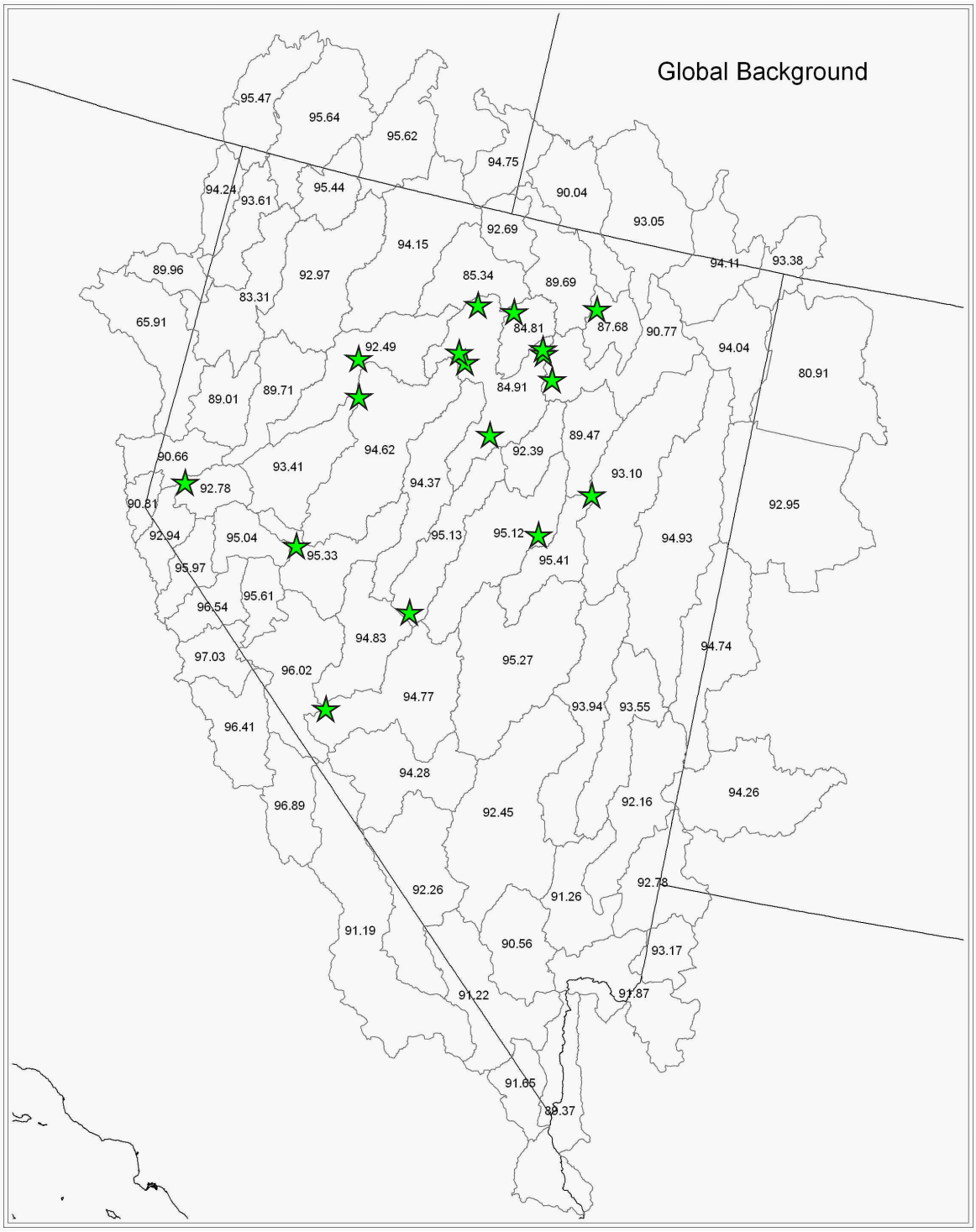



**LEGEND**

Location of Nevada Mines

N

Source: Lewis, 2007.

**Betze Pit Expansion Project**

Figure 3.11-5

Global Background Mercury Deposition Contributions as a Percent of Total

08/05/08

### 3.11.4 Residual Impacts

There would be no residual adverse impacts to air quality from the proposed action or alternatives because reclamation and revegetation would stabilize exposed soil and control fugitive dust emissions. As vegetation becomes established, particulate levels should return to typical conditions of a dry desert environment. Once the disturbance ceases and wind erodible surfaces are reclaimed, the resource would return to approximately its pre-mining condition.

## 3.12 Social and Economic Values

### 3.12.1 Affected Environment

The social and economic values study area for direct and indirect impacts and the CESA includes Elko County and Eureka County with particular focus on the communities of Elko, Carlin, and Spring Creek (**Figure 3.12-1**). The Goldstrike Mine is located in Elko and Eureka counties and generates public revenue for both counties, a substantial majority of the workers, over 95 percent, live in west-central Elko County. Approximately 56 percent live in the City of Elko and vicinity, 32 percent in or near Spring Creek, and 7 percent live in Carlin. Approximately 3 percent of the workers are scattered throughout Nevada, including less than 0.5 percent in Eureka County; and slightly fewer than 2 percent claim primary residences distributed among 8 other nearby states.

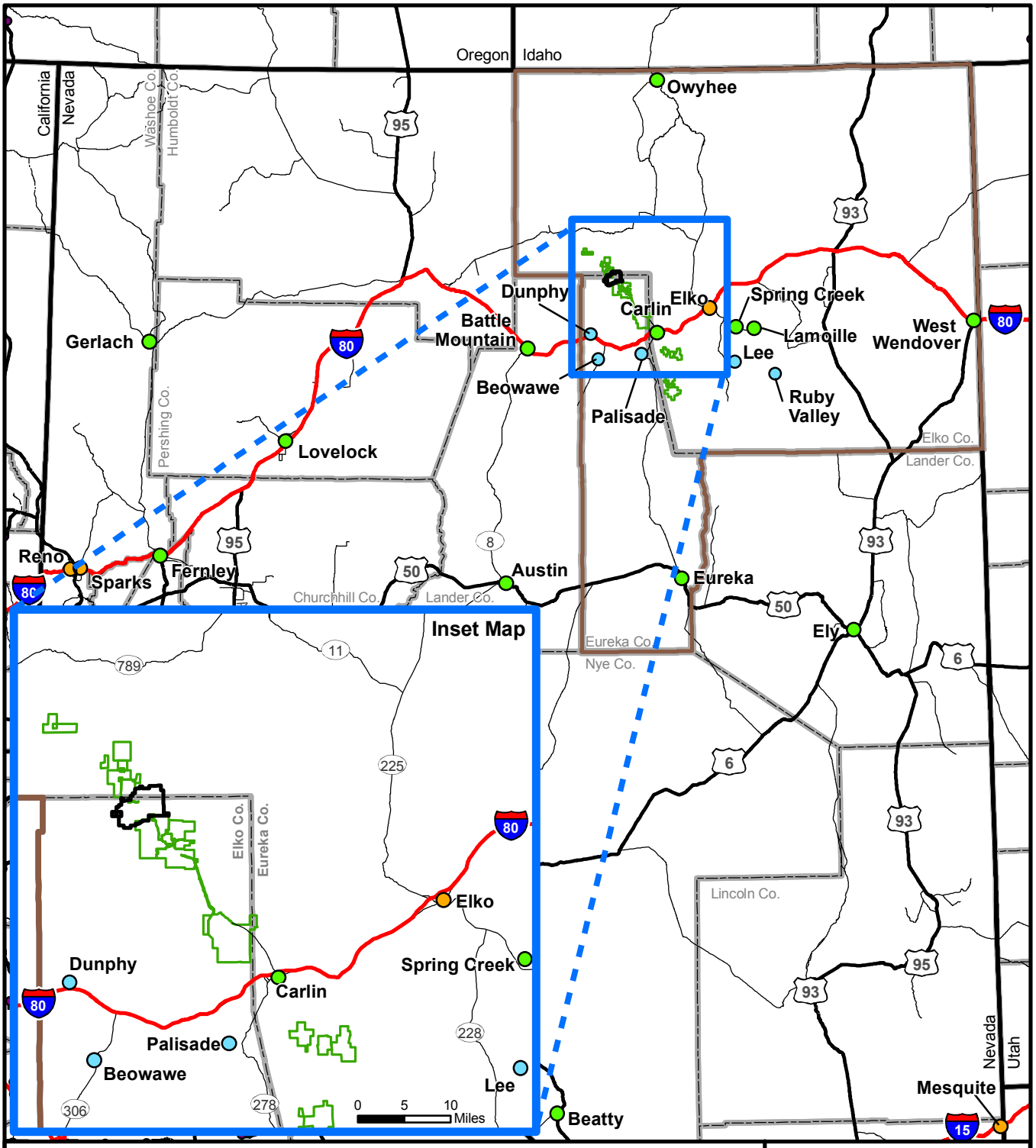
The following social and economic values assessment is focused on issues relevant to the proposed project. Due to the extensive previous analyses in recent years, this report is tiered to studies conducted for the Leeville and SOAPA projects (BLM 2002a,b). It is particularly appropriate to address the potential effects of the No Action Alternative, (e.g., when the existing mine closes, because a substantial reduction in employment and income for the area would likely be the result). Project-related effects are analyzed in the context of the existing regional community and cumulative development activities addressed in the Draft Leeville and SOAPA Cumulative Impact Analyses (BLM 2007b,c) and the Betze Project EIS (BLM 1991a,b) and Betze Project SEIS (BLM 2000a, 2003a).

#### 3.12.1.1 Population and Demography

Elko is the fifth largest county in Nevada, by population, with an estimated 47,114 people in 2006 (Nevada State Demographer 2007). Eureka County, in contrast, is the 16th largest out of the 17 counties with an estimated 1,480 people (Nevada State Demographer 2007). Nevada has been one of the country's fastest growing states in recent years. However, the bulk of the growth has occurred in urbanized areas, particularly southern Nevada. Elko County experienced rapid growth in the 1980s, tapering off in recent years **(Table 3.12-1)**. Eureka County has trailed the state growth rate by a substantial margin for two decades and is estimated to have lost population since 2000. The most dramatic growth in the area has occurred in unincorporated Spring Creek, which is more than five times as large as it was in 1980.

The workforce is distributed due to a combination of mine proximity, housing availability, and public and private services accessibility. Because of the dominance of Elko County as a residence location of choice for BGMI employees, some topics related to residential services in the following discussion focus primarily on Elko County.

Both Elko and Eureka counties are notably less ethnically and racially diverse than the state as a whole. Eureka County, in particular, is over 87 percent white non-Hispanic, compared with nearly 73 percent for Elko County and 61 percent for Nevada. Elko County has less than 1 percent blacks or Asians, but over 20 percent Hispanic, compared with 24 percent Hispanic for the state. Elko County also has a higher percentage of American Indian, Eskimo, or Aleut population with 5.1 percent compared with the state's 1.3 percent (Nevada State Demographer 2006). This is largely attributable to the presence of the Elko Band Colony, one of four colonies that comprise the Te-Moak Tribe of Western Shoshone Indians with headquarters in Elko.




**LEGEND**

- Goldstrike Mine Operations Boundary
- Social and Economic Values Cumulative Effects Study Area
- Mine Plan Boundaries
- Highway
- Road
- County Boundary
- City
- Community
- Rural Post Office

N

0 5 10 20 Miles

Source: BLM 2007a,b.

**Betze Pit Expansion Project**

Figure 3.12-1

Social and Economic Values CESA

07/24/2008

**Table 3.12-1 Population Characteristics**

| Area | 1980 | 1990 | 2000 | 2006 | Annual % Change 1980-1990 | Annual % Change 1990-2000 | Annual % Change 2000-2006 |
|---|---|---|---|---|---|---|---|
| Elko City | 8,771 | 14,736 | 16,708 | 18,183 | 5.3 | 1.3 | 1.4 |
| Spring Creek CDP[1] | 2,002 | 5,866 | 10,548 | n.a. | 11.3 | 6.0 | -- |
| Carlin | 1,233 | 2,220 | 2,161 | 2,281 | 6.1 | (0.3) | 0.9 |
| Elko County | 17,269 | 33,530 | 45,291 | 47,114 | 6.9 | 3.1 | 0.7 |
| Eureka County | 1,198 | 1,550 | 1,651 | 1,480 | 2.6 | 0.6 | (1.1) |
| Nevada | 800,493 | 1,201,833 | 1,998,257 | 2,623,050 | 4.1 | 5.2 | 4.6 |

[1]Census Designated Place.

Sources: Nevada State Demographer 2007; U.S. Census Bureau 2000.

### 3.12.1.2 Income

Mining wages and salaries are among the highest for any industry in Nevada. Median annual wages for all workers in the natural resources and mining industries in Elko County were $47,289 (without overtime) (Nevada Department of Employment, Training & Rehabilitation [NDETR] 2007). This is substantially higher than the median for workers in all industries in Elko County combined, which was $27,164. Eureka County's wage levels are not available disaggregated by industry because of the relatively small total workforce and the dominance of the mining industry in the county's economy.

Although mining wages and salaries are typically higher than average, per capita personal income (PCPI) in the study area continues to lag behind the state level; data from 2000 indicated a state income average of $30,433. Elko County's income average was $24,608 (80.1 percent of the state level), and Eureka County's income average was $23,299 (76.6 percent of the state level). By 2005, Elko County PCPI had risen to $30,127, which was an improvement to 84.3 percent of the state average of $35,744 and 87.4 percent of the national average of $34,471. Eureka County's PCPI rose to $30,052 in 2005, 84.1 percent of the state average and 87.2 percent of the national average. Elko and Eureka counties' PCPI ranked 10th and 11th, respectively, out of 17 counties in the state.

In contrast, median household incomes in the study area are much closer to statewide household incomes. The median household income for the state for 2006 was $59,550, compared with $60,100 for Elko County (100.9 percent of the state level) and $57,500 for Eureka County (96.6 percent of the state level) (NDETR 2007).

An estimated 8.7 percent of Elko County's population and 9.0 percent of Eureka County's population were considered to be living in poverty in 2004 according to Census estimates (U.S. Census Bureau 2006). Both counties' estimates were lower than the statewide rate of 11.1 percent and the national estimate of 12.7 percent. The rates for children and youth under 18 living in poverty also were lower than state and national rates (U.S. Census Bureau 2006).

### 3.12.1.3 Economy and Employment

Elko and Eureka counties are major contributors to Nevada's mining industry. **Table 3.12-2** illustrates a comparison of the two counties' employment by major industry with statewide employment by the same

**Table 3.12-2 Nonagricultural Wage and Salary Employment[1] by Sector**

| | State of Nevada | | Elko County | | Eureka County | |
|---|---|---|---|---|---|---|
| | **Employees** | **%** | **Employees** | **%** | **Employees** | **%** |
| **Goods Producing - Private** | **206,693** | **16.3** | **3,883** | **19.0** | **3,706** | **86.4** |
| Natural Resources & Mining | 13,800 | 1.1 | 2,366 | 11.6 | 3,706 | 86.4 |
| Construction | 142,659 | 11.2 | 1,310 | 6.4 | * | 0.0 |
| Manufacturing | 50,234 | 4.0 | 208 | 1.0 | * | 0.0 |
| **Service Providing - Private** | **916,705** | **72.1** | **12,893** | **63.0** | **100** | **2.3** |
| Trade, Trans., Warehouse & Util. | 225,606 | 17.7 | 3,598 | 17.6 | 52 | 1.2 |
| Information | 15,129 | 1.2 | 191 | 0.9 | * | 0.0 |
| Financial Activities | 65,510 | 5.2 | 521 | 2.5 | * | 0.0 |
| Prof. & Business Services | 157,963 | 12.4 | 920 | 4.5 | * | 0.0 |
| Educational & Health Services | 87,282 | 6.9 | 1,095 | 5.3 | * | 0.0 |
| Leisure & Hospitality | 336,779 | 26.5 | 6,045 | 29.5 | 39 | 0.9 |
| Other Services | 28,436 | 2.2 | 523 | 2.6 | 9 | 0.2 |
| **Unclassified** | **1,369** | **0.1** | **0** | **0.0** | **0** | **0.0** |
| **Subtotal - Private** | **1,124,767** | **88.5** | **16,776** | **81.9** | **4,096** | **95.5** |
| | | | | | | |
| **Service Providing - Public** | **146,433** | **11.5** | **3,690** | **18.0** | **193** | **4.5** |
| Government | 146,433 | 11.5 | 3,690 | 18.0 | 193 | 4.5 |
| **Subtotal - Public** | **146,433** | 11.5 | **3,690** | **18.0** | **193** | **4.5** |
| | | | | | | |
| **TOTAL** | **1,271,200** | 100.0 | **20,478** | **88.4** | **4,289** | **100.0** |

[1]2006 Annual Averages.

* Confidential data, not released.

Source: NDETR 2007.

sectors. The employment numbers are based on work location not residence, which explains why Eureka County has more employees in the natural resources and mining sector than it has residents. Several major mines on the Carlin Trend, including Barrick's Goldstrike Mine, are located in Eureka County. Most workers live in Elko County, however, as noted above. The two counties account for 44 percent of all mining employment in Nevada. Over 86 percent of all employment in Eureka County is mining and natural resource related. Elko County, in contrast, has a substantial casino and hospitality industry and offers a variety of other services, which notably broadens its base of employment.

The Elko County School District is the largest single employer in the county with the next five largest employers all casinos. The top two and three of the top five largest employers in Eureka County are mining companies. BGMI is the second largest employer in Eureka County with slightly over 1,600 employees (NDETR 2007).

The combined labor force in the two counties is currently estimated at 27,400, approximately 26,400 of whom are employed. The remaining 1,000 unemployed individuals represent a 3.5 percent unemployment rate. This level is notably lower than both the 5.0 percent statewide unemployment rate and the national rate, estimated at approximately 4.5 percent (NDETR 2007).

#### 3.12.1.4 Housing

The Census Bureau collected data for the 2000 census, and, although that data is now more than 7 years old, it is the most consistent available (U.S. Census Bureau 2000). The 2000 census found 18,456 housing units in Elko County and 1,025 units in Eureka County. At the time, 15,638 units were occupied in Elko and 2,818 (15.3 percent) were vacant. Some of the vacant units were seasonal, recreational, or for occasional use only. Vacancy rates were at a modest 3.2 percent in homeowner units, but a sizable 16.9 percent in rental units (U.S. Census Bureau 2000). Vacancy rates varied geographically as well as by type. The Spring Creek area had a 93 percent occupancy rate, while Elko was at 89 percent and Carlin was at 78 percent. Eureka County had 359 vacant housing units in 2000, which was 35 percent of the total 1,025 units. A moderate 5.4 percent of homeowner units were vacant, but a very substantial 37.9 percent of rental units were vacant (U.S. Census Bureau 2000).

The Census Bureau estimated that the number of housing units as of 2006 had increased to 19,239 in Elko County and 1,060 in Eureka County, which matches the population growth rate for Elko County, but raises questions for Eureka County because the population estimate showed a decline for that county.

The Nevada State Demographer also estimates housing units for use in developing annual population estimates, which, when certified, become the basis for revenue distributions throughout the state. Housing unit estimates for Elko and Eureka counties are based on assessors' records and utility data. The State Demographer's estimates for 2007 indicated that Elko County had 18,103 housing units, 16,915 (93.4 percent) of which were occupied and 1188 of which were vacant; and Eureka County had 887 housing units, 577 (65.1 percent) of which were occupied and 310 of which were vacant (Hardcastle 2007).

The estimated 6.6 percent vacancy rate in Elko County suggests a relatively healthy housing market in the county, likely based on the diversity in the county's economy and the relative stability in the mining industry in recent years.

The explanation for the discrepancy between the Demographer's estimates and the Census Bureau's estimates is uncertain, although at least a portion of the difference for Elko County is likely based on the fact that the State Demographer estimates the Native American population separately so their housing is not included in the totals. The City of Elko believes both estimates are too conservative, and has hired a statistician to evaluate the housing and population estimates (Barkdull Spencer 2008). The Elko County Economic Diversification Authority (ECEDA) also believes the Census and State Demographer estimates are low, based on their own study, which estimated there were more than 23,000 housing units in the county (Barkdull Spencer 2008). ECEDA contends there is considerable growth pressure occurring in the county from expansion in mining and casino industries and from the new Northeastern Nevada Regional Railport and Industrial Park. In response, there are 10 new subdivisions, 4 of which are under construction and 3 are scheduled for construction in the summer of 2008 (Barkdull Spencer 2008). Current activity is heaviest near West Wendover and between Elko and Spring Creek where new housing could fill the current gap between the two communities in the next few years (Barkdull Spencer 2008).

Elko is the primary location for short-term housing opportunities in the area, with at least 26 motels, hotels, and casinos hosting over 1,500 rooms. There also are numerous mobile home parks and recreational vehicle (RV) parks in the city and county.

### 3.12.1.5 Community Facilities and Services

*Public Utilities*

Water

The City of Elko obtains municipal water from 18 deep-water wells, with 25 million gallons of storage capacity. The system has a maximum production capacity of 14.5 million gallons per day (mgd) with current usage ranging from 3 mgd to a peak of 13 mgd. Spring Creek residents are served by nine public wells. Carlin obtains water from one deep-water well and several natural springs. Water is stored in a 2-million-gallon tank. Peak production capacity is 980 gpm, or approximately 1.4 mgd, averaging 450 gpm.

Wastewater

Elko and Carlin both have wastewater treatment facilities. Elko's is a "fixed film" biological treatment plant averaging 3.5 mgd. Approximately 60 percent of treated water is reused for irrigation. Carlin employs two lagoons with rapid infiltration basins. Wastewater treatment in Spring Creek utilizes private septic systems.

Solid Waste

The City of Elko operates a regional solid waste landfill. At current use rates, it has capacity in excess of 200 years.

Energy

Electricity is provided to study area residents by Sierra Pacific Power Company. Southwest Gas Corporation provides natural gas.

*Public Safety*

Law Enforcement

Law enforcement for unincorporated areas in Elko County is provided by the County Sheriff. Elko and Carlin police departments are responsible for incorporated jurisdictions. The Bureau of Indian Affairs Police are responsible for the 193-acre Elko Band Colony. The Eureka County Sheriff provides law enforcement for rural Eureka County. The Nevada Highway Patrol provides law enforcement on the state highway system.

Fire Protection

Fire protection services in the study area are provided by the City of Elko Fire Department, the Carlin City Volunteer Fire Department, the BLM, the USFS, and the Northeastern Fire Protection Department of the Nevada Division of Forestry. These departments are all involved in mutual aid/cooperative agreements. The Elko City Department is the largest of the agencies with 3 staff positions and 15 career firefighters supported by 34 volunteer positions. The department has 10 major pieces of equipment, including 7 regular engines, 2 smaller specialty trucks, and a specialized airport engine. The department also houses four pieces of Nevada Division of Forestry firefighting equipment. The Elko and Carlin fire departments primarily serve residents within their city limits and the Elko Band Colony. The BLM is primarily responsible for fighting wildland fires (BLM 2002).

Health Care

The Northeast Nevada Regional Hospital in Elko is the principal health care facility for all of northeastern Nevada. It provides 24–hour emergency care and has 75 acute care rooms. The hospital has a full service laboratory, an intensive care unit (ICU), both magnetic resonance imaging (MRI) and computerized axial

tomography (CAT) scan capabilities, and provides most major medical specialty services. The hospital also provides services to the Elko Band Colony Health Center under an Indian Health Service contract.

*Education*

Elementary and secondary schools in the study area are operated by the Elko County School District with administrative offices in Elko. The district serves the entire county and had a fiscal year (FY) 2007 enrollment of 9,907 pupils from pre-kindergarten through 12th grade on "count day" for a 0.8 percent increase over FY 2006.

Eleven of the district's schools are located in the Elko-Spring Creek-Carlin area. Elko has four elementary schools, one middle school, and one high school. Spring Creek has two elementary schools, a middle school and a high school. Carlin has a combined school for elementary through high school. The district has an overall ratio of 16.2 students per teacher.

Students from the Elko Band Colony attend Elko District schools. There also is a Head Start Program at the Colony for children from 3 to 5 years old.

Great Basin College provides higher education opportunities to residents in the study area. The college, a pioneer in distance learning techniques, serves nearly 4,000 students in six of Nevada's largest rural counties (Great Basin College [GBC] 2008). Its main campus, and only residential facility, is located in Elko. GBC also has a branch center with extensive course offerings in Battle Mountain and a satellite center with limited offerings in Carlin.

In addition to Great Basin College, the University of Nevada, Reno Fire Science Academy (FSA) is located at Carlin. The FSA is purported to be "one of the finest emergency response programs and training facilities in the world" (FSA 2008). It offers highly specialized training in emergency response and emergency management.

#### 3.12.1.6 Public Finance

There are four main general governmental entities influencing the study area: Elko and Eureka counties, the City of Elko and the City of Carlin. Elko County has a professional county manager and a five-member Board of Commissioners, who oversee the operations of the county including administration, law enforcement, courts and public works. Eureka County operates with a three-member Board of Commissioners who function as both policy makers and administrators. Both the City of Elko and the City of Carlin employ council-manager governmental structures with professional city managers and policy making city councils each made up of a directly elected Mayor and four council members.

Local government finance in Nevada is a complex admixture of locally derived and state shared revenues. Local revenues are primarily *ad valorem* property taxes on real and personal property and the net proceeds of mines in the jurisdiction. State shared revenues include sales, motor vehicle, fuel and gaming taxes. State revenue sharing addresses significant economic disparities between the relatively wealthy urban centers of Reno and Las Vegas and the often less affluent rural agricultural and mining communities.

Both Elko County and Eureka County approved deficit budgets for FY 2006 to 2007, with plans to access ample reserves to cover the current revenue shortfalls if necessary **(Table 3.12-3)**. Elko County, in particular, chooses to budget conservatively by underestimating revenue for the forthcoming year and appropriating "every dime" for expenditures (Armuth 2008). The county's experience with this approach has been that, at the end of a fiscal year, actual revenue has exceeded their projections and expenditures for most funds rarely reach the appropriated levels (Armuth 2008). The result has been that the county's ending fund balance has grown consistently in recent years (Armuth 2008).

**Table 3.12-3 County and City Budgets for Fiscal Year 2006-2007**

| | Governmental Fund Types and Expendable Trust Funds ($) | | | |
|---|---|---|---|---|
| | **City of Elko** | **City of Carlin** | **Elko County** | **Eureka County** |
| **Revenues** | | | | |
| Property Taxes | 2,805,738 | 250,000 | 7,808,869[1] | 5,613,833 |
| Other Taxes | 2,513,232 | 64,500 | 14,000 | 110,500 |
| Licenses and Permits | 1,414,407 | 53,100 | 918,000 | 8,250 |
| Intergovernmental Resources | 12,267,317 | 1,509,328 | 18,165,592 | 4,943,536 |
| Charges for Services | 689,621 | 72,700 | 2,525,500 | 495,000 |
| Fines and Forfeits | 158,137 | 22,250 | 1,236,960 | 102,310 |
| Miscellaneous | 1,067,559 | 132,195 | 2,664,233 | 340,250 |
| **Total Revenues** | **20,916,011** | **2,104,073** | **33,333,154** | **11,273,429** |
| **Expenditures** | | | | |
| General Government | 1,795,928 | 446,582 | 6,354,941 | 6,540,302 |
| Judicial | 240,500 | 55,427 | 8,566,111 | 1,164,550 |
| Public Safety | 8,527,841 | 566,627 | 9,699,293 | 2,021,184 |
| Public Works | 5,881,997 | 500,000 | 7,775,924 | 2,744,000 |
| Sanitation | 0 | 0 | 0 | 342,000 |
| Health[2] | 456,630 | 67,285 | 125,000 | 563,000 |
| Welfare[2] | | | 1,755,035 | |
| Culture and Recreation | 2,494,210 | 263,997 | 1,502,158 | 888,606 |
| Community Support | 28,000 | 47,315 | 569,325 | 737,900 |
| Intergovernmental Expenditures | 0 | 0 | 161,055 | 1,120,000 |
| Capital Projects | 0 | 0 | 0 | 0 |
| Contingencies | 0 | 0 | 440,000 | 200,000 |
| Utility Enterprises | 0 | 0 | 0 | 0 |
| Hospitals | 0 | 0 | 0 | 0 |
| Transit Systems | 0 | 0 | 0 | 0 |
| Airports | 0 | 0 | 0 | 0 |
| Other Enterprises | 0 | 0 | 0 | 0 |
| Debt Service – Principal | 353,107 | 26,564 | 1,119,888 | 0 |
| Interest Cost | 125,946 | 10,461 | 196,130 | 0 |
| **Total Expenditures** | **19,904,159** | **1,984,258** | **38,264,860** | **16,321,542** |
| **Excess Revenues Over (Under) Expenditures** | **1,011,852** | **119,815** | **(4,931,706)** | **(4,707,863)** |

[1]Ad valorem revenues from net proceeds of mines were estimated at approximately 10 percent of total property tax revenue.

[2]The cities of Elko and Carlin combine Health and Welfare into one line item; Eureka County does not have a Welfare line item.

Sources: Nevada Department of Taxation 2007 (Schedules S-1 from local government entities' FY 2007 to 2008 budgets).

Elko County anticipated revenues of $33.3 million against planned expenditures of $38.3 million, resulting in an expected deficit of $4.9 million. Eureka County anticipated revenues of $11.6 million and expenditures of $16.3 million. Note that the expected deficit of $4.7 million was similar to Elko County's deficit with a total budget less than half the size. After covering the planned deficit, Eureka County would still have an unreserved fund balance of over $28 million. The City of Elko's FY 2006 to 2007 budget anticipated revenues of $20.9 million and expenditures of $19.9 million, producing a $1.0 million surplus. The much smaller City of Carlin planned revenues of $2.1 million and expenditures of $2.0 million, leaving a $0.1 million surplus.

The two largest revenue sources for all four local governments are projected to be property taxes and intergovernmental transfers. Expenditure emphases vary notably among jurisdictions, as illustrated in **Table 3.12-3**.

BGMI paid $326,170 in property taxes to Elko County and $2,455,556 to Eureka County in 2006 for the Goldstrike Mine property (Hofland 2007). These payments represented 3.9 percent of Elko County's total property tax revenue and fully 45.9 percent of Eureka County's total property tax revenue, which illustrates the importance of the mine to Eureka County, in particular.

BGMI's Betze Pit (and most of the Goldstrike Mine) is in Eureka County; therefore, nearly 89 percent of the total net proceeds taxes ($12.2 million in 2006) accrue to Eureka County, while Elko County collected 10 percent, and Lander County collected 1 percent (Hofland 2007). Net proceeds of mines constitute nearly 40 percent of the total assessed valuation in Eureka County, but slightly less than 6 percent of Elko County's total assessed valuation. Elko County's ad valorem tax rate was $0.8386 per $100 of assessed value for FY 2006 to 2007; Eureka County's rate was a similar $0.8458 per $100 of assessed value. Net proceeds of mines constitute only a tiny fraction of the total assessed valuation in the City of Elko and none of Carlin's assessed valuation.

Net proceeds taxes from mine production are particularly important to Eureka County's general fund budget. The actual amount received (not the budgeted amount) from net proceeds of mines was slightly over $2.5 million in FY 2006 to 2007, which was nearly 22 percent of what Eureka County budgeted for general fund revenues (Rebaleati 2007). Net proceeds taxes also contribute to Elko County's budget, but to a relatively smaller degree. Elko County's general fund received over $0.5 million in FY 2006 to 2007, which was approximately 1.6 percent of the county's budgeted revenue (Minor 2008). School districts also are major beneficiaries of revenue from taxes on net proceeds of mines; numerous other county funds receive smaller amounts from that source.

Both Elko County and Eureka County assess 6.5 percent sales and use taxes. The mine purchases material and services in both Elko County and Eureka County, generating sales and use tax payments to both. Sales and use tax payments totaled $26.7 million in 2006, with an estimated 75 percent attributed to Eureka County and 25 percent to Elko County (Hofland 2007). The counties don't realize all the benefit of the tax, however, because 2 percent (31 percent of the revenue collected) goes to the state general fund and 2.25 percent (35 percent of the revenue) goes to school districts. The county where the tax is generated receives 0.5 percent (8 percent of the revenue), and the remaining 1.75 percent (27 percent of the revenue) is distributed to all counties under a statutory formula (Nevada Department of Taxation 2006, 2007).

#### 3.12.1.7 Social Conditions

Elko, Spring Creek, and Carlin, in western Elko County, grew very rapidly in the 1980s, due to a boom in mining and related support activities, but stabilized in subsequent years when they experienced years of modest population growth and decline through about 2003. Growth has resumed in recent years, but at more moderate rates. The passage of time and the community's ability to weather not only the booms, but also subsequent downturns, have allowed for development of the relatively stable social setting that now exists in Elko County. Many residents have lived in the area for a number of years, social ties have become established, and residents take pride in their communities. Many of the people place a high priority on maintaining informal lifestyles and small town traditions.

Social stratification in the area is often defined by income, length of residence, educational attainment, and ethnicity. Local residents earning high incomes are considered to be the most influential in the community. The most powerful groups viewed by residents as making decisions about the area's future include federal and state government, county commissioners, environmental organizations, and large corporations (BLM 2002a).

Gold prices continue to be a key factor driving the growth or decline of the communities. When prices dropped in the late 1990s, workers were laid off, some mines announced early closures, and expansion plans were mothballed. As prices have risen recently, the reverse is true. Several mines are working towards implementing growth plans to take advantage of the opportunity. Although Elko County is more diversified than it was 2 decades ago, the mining industry is still an important sector, affecting both the economy and the psychology of area communities.

## 3.12.2 Environmental Consequences

The primary issues related to social and economic values include:

- Effects associated with the continued employment of current BGMI workers at the proposed project site;
- The potential growth effects of increased employment required for the proposed project;
- The economic impacts of 4 years of additional employment for a large proportion of the mining workforce in the area;
- The effects of the No Action Alternative as work forces from existing mines may be unable to find local employment after closure of approved projects; and
- The effects of the closure of the Goldstrike Mine (as they relate to both the Proposed Action and No Action Alternative).

### 3.12.2.1 No Action Alternative

Population and Demography

Under the No Action Alternative, mining of the Betze Pit would continue to operate until the end of 2011. Subsequent to the end of mining, processing of ore stockpiles would continue for approximately 14 additional years, followed by reclamation and closure lasting approximately 3 to 5 years.

The specific effect on study area population is uncertain. With an average family size of 3.33 people in Elko County, where over 95 percent of the Goldstrike Mine workers live, as many as 5,100 county residents (11 percent of the county population) are currently directly supported by the mine. An additional increment of the population, perhaps as many as 4,300 people based on the multiplier effect addressed below, is indirectly supported by the mine as well. A potentially affected total of 9,400 people would be over 19 percent of the study area population.

It is assumed that layoffs would begin at the time mining was completed, if not before, and that additional layoffs would occur as stockpile processing wound down 14 years later, with nearly all employees gone at the time of closure, but the actual pace of layoffs is unknown. The unemployment rate in the study area is currently quite low. If it remains low, and other mining projects in the area remain in a growth mode, it is likely that many laid off BGMI workers would remain in the community to search for new jobs, at least initially, which would result in a lessening of population losses in the study area. However, the availability of alternative employment in the area from 4 to 20 years in the future is difficult to predict. Ultimately, it is expected that a substantial number of current workers and their families may have to leave the area to find employment.

It is assumed that the workers at the Goldstrike Mine approximately reflect the ethnic and racial pattern of the study area. As such, it is unlikely that any population change related to early termination of production at the mine would alter the demography of the study area.

Income, Economy, and Employment

As noted above, closure of the Betze Pit under the No Action Alternative would require reduction of the workforce beginning about 2011. There are currently approximately 1,600 workers employed at the mine, representing more than one-quarter of the "natural resources and mining" workers and 6.5 percent of all workers in Elko and Eureka counties (**Table 3.12-2**). It is not known how many of these jobs would be lost in the short term or how rapidly layoffs would occur after 2011, although it is reasonable to assume that nearly all would be terminated between 2011 and final closure of the project, which would occur in approximately 2026.

If large numbers of workers were terminated simultaneously, the unemployment rates for Elko and Eureka counties would increase substantially.

Any loss of jobs also would reduce the dollars flowing into the local and state economy. The Goldstrike Mine provided an estimated $153.4 million in wages and salaries in 2006, including benefits. The mine also purchased supplies, services, and commodities worth an estimated $411.5 million in the state. Under the No Action Alternative, the combined $564.9 million per year of annual labor and materials currently flowing into the Nevada economy would decline, beginning in 2011 with the end of mining.

In addition to the direct employment and income provided by the Goldstrike Mine, the economic activity spawns indirect and induced employment and income in the local economy. Employees of the mine spend their income in the local area for goods and services, which provides opportunities for other businesses selling cars, groceries, and fuel to hire workers and for service providers such as the school district to hire teachers. It has been estimated that each direct employee in the hard rock mining industry generates demand for an additional 0.85 indirect and induced employees in the Elko/Eureka counties economy (Price and Harris 2007). Also, each $1.00 of direct labor income ("labor income" includes the sum of employee compensation and proprietor income) from the hard rock mining sector generates an additional $0.38 of indirect and induced labor income (Price and Harris 2007). Based on these multipliers, the loss of 1,600 jobs from the Goldstrike Mine would result in the loss of an additional 1,360 jobs in the rest of the Elko and Eureka counties' economy. In addition, it would result in a loss of approximately $142.1 million in direct labor income plus approximately $54.0 million in indirect and induced labor income.

As noted above, the timing of the job losses is not precisely known. It is assumed that the losses would begin in 2011 and continue over the following 13 to 15 years. The actual effects on the study area economy would depend on both the timing of layoffs and the type and availability of other employment that may be available in the area when the layoffs occur. Some laid off workers would be expected to find replacement employment in the area, although it is uncertain whether they would find jobs at wage levels they currently have.

Housing

Effects on the local housing market from the No Action Alternative would depend on the capacity of the local economy to absorb workers into new jobs. If a majority of the workers find new jobs in or near Elko County in a reasonable period of time, it is expected that housing market effects would be minor. There could be a short-term, minor downward influence on demand and prices. Under current conditions, with low vacancy rates in the homeowner segment of the market, this would be a minor source of irritation in the market. If the housing market were in a downturn at the time, the adverse effect would be more detrimental.

The size of the Goldstrike Mine workforce is substantial. If, ultimately, many workers could not find new local employment or had to settle for new jobs at lower wage rates, the effects on the housing market would be worse. Some families might leave the area; others might have difficulty maintaining mortgages obtained with

higher incomes. The adverse effects could be moderate to substantial because of the percentage of the total housing market represented by Goldstrike Mine workers and their families.

Community Facilities and Services

The No Action Alternative would not be expected to adversely affect most public facilities and services in the study area in the short term. Over time, as mine employment declined, some community facilities may be underutilized. Assuming some portion of the population would depart the area, service demands would decline and the need for services would be reduced (possibly resulting in loss of service jobs, which are part of the induced employment noted above). Some families might have difficulties making payments for services until and unless they were able to find new employment in the area. Growth pressure on public services and facilities would be reduced, at least for a period of time. The greatest effect could be on the school district if some families were forced to leave the area to find new employment. A loss of school-aged children would result in enrollment declines and, perhaps, underutilization of school facilities.

Public Finance

In addition to wages, salaries, and purchases, the Goldstrike Mine annually pays taxes and fees to local and state agencies. The Goldstrike Mine paid an average of $36.9 million per year in taxes from 2004 through 2006, including $11.4 million in net proceeds taxes, $21.6 million in sales and use taxes, $0.6 million in business activity taxes, and $3.4 million in ad valorem property taxes (Hofland 2007). These dollar flows would likely continue at similar levels through the end of mining in 2011, and would then decline over time to a small fraction of current levels between the end of mining and complete closure of the project 13 to 15 years later.

Social Conditions

The No Action Alternative, which would result in job losses for over 1,600 mine workers and, potentially, several hundred others from secondary jobs, would be expected to increase stress on the individuals and families involved. Their quality of life would be adversely affected for at least the period of time they were unemployed, and longer if replacement jobs resulted in a reduced standard of living. The proportion of the total local population affected would not be large enough to dramatically alter the social structure of the community, but closure of one of the largest mines in the study area could be expected to adversely affect the security and confidence of people beyond those personally affected by a downsizing.

#### 3.12.2.2 Proposed Action

Population and Demography

Implementation of the proposed Betze Pit Expansion Project would have no permanent effect on the population or demographics of Elko or Eureka counties as the permanent workforce is already in place at the existing mine. There may be an increase in temporary contract workers to perform prestripping operations, but it is expected that prestripping would be conducted by local workers. Prestripping also would be of relatively short duration so any non-local workers involved would be unlikely to move their families to the area. With no change in the permanent workforce, there would be no change expected in the permanent population of the study area.

Income, Economy, and Employment

The current Goldstrike Mine workforce of approximately 1,600 would continue to be employed for an additional 4 years beyond the currently permitted operation. The proposed Betze Pit Expansion Project is not expected to need any additional permanent workers beyond the current staff. The effects of closure would occur at some point in time, probably 4 years later than in the No Action Alternative. The base of economic activity provided by wages and local purchases by the mine would continue with only minor adjustments as the project's three major components were developed and brought on line. The local economy would benefit from continuation of current activity for an additional 4 years. In addition, local communities in the study area would have additional time in which to continue their efforts to diversify their economies, which are currently heavily

dependent on mining in Eureka County and well above the state average for dependence on mining in Elko County. Economic development efforts are long term endeavors that take time to produce results. Continuation of mining operations at the Betze Pit for an additional 4 years would be notably beneficial to such efforts in the study area.

Housing

With no change in permanent employment or population, there would be no anticipated increase in the demand for permanent housing. Temporary non-local contract workers, if any, would need temporary housing. With over 1,500 hotel, motel, and casino rooms in Elko and numerous RV spaces with full hookups, there should be no problem housing a relatively small number of temporary workers, if necessary, without adversely stressing the housing market. A minor, project-related increase in the demand for temporary housing would be a beneficial local economic effect.

Community Facilities and Services

The proposed Betze Pit Expansion Project would have no long-term effect on service demands because the permanent workforce is already resident in the community. Depending on how many, if any, non-local contract workers are needed for the mine preparation projects, there could be a minor increase in the need for law enforcement efforts for low level criminal behavior. Any increase would be expected to be accommodated by the existing capabilities of the Elko and Carlin police forces and the Elko and Eureka County Sheriffs.

The very minor increase in demand for other public facilities and services, such as the hospital and the water and sewer systems, should be well within the existing capacities of the systems to accommodate them. It is unlikely that measurable numbers of additional school age children would join the community as a result of minor contract prestripping activity.

Public Finance

Developing the Betze Pit Expansion Project would extend the life of the mine for 4 years. As such, it would continue the provision of revenues to local governments, school districts, and certain other taxing jurisdictions, and to the State of Nevada for the duration of the additional mine life. From 2004 through 2006, BGMI generated annual revenues averaging $11.4 million from net proceeds taxes, $21.6 million from sales and use taxes, $0.6 million from business activity taxes, and $3.4 million from ad valorem property taxes. These levels of tax payments are likely to continue at similar levels for the additional 4 years of mine life, with the possible exception of net proceeds taxes, which can be highly variable, depending on gold prices and production costs.

Social Conditions

With no substantive change in permanent employment or population expected from the proposed Betze Pit Expansion Project, it is not expected to cause adverse changes in the social structure or traditional lifestyles of Elko County communities. A possible influx of a small number of contract workers would not noticeably affect the quality of life of people currently living in the community. Continuation of the Betze mining activity and the jobs of current employees would be expected to sustain their individual lifestyles, but would have little or no effect on the social structure of the community as a whole. Extending the life of the mining activity could, however, be beneficial to the long-term sustainability of the community as it would provide additional time for local economic diversification efforts to bear fruit.

#### 3.12.2.3 Bazza Waste Rock Facility Alternative

Population and Demography

The Bazza Waste Rock Facility Alternative would require hiring 20 additional workers for approximately 2 years during 2011 and 2012. Although the unemployment rate in Elko and Eureka counties is a relatively low 3.5 percent, there are an estimated 1,000 unemployed workers in the 2 counties (NDETR 2007). Consequently, it is assumed that most, if not all, of the new workers would be hired locally. Under this

assumption, there would be little or no effect on population or demography in the two-county study area from implementation of the Bazza Alternative.

Income, Economy and Employment

The Bazza Alternative would add 5 additional trucks to the haul fleet for approximately a 2-year period during 2011 and 2012. The trucks would add estimated capital costs of $19 million and would require hiring 20 additional drivers to operate them, over and above the existing Goldstrike workforce which would continue at current levels under the Proposed Action.

Twenty new workers would increase the total Goldstrike workforce by 1.3 percent. They would increase total employment in Eureka County by less than 0.5 percent and Mining and Natural Resources employment by just over 0.5 percent. Twenty hires would represent 2.0 percent of the estimated 1,000 workers currently unemployed in the two-county area, which would only minimally reduce the unemployment rate, assuming all 20 were hired locally.

Assuming the new workers would be hired at approximately the overall average compensation rate for the mine workforce, 20 additional workers would increase total salary and benefits payroll by approximately $1.9 million per year for 2 years. Further assuming the multiplier effect at $0.38 of indirect and induced labor income for each $1.00 of direct labor income (Price and Harris 2007), there would be an additional $0.7 million per year of labor income generated under this alternative for a total of $2.6 million per year for 2 years.

Housing

Since the effect on population in the study area from the Bazza Waste Rock Facility Alternative would be minimal, it is expected that there would be little or no effect on the housing market from this alternative.

Community Facilities and Services

With minimal to no effect on population or housing in the study area, there would be no perceptible effect on existing levels of demand for public facilities and services in the study area under the Bazza Waste Rock Facility Alternative.

Public Finance

Purchase and use of 5 additional haul trucks at $19 million would increase sales and use taxes to Eureka County and the State of Nevada by approximately $1.2 million for 2 years. An additional 5.3 million gallons of fuel would also be needed, which would increase sales tax revenues to the state and county. These additional tax revenues would represent a modest benefit to the state and county. In addition, the estimated $2.6 million per year in worker compensation would generate modest increases in sales tax revenues, primarily to the City of Elko, the two study area counties and the state with lesser benefits to the City of Carlin and other communities and counties.

## 3.12.3 Cumulative Impacts

The CESA for social and economic values is shown in **Figure 3.12-1**. The past and present actions and RFFAs are identified in Section 3.3.1 and shown in Section 3.1. The social and economic effects of past and present actions are reflected in the affected environment information presented in Section 3.12.1. As a result, any potential cumulative effects for past and present actions are discussed in the environmental consequences section (Section 3.12.2).

### 3.12.2.4 No Action Alternative

The No Action Alternative would result in declines in employment, public revenues, possibly population, and economic and social activities currently supported by the mine, beginning at the end of mining in approximately 2011. If other mines in the area reach the end of their economic lives in a similar time frame, these adverse

effects would be exacerbated by the No Action Alternative. These effects are addressed in greater detail in the Draft Leeville and SOAPA Cumulative Impact Analyses (BLM 2007b,c) and the Betze Project EIS (BLM 1991a,b) and Betze Project SEIS (BLM 2000a, 2003a).

#### 3.12.2.5 Proposed Action

No adverse social or economic effects have been identified for the proposed Betze Pit Expansion Project. Consequently, there would be no cumulative adverse social or economic effects for the Proposed Action.

#### 3.12.2.6 Bazza Waste Rock Facility Alternative

No adverse social or economic effects have been identified for the Bazza Waste Rock Facility Alternative. Consequently, there would be no cumulative adverse social or economic effects for this alternative.

### 3.12.4 Mitigation Measures and Monitoring

No mitigation or monitoring of social or economic resource effects is recommended.

### 3.12.5 Residual Impacts

The additional 4 years of mining will result in increased training and experience of the workforce, providing for greater employment opportunity elsewhere after the mine closes. The 4 years of mining and employment also will result in investment in homes and infrastructure in Elko that will last a very long time, and the mining of the gold will create wealth that will benefit the nation and perhaps the world for a very long time.

## 3.13 Visual Resources

The visual resources study area for the proposed project is defined as the viewshed of the project, or the area from which the project can be seen. The viewshed includes an area bounded by foothills and ridges on the east and north and less well-defined topographic rises to the south and west of the project site. The project area is located in the Rodeo Creek and Brush Creek drainages above the Boulder Valley, between the Sheep Creek Mountain Range and Tuscarora Mountain Range. The CESA encompasses existing activities and reasonably foreseeable mining activity on the Carlin Trend (**Figure 3.13-1**).

The proposed project is located in the Basin and Range Physiographic Province, as defined by Fenneman (1931). This province is characterized by extensive vistas, and alternating valleys and north-south trending mountain ridges.

The BLM is responsible for identifying and protecting scenic values of public lands under several provisions of the FLPMA and NEPA. The BLM Visual Resource Management (VRM) system was developed to facilitate the effective discharge of that responsibility in a systematic, interdisciplinary manner. The VRM system provides the methodology to:

- Inventory existing scenic quality;
- Assign visual resource inventory classes based on a combination of scenic values, visual sensitivity and viewing distances; and
- Assign visual management objectives.

Four visual resource classes have been established to:

- Serve as an inventory tool portraying the relative value of existing visual resources; and
- Serve as a management tool portraying visual management objectives for the respective classified lands.

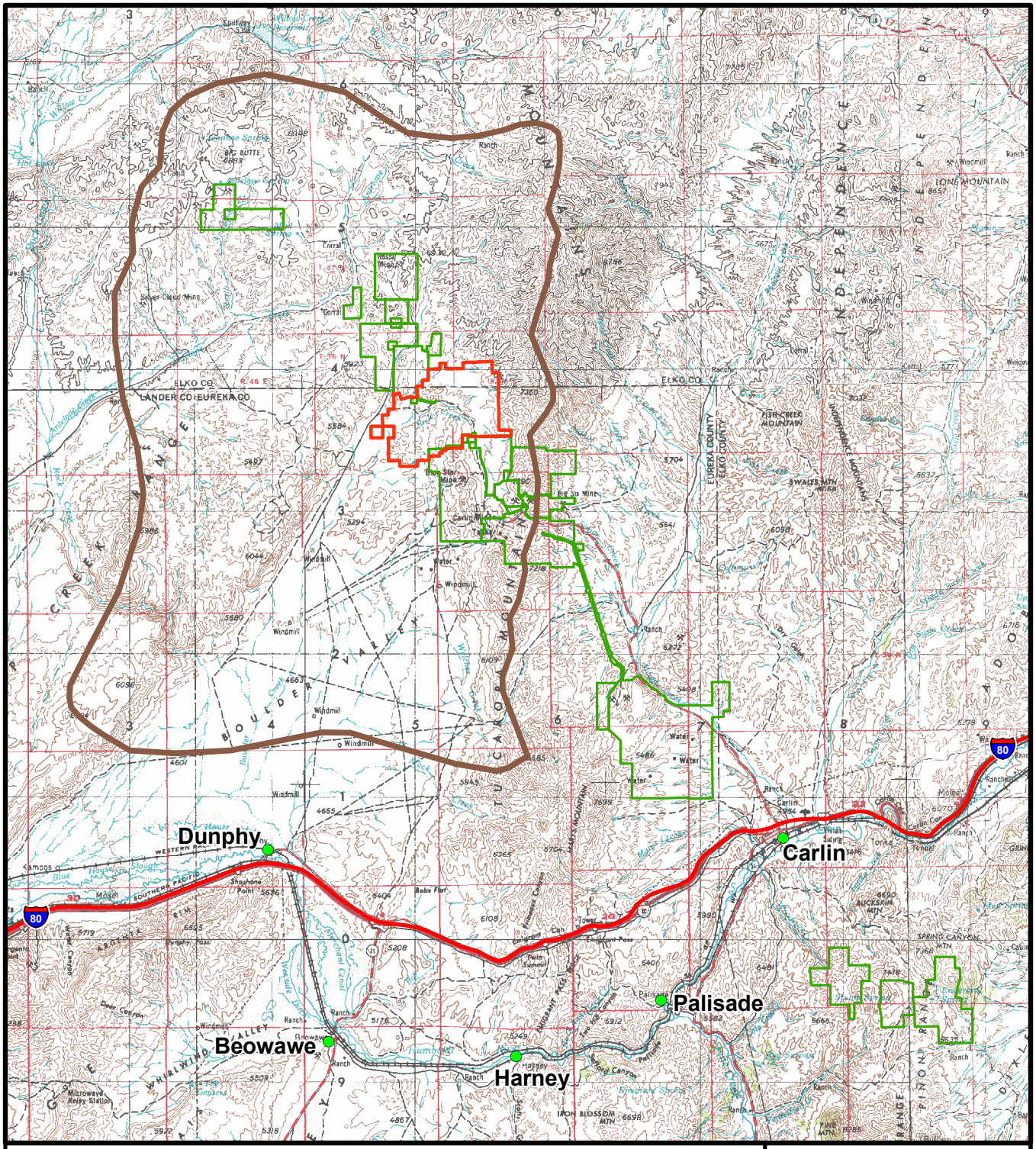
Management objectives for each of the visual resource classes are listed as follows:

**Class I Objective**. The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes. However, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.

**Class II Objective**. The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

**Class III Objective**. The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

**Class IV Objective**. The objective of this class is to provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.




**LEGEND**

- Visual Resources Cumulative Effects Study Area
- Goldstrike Mine Operations Boundary
- Mine Plan Boundaries
- Towns

N

0 2.5 5 Miles

Source: BLM 2007b,c.

**Betze Pit Expansion Project**

Figure 3.13-1

Visual Resources Cumulative Effects Study Area

**Visual Rehabilitation Areas.** Areas in need of rehabilitation from a visual standpoint are flagged during the inventory process. The level of rehabilitation is determined through the RMP process by assigning the VRM class approved for that particular area.

The VRM system also includes a contrast rating procedure for evaluating the potential visual consequences of a proposed project or management activity. The VRM system provides the basic approach for evaluating direct visual impacts as well as potential cumulative visual impacts of the proposed expansion project.

### 3.13.1 Affected Environment

The visual resources of the project area are composed of mountains giving way to gentle slopes and rolling hills bisected by several smaller drainages. Vegetation consists of sagebrush, rabbitbrush, and various grasses that color the hills in shades of green, gold, and brown. Grey, brown, and black coloration indicate areas of sparse vegetation, soil, and rocks.

The project area is not easily visible from any major roadway, town, or recreation area. The prominent views would be from the main access road, making the primary viewers mine employees and/or mine service contractors. Occasional four-wheel-drive recreationists and hunters would see the project area.

The topography in the vicinity of the project area is flat to moderately sloping. The existing site is situated at an elevation of approximately 5,400 feet. Surface soils and rocks in the vicinity generally range from dark umber to buff to grayish-tan hues of light-to-medium-to-dark values.

The existing operations exhibit strong color and landform contrast with the natural surroundings and moderate to strong line and surface texture contrast. The browns, light tans, and gold of the recently mined waste rock dumps stand out moderately to strongly in comparison with the surrounding natural landforms and vegetation.

Areas that have been reclaimed show substantial mitigating effects that the reclamation has had on the visual environment. The AA Leach Pad has been reclaimed with sagebrush and grasses growing on the surface that result in the reclaimed facility blending into the natural terrain. BGMI received an award in 2007 for the reclamation design of the Bazza Waste Rock Facility. BGMI was noted for its reclamation design of natural topographic features and vegetation cover of the native shrubs and grasses that would be beneficial to wildlife (Section 2.3.7.3).

Vegetation in the project area is relatively homogeneous, consisting of sagebrush shrubland and semi-desert grassland. Grasses are short and typically sparse, reflecting the arid conditions of the region. Vegetation colors in the growing season range from silvery gray-green to medium olive. During the dormant seasons, vegetation ranges from silvery gray-green of shrubs to tan, buff, umber, and gold of grasses and forbs.

Structures in the visual area of influence are limited mainly to industrial forms, colors, and characters.

The BLM has identified the project area as Class IV and has identified one Visual Rehabilitation Area. The existing mine area is located in the Visual Rehabilitation Area. Designation of a Visual Rehabilitation Area indicates the area should be managed to improve the existing visual condition. In this case, the Visual Rehabilitation Area is targeted for management to the standards of VRM Class IV, in keeping with other areas of the valley floor having similar visual characteristics.

Two KOPs have been identified in the study area; they are shown in **Figure 3.13-2**. KOP locations are utilized for analyzing detailed landscape character in the affected environment and for comparison with the characteristics of the proposed project (Section 3.13.2, Environmental Consequences). Factors considered in selecting KOPs are:

- Angle of observation;
- Number of viewers;
- Length of time the project is in view;
- Relative project size;
- Season of use; and
- Light conditions (BLM 2007e).

## 3.13.2 Environmental Consequences

Potential visual impacts associated with the proposed expansion of the Goldstrike Mine were analyzed using the procedures outlined in the BLM Visual Contrast Rating Handbook H-8431-1 (BLM 1986b). Visual impacts were determined by comparing visual contrast ratings for the proposed project facilities with the VRM class objective for the project area, portions of which are designated VRM Class IV. The process involves comparing the degree of visual contrast from the proposed facilities and activities with the existing landscape character both during active mining and after reclamation is completed. The contrast rating process used the two KOPs as representative viewpoints for conducting the impact analysis.

KOP #1 is located on the access road at the southern entrance to the project area. This viewpoint was selected to represent the view for travelers approaching from the south. KOP #2 is located on the Dunphy road at the northern entry to the project area and represents the view for travelers approaching from the north. These approach routes are the only improved routes to and through the project area. Most traffic in the area is generated by mineral development; there also is traffic generated by ranching and recreational activities including hunting, fishing, and camping where access is not restricted by mining company safety closures and security gates.

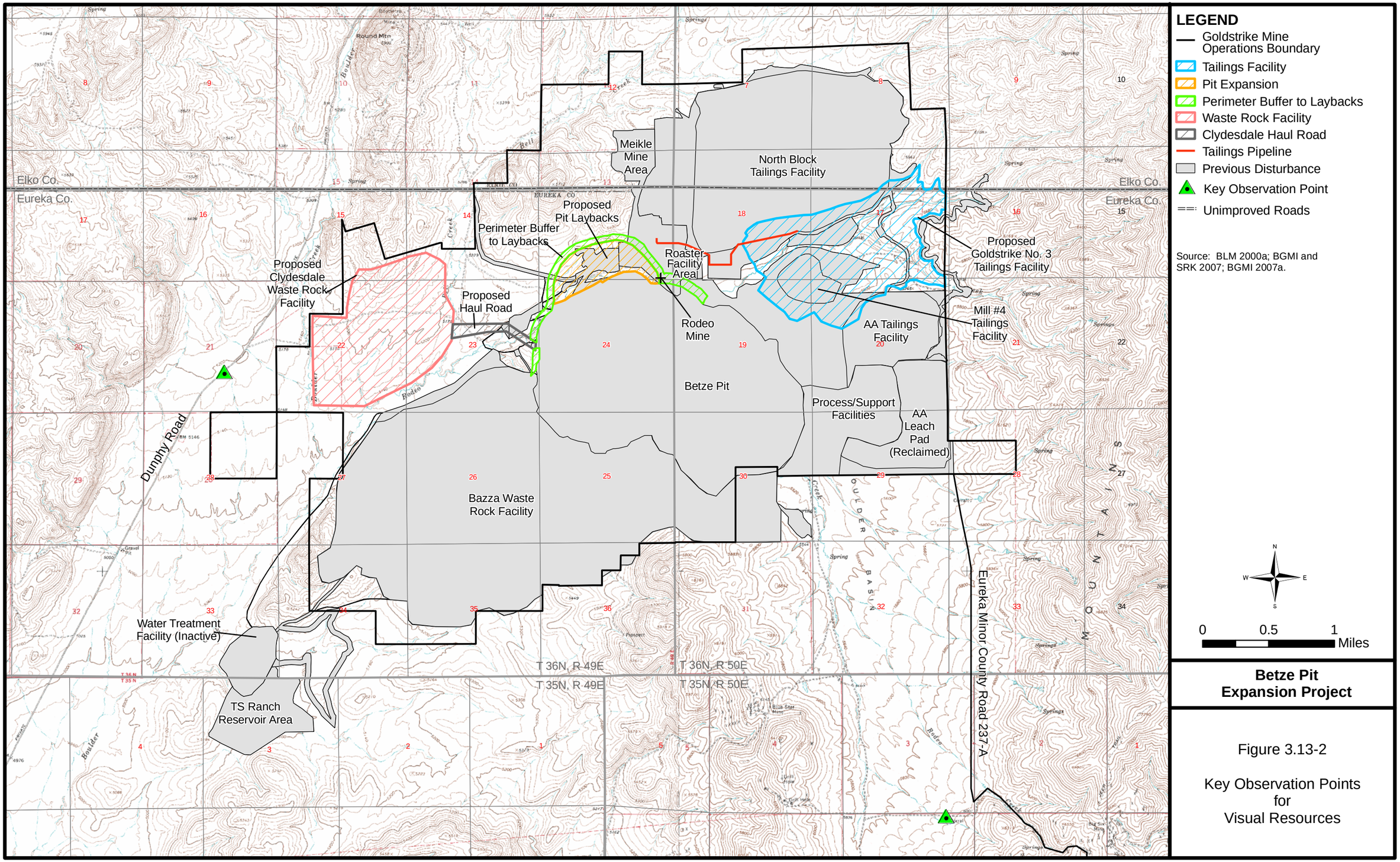
### 3.13.2.1 No Action Alternative

Under the No Action Alternative, the proposed Betze Pit Expansion Project would not be constructed. As a result, there would be no additional disturbance beyond what currently exists or is currently permitted. Rodeo Creek would be diverted from its current channel north of the Betze Pit to the south of the pit to accommodate mine expansion under current authorizations. This diversion would have minimal visual impact considering the close proximity to the Betze Pit, Bazza Waste Rock Facility, and other disturbed sites within the VRM Class IV area. Descriptions of each facility are presented in Section 2.2, No Action Alternative. Visual effects would be essentially as described in the 1991 Betze Project EIS (BLM 1991a,b). Activities permitted under these NEPA documents would continue, including reclamation of disturbance areas (BGMI 2007a), which ultimately would reduce the visual contrast from mining-related activities.

The visual effects of the existing and approved project were considered to be “less than significant” in the 1991 Betze Project EIS (BLM 1991a,b).

### 3.13.2.2 Proposed Action

Development of the proposed Betze Pit Expansion Project would expand the extent of the visual contrast that currently occurs between existing and previously approved mine-related facilities and the natural character of the landscape. The primary change in visual effects from the currently approved levels would be the expansion of the project footprint. Of somewhat lesser importance, the proposed project also would extend the duration of active mining, which is the time when visual effects are most prominent. Prior to completion of reclamation, the existing features exhibit strong color contrast, especially under bright, clear light conditions. In addition, there are moderate to strong line and landform contrasts generated to a large extent by the flat tops and geometric




**Betze Pit Expansion Project**

Figure 3.13-2

Key Observation Points for Visual Resources

shapes of the waste rock and tailings facilities. Finally, there is moderate texture contrast between the bare surfaces of the mine features and the vegetation textures and patterns in the natural landscape. The visual contrast effects gradually would become less prominent with implementation of reclamation.

Development of the proposed project would result in new and expanded features in the landscape. From a visual perspective, the most visible proposed features would include the new Clydesdale Waste Rock Facility, the new Goldstrike No. 3 Tailings Facility, and expansion of the Betze Pit. Descriptions of each facility (including maximum elevation above native ground surface) are presented in Section 2.3, Proposed Action.

The proposed waste rock and tailings facilities would have visual characteristics during active mining that would be similar to existing facilities, notably a geometric form and exposed rock surfaces. As a result, the proposed Betze Pit Expansion Project would have similar, but expanded, visual effects to those already occurring from the existing facilities, including strong color contrast, moderate to strong line and landform contrast, and moderate texture contrast. The key considerations, therefore, are the degree of expansion of the visual impacts, and the amount of contrast permissible under the relevant VRM class objectives.

Most visual effects of the proposed project would be seen from both KOPs #1 and #2. The Clydesdale Waste Rock Facility would rise nearly 500 feet above the existing grade; the Goldstrike No. 3 Tailings Facility would rise approximately 335 feet; and the Betze Pit layback areas would be approximately 4,300 feet long and approximately 1,100 feet wide at their maximum extent. During active mining, the disturbance would be more visually prominent than existing and previously approved activities. In addition, lighting used to facilitate around-the-clock mining would emphasize the visual contrast at night. The area proposed for disturbance is rated VRM Class IV. The class objective provides for "... major modification of the existing character of the landscape ..." therefore, the visual disturbance would be in conformance with the objective if "every effort" is made to minimize the visual impact. Recent past and on-going reclamation efforts by BGMI have been effective at mimicking natural landforms in the project vicinity. Assuming the same reclamation standards would be implemented for the proposed project, it would be expected that the visual contrasts from waste rock and tailings facilities would be substantially reduced after reclamation. BGMI has committed to constructing the margins of the waste rock facilities to provide for variable topography during final regrading, thereby providing a more natural post-mining landscape. Concurrent reclamation would be implemented to the extent possible (Section 2.2.1.13, Applicant-committed Environmental Protection Measures). As a result, the long-term visual effects would achieve the VRM class objectives of Class IV. The upper portion of the Betze Pit wall would remain visible, and the color contrast from the wall likely would remain strong for a long period of time. However, the pit would be in a Class IV area and the "major modification" standard would permit the strong contrast effect to continue if efforts are made to minimize the effect to the degree possible.

The proposed project would meet the VRM Class IV management objectives during active mining, although meeting the specific objectives regarding "minimizing disturbance" and "repeating basic elements (form, line, color, and texture)" would be a challenge in some areas. The objectives also indicate that "major modification" is anticipated and that visual dominance can be accommodated in Class IV areas. Based on the reclamation plan and applicant-committed environmental protection measures (Section 2.2.1.13), waste rock and tailings facilities would be recontoured and revegetated resulting in a smoothing and rounding of the side slopes into an irregular pattern to more closely approximate the surrounding landscape. Revegetation would be necessary in meeting the VRM class objectives, as the most pronounced visual contrast would be the color difference introduced by the bare rock in comparison to the natural vegetative color palette. Recontouring and revegetation of the waste rock and tailings facilities would "minimize the disturbance" and would bring the proposed project into conformance with the VRM objectives, once reclamation activities have been successfully implemented. As a result, the long-term visual effects would not exceed the VRM Class IV Management Objectives and visual impacts are estimated to be low. Reclamation is proposed to occur concurrently with mining to the extent possible, as discussed in Section 2.2.1.13, Applicant-committed Environmental Protection Measures. This would ensure that visual contrast would be minimized at the earliest possible time.

#### 3.13.2.3 Bazza Waste Rock Facility Alternative

Under this alternative, up to an additional 350 million tons of waste rock would be disposed of in the existing Bazza Waste Rock Facility. The maximum height of the facility would be increased to approximately 800 feet above the original topography compared with approximately 700 feet for the existing facility. The increase in height would make the facility slightly more visible from viewpoints, but the visual impact would be minimal compared with size and height of the existing facility.

This alternative has similar long-term visual impacts as for the Proposed Action without construction of the haul road and Clydesdale Waste Rock Facility. The Bazza Waste Rock Facility Alternative would meet the VRM Class IV management objectives during active mining, although meeting the specific objectives regarding “minimizing disturbance” and “repeating basic elements (form, line, color, and texture)” would be a challenge in some areas.

### 3.13.3 Cumulative Impacts

The CESA for visual resources encompasses the Carlin Trend and is shown in **Figure 3.13-1**. The Carlin Trend was selected as the CESA boundary as this area incorporates the major surface disturbance activities primarily as a result of mining activities. Past, present, and RFFAs are identified in Section 3.1.

#### 3.13.3.1 No Action Alternative

Visual effects of past and present actions are included in the description of the affected environment (Section 3.13.1). The future actions, through the year 2025, that will create visual effects are predominantly mining-related activities, including both exploration and development projects. There also will be a potential increase in the construction of dirt roads. Among these actions, the mining projects would be the most likely to introduce strong visual contrast in the cumulative effects study area. However, all of the identified future actions will be located in VRM Class IV areas, so it is anticipated that the visual disturbance would be accommodated by the standards of the VRM Class IV objectives, which provide for “major modification” of the landscape. Based on the No Action Action Alternative’s reclamation plan and the assumption that standard reclamation requirements will be required for permitting of future projects, the cumulative visual effects would be minimized to the degree possible after completion of the projects.

#### 3.13.3.2 Proposed Action

Cumulative effects to visual resources under the Proposed Action would be similar to the cumulative impacts described for the No Action Alternative except that the Proposed Action would incrementally add a new waste rock and tailings facility and would expand the Betze Pit. These additional mine facilities and associated visual disturbances are located in VRM Class IV areas that allow “major modifications” to the landscape. The cumulative visual effects would be minimized to the extent practical after reclamation was completed.

#### 3.13.3.3 Bazza Waste Rock Facility Alternative

Cumulative impacts to visual resources under the Bazza Waste Rock Facility Alternative would be similar to the Proposed Action.

### 3.13.4 Mitigation Measures and Monitoring

During active mining, little can be done to reduce the landform and color contrasts without unduly interfering with mine operations. However, based on BGMIs applicant-committed environmental protection measures (Section 2.2.1.13) and this environmental analysis, the residual visual effects would be minimized to the extent possible as required by VRM Class IV objectives. As a result, no monitoring and mitigation beyond implementation of the applicant-committed environmental protection measures and reclamation plan have been identified for visual resources.

### 3.13.5 Residual Impacts

Increased surface disturbance and the long-term presence of surface activities in the project area would result in unavoidable adverse impacts to the visual resources that cannot be completely mitigated. Residual adverse visual effects would result from the long-term changes in landform and color contrasts associated with the Betze Pit Expansion Project landform walls. The visual effects gradually would diminish over time as natural vegetation patterns would develop to help mask the landform and color contrasts. However, the unreclaimed pit and pit walls would result in permanent visual effects.

## 3.14 Hazardous Materials and Solid Waste

### 3.14.1 Affected Environment

The affected environment for hazardous materials includes air, water, soil, and biological resources that potentially could be affected by an accidental release of hazardous materials during transportation to and from the mine and during storage and use at the mine. The study area for direct and indirect impacts for hazardous materials and solid waste encompasses the Goldstrike Mine operations boundary and transportation routes for hazardous materials and wastes between I-80 and Goldstrike Mine, including SR 766 and Eureka County Road 237A (**Figure 3.14-1**). The CESA for hazardous materials and solid waste encompasses the permitted mine sites in the Carlin Trend (**Figure 3.1-2**).

#### 3.14.1.1 Project-related Hazardous Materials

The mining and ore processing operations for the proposed project would require the use of the following materials classified as hazardous:

- Diesel fuel, gasoline, oils, greases, anti-freeze, and solvents used for equipment operation and maintenance;
- Sodium cyanide, sodium hydroxide, acid, flocculants, lime, and antiscalants used in mineral extraction processes;
- Ammonium nitrate and high explosives used for blasting in the open pits; and
- Various by-products classified as hazardous waste and chemicals used in the existing assay laboratory.

There would be no change in the current reagent consumption rate at the existing operations.

#### 3.14.1.2 Regulatory Framework for Hazardous Materials

"Hazardous materials," which are defined in various ways under a number of regulatory programs, can represent potential risks to both human health and the environment when not properly managed. The term "hazardous materials" includes the following materials that may be utilized or disposed of in conjunction with mining operations:

- Substances covered under Occupational Safety and Health Administration and MSHA Hazard Communication Standards (29 CFR 1910.1200 and 30 CFR 42): the types of materials that may be used in mining activities and that would be subject to these regulations would include almost all of the materials identified above.
- "Hazardous materials" as defined under USDOT regulations at 49 CFR, Parts 170-177: the types of materials that may be used in mining activities and that would be subject to these regulations would include sodium cyanide, explosives, cement, fuels, some paints and coatings, and other chemical products.
- "Hazardous substances" as defined by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and listed in 40 CFR Table 302.4: The types of materials that may contain hazardous substances that are used in mining activities and that would be subject to these requirements would include sodium cyanide, solvents, solvent-containing materials (e.g., paints, coatings, degreasers), acids, and other chemical products.

"Hazardous wastes" as defined in the Resource Conservation and Recovery Act (RCRA): procedures in 40 CFR 262 are used to determine whether a waste is a hazardous waste. The types of materials used in mining activities and that could be subject to these requirements could include liquid waste materials with a

flash point of less than 140°F, spent solvent containing wastes, corrosive liquids, and lab assay wastes. Hazardous wastes are regulated under Subtitle C of RCRA.

- Any “hazardous substances” and “extremely hazardous substances” as well as petroleum products such as gasoline, diesel, or propane, that are subject to reporting requirements if volumes on-hand exceed threshold planning quantities under Sections 311 and 312 of Superfund Amendments and Reauthorization Act (SARA): the types of materials that may be used in mining activities and that could be subject to these requirements would include fuels, coolants, acids, and solvent-containing products such as paints and coatings.
- Petroleum products defined as “oil” in the Oil Pollution Act of 1990: The types of materials used in mining activities and that would be subject to these requirements include fuels, lubricants, hydraulic oil, and transmission fluids.

In conjunction with the definitions noted above, the following lists provide information regarding management requirements during transportation, storage, and use of particular hazardous chemicals, substances, or materials:

- The SARA Title III List of Lists or the Consolidated List of Chemicals Subject to Emergency Planning and Community Right-to-Know Act and Section 112(r) of the CAA; and
- The USDOT listing of hazardous materials in 49 CFR 172.101.

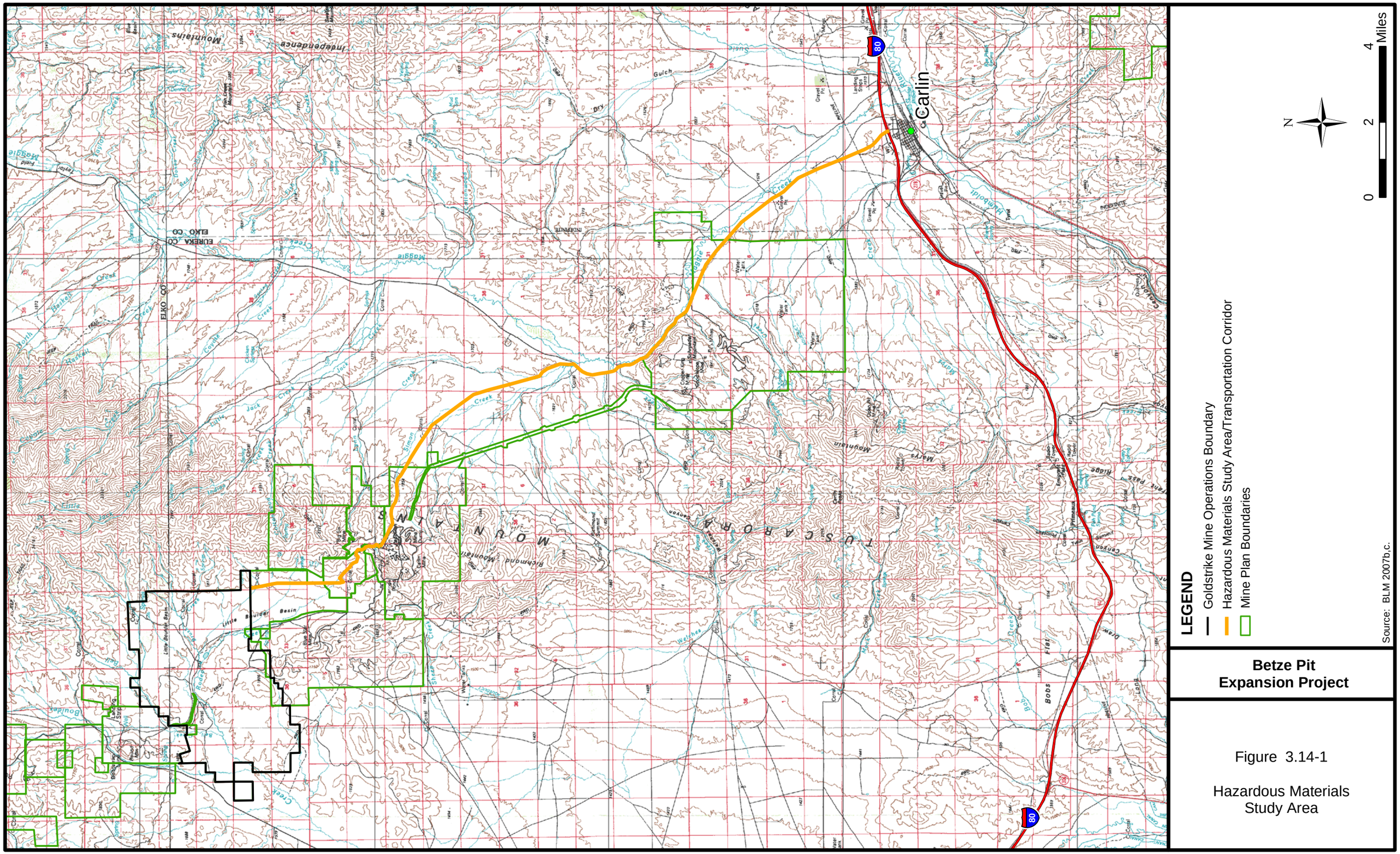
Certain types of materials, while they may contain potentially hazardous constituents, are specifically exempt from regulation as hazardous wastes. Used oil, for example, may contain toxic metals, but would not be considered a hazardous waste unless it meets certain criteria. Other wastes that might otherwise be classified as hazardous are managed as “universal wastes” and are exempted from hazardous waste regulation as long as those materials are handled in ways specifically defined by regulation. An example of a material that could be managed as a universal waste is lead-acid batteries. As long as lead-acid batteries are recycled appropriately, requirements for hazardous waste do not apply.

Pursuant to regulations promulgated under CERCLA, as amended by SARA, release of a reportable quantity of a hazardous substance to the environment must be reported within 24 hours to the National Response Center (40 CFR Part 302). The NAC (445A.347) also requires immediate reporting of a release of a reportable quantity of a hazardous substance to the Nevada Division of Emergency Management. In addition, under the State of Nevada Water Pollution Control Permit program, all releases of a reportable quantity must be reported as soon as possible, but not later than 24 hours after the event, to the NDEP Bureau of Corrective Actions. Nevada regulates the storage and handling of certain defined “highly hazardous substances” under NAC 459.952-459.9542.

Incidental spills of hazardous substances in the study area have occurred during previous mining and mineral processing operations at the project site. All reported spills have been mitigated, and contaminated materials have been managed in accordance with federal and state regulations.

#### 3.14.1.3 Regulatory Framework for Solid Waste

Solid waste consists of a broad range of materials that include garbage, refuse, wastewater treatment plant sludge, non-hazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances) resulting from industrial, commercial, mining, agricultural, and community activities (USEPA 2003). Solid wastes are regulated under different subtitles of RCRA and include hazardous waste (discussed in the previous section) and non-hazardous waste. Non-hazardous wastes are regulated under RCRA Subtitle D. In Nevada, solid waste rules are found in the NAC. Disposal of solid waste is regulated under NAC 444.570-444.7499; disposal of hazardous waste is regulated under NAC 444.850-444.8746.




**Betze Pit Expansion Project**

Figure 3.14-1

Hazardous Materials Study Area

06/06/2008

#### 3.14.1.4 Solid Wastes Generated from Mining Operations

The major wastes within the study area include hazardous waste, petroleum contaminated soil, construction debris, trash, and sanitary waste. The Goldstrike Mine generates enough hazardous waste to be considered a large quantity generator under the RCRA waste generator rules (greater than 2,200 pounds per month). Petroleum contaminated soil is treated at an on-site bioremediation treatment facility. Construction debris and trash are disposed of at an on-site landfill, and sanitary wastes are treated in a wastewater treatment system. **Table 3.14-1** lists hazardous waste generated typically on an annual basis.

**Table 3.14-1 Goldstrike Mine Hazardous Waste Generated in 2005[1]**

| Type of Waste | Quantity Generated (lbs) |
|---|---|
| Aerosol Can Waste | 1,162 |
| Aerosol Filters, Paint Filters | 280 |
| Waste Paint Related Material | 1,126 |
| Debris Contaminated w/used oil and Tetrachlorethylene | 250 |
| Inorganic Lab Waste | 185,658 |
| Computer | 34,220 |
| Baghouse Dust from Assay Lab | 10,151 |
| Brick, Mortar, and Soil | 19,180 |
| Hepa Filters and Debris | 14,240 |
| Used Oil Contaminated with Tetrachlorethylene | 21,912 |
| Used Oil Contaminated with Trichloroethylene | 13,031 |
| Used Solvent | 457 |
| Waste Lead/Acid Batteries | 400 |
| Lead Contaminated Sandblast Grit | 8,952 |

[1]All hazardous waste is sent to a Transfer Storage Disposal Facility.

Source: BGMI (2006a,b).

### 3.14.2 Environmental Consequences

#### 3.14.2.1 No Action Alternative

Important issues related to the presence of hazardous materials at the Goldstrike Mine are the potential impacts to the environment from an accidental release of hazardous materials during transport to the project area or a release related to use or storage at the site.

Under the No Action Alternative, the proposed Betze Pit expansion would not occur. However, the transport, storage, use, and disposal of hazardous materials for the ongoing processing of ore at the existing Goldstrike Mine would continue until recovery has been completed. The type and frequency of hazardous materials shipments would not change from present authorized consumption and use. There would be a low likelihood of a hazardous material release during transportation. In addition, the existing facilities have an Environmental Incident Response Manual in place that provides the training and facility infrastructure to minimize the potential

effects of a hazardous materials spill (BGMI 2007b). The No Action Alternative would present a very low potential for a significant impact involving a release of hazardous materials during transportation and storage.

#### 3.14.2.2 Proposed Action

Under the Proposed Action the transport, storage, use, and disposal of hazardous materials for mine operations would continue for an additional 4 years beyond the time frame for the No Action Alternative. The type and frequency of hazardous material shipments would not change from current authorized consumption and use. If some of the chemicals identified for use during the life of the proposed expansion were to enter the environment in an uncontrolled manner, there could be associated direct or indirect adverse effects. The environmental effects of a release would depend on the substance, quantity, timing, and location of the release. The event potentially could range from a minor oil spill on the project site where cleanup equipment would be readily available, to a severe spill large release of sodium cyanide solution. As a result, the potential risk for impacts due to spills would be the same as discussed under the No Action Alternative.

Transportation

All hazardous substances would be transported by commercial carriers or vendors in accordance with the requirements of Title 49 of the CFR. Carriers would be licensed and inspected as required by Nevada Department of Transportation and USDOT. Tanker trucks would be inspected and would have a Certificate of Compliance issued by the Nevada Motor Vehicle Division. These permits, licenses, and certificates are the responsibility of the carrier. Title 49 of the CFR requires that all shipments of hazardous substances be properly identified and placarded. Shipping papers must be accessible and must include information describing the substance, immediate health hazards, fire and explosion risks, immediate precautions, fire-fighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers. Goldstrike Mine was certified May 17, 2007, by the ICMC (ICMC 2008). This certification applies to the manufacture, transport, and use of cyanide in the production of gold.

A large-scale release of fuel or reagents would have implications for public health and safety. The location of the release would again be the primary factor in determining its importance. A release in a populated area could have effects ranging from simple inconvenience during cleanup to potential loss of life if an explosion and fire were involved. However, the probability of a release anywhere along a transportation route is very small; the probability of a release within a populated area is smaller; and the probability of a release involving an injury or fatality is smaller still. USDOT statistics show that for the State of Nevada from 2002 to 2005, no fatalities resulted from large truck transportation incidents involving a hazardous material release (USDOT 2007). Over the same time period, there were a total of six releases of hazardous materials from large truck transportation incidents. Fifty percent of the releases involved flammable liquid. It is not anticipated that a release involving severe effects to human health or safety would occur during the life of the project. The total number of crashes involving large trucks carrying hazardous materials during the 2002 to 2005 period was 42 for the State of Nevada. Six of the incidents occurred in Elko County, and two occurred in Eureka County (USDOT 2007).

Storage and Use

BGMI has developed a Spill Prevention, Control, and Countermeasures (SPCC) Plan in accordance with 40 CFR Part 112, which describes the required level of containment and safety measures associated with storage, handling, and spill clean-up of oil (includes but not limited to petroleum, fuels, sludge, used oil, and mineral oil) (BGMI 2007b). Operations conducted in accordance with the SPCC Plan would ensure that impacts from spills would be minimized and the spilled materials contained and removed. BGMI would have the necessary spill containment and cleanup equipment available at the site, and personnel would be able to quickly respond.

In the event of a spill of hazardous waste occurring on site, BGMI has prepared an Environmental Incident Response Manual that establishes procedures for preventing, controlling, and reporting environmental releases within or from facilities located at the Goldstrike Mine (BGMI 2007b).

Environmental effects of releases are minimized by prompt clean up of impacted media. **Table 3.14-2** summarizes large spills that occurred from July 2002 to July 2003 and is provided as an example of the types of spills and spill frequency that might be expected during mining operations. Most of the spills consist of diluted water-cyanide solutions while the rest are fuel or oil. Petroleum contaminated soil (PCS) is handled onsite in a two-step process. PCS is excavated from the spill site and taken to a permitted biotreatment facility. After treatment, it then is used for supplemental fuel in the facility roaster. Typically, about 300 to 500 cubic yards of soil is brought to the biotreatment facility on an annual basis. For spills of WAD cyanide (CN) solutions that impact soil, soils are immediately excavated and the excavated area is sampled (Girardo 2008). The clean up confirmation soil samples are tested at an independent laboratory to ensure that the area has been adequately cleaned up and no impacted soil remains. Spill areas are excavated until laboratory analyses indicate non-detect in confirmation samples. If laboratory analyses indicate non-detect concentrations, the excavations are backfilled with clean soil. As a Bevill Amendment exempt waste, soils impacted by WAD CN solution spills are placed on leach piles or tailing impoundments. Such handling of spill impacted media ensures that the public health and environment are protected from the effects of hydrocarbons or process solutions.

**Table 3.14-2 Large Spills Recorded from June 2002 to July 2003 at the Goldstrike Mine**

| Date | Material | Quantity and Concentration (ppm) | Location |
|---|---|---|---|
| 07/17/02 | Hydraulic oil | 70 gallons | South Ramp, Betze pit; T36N, R49E, Sec. 30 |
| 08/07/02 | Reclaim/fresh water | 25,600 gallons/0.2 ppm WAD CN | N.B. seep pump return line; T36N, R50E, Sec.18 |
| 08/07/02 | Reclaim/fresh water | 14,000 gallons/0.14 ppm WAD CN | N.B. seep pump return line; T36N, R50E, Sec.18 |
| 09/20/02 | Form oil | 230 gallons | Meikle 1225 vent access; T36N, R49E, Sec.13 |
| 10/05/02 | CIL clean-out solution | 3,500 gallons/0.48 ppm WAD CN | Mill crusher #2 feed surge pile; T36N, R50E, Sec. 29 |
| 01/06/03 | Diesel fuel | 200 gallons | Q5 parking area, R36E, T49N, Sec. 19 |
| 01/21/03 | Gear oil | 200 gallons | Roaster primary crusher; R36E, T49N, Sec. 13 |
| 06/23/03 | Acidulation slurry | 3,900 gallons/0.1ppm WAD CN | 603 Acidulation Tank, T36N, R50E, Sec. 29 |
| 07/24/03 | Reclaim and fresh water mixture | 145,000 gallons/0.02 ppm WAD CN | AA Emergency Containment Pond/Storm Containment Pipe; T36N, R50E, Sec. 20 |
| 07/25/03 | Used oil | 94 gallons | Meikle – road west of vent shaft |

Source: BGMI and SRK 2007.

The existing processing facilities, which would be used under the proposed project, were designed to minimize the potential for an upset that could result in a major spill. The SPCC Plan and the Emergency Response and

Contingency Plan would continue to be in place to provide the structures, procedures, and training to minimize the impacts of spills of hazardous materials.

All hazardous substances would be handled in accordance with applicable MSHA regulations (Title 30 CFR). The hazardous materials to be used under the Proposed Action would be handled as recommended on the manufacturer's Material Safety Data Sheets. Based on the facility's design features and the operational practices in place, the probability of a major release occurring at the site during the life of the proposed mine expansion would be low.

Disposal

All hazardous waste generated at the mine (including any liquid lab wastes that meet the hazardous waste criteria) would be transported to licensed disposal facilities in accordance with applicable federal and state regulations. Other solid wastes would be disposed of appropriately depending upon waste type.

Potential Effects of a Release

The environmental effects of a release would depend on the material released, the quantity released, and the location of the release. Potential releases could include a small amount of diesel fuel spilled during transfer operations at the mine site or the loss of several thousand gallons of sodium hydroxide, diesel fuel, or sodium cyanide into a riparian drainage. In general, the materials of greatest concern would be sodium cyanide, sodium hydroxide, and diesel fuel.

The release of a hazardous material or waste into a sensitive area (such as stream, wetland, or populated area) is judged to be very unlikely. Depending on the material released, the amount released, and the location of the release, an accident resulting in a release could affect soils, water, biological resources, and human health.

Response to a Release

All spills, including transportation and loading/unloading spills occurring on site, would be cleaned up as soon as possible. If a spill exceeds reportable quantities, it would be reported to the Nevada Division of Emergency Management, NDEP, BMRR, USEPA, National Response Center, BLM, and the Eureka or Elko County Emergency Response Coordinator.

In the event of a release en-route to the mine site, the transportation company would be responsible for response and cleanup. Law enforcement and fire protection agencies also may be involved to initially secure the site and protect public safety. Hazardous materials transporters are required to maintain an emergency response plan which details the appropriate response, treatment, and cleanup for a material spilled onto land or into water. For example, a release of hydrochloric acid could require neutralizing the spill with lime, flushing the area with water, or removing contaminated soil. Specific procedures would be developed for fuels, acids, and other hazardous materials. Any cleanup would be followed by appropriate restoration of the disturbed area, which could include replacing removed soil, seeding the area to prevent erosion, and the return of the land to its previous use.

#### 3.14.2.3 Bazza Waste Rock Facility Alternative

There would be differences in hazardous materials use under the Bazza Waste Rock Facility Alternative, but solid waste generation and disposal is expected to be the same as compared to the Proposed Action. The Bazza Waste Rock Facility Alternative would require five additional haul trucks and result in consumption of an additional 5.3 million gallons of diesel fuel. There would be a very slight increase in the probability of a spill occurring during transportation of additional diesel fuel to the mine, but given the already low probability of a release, potential risk for impacts due to spills would be the same as for the No Action and Proposed Action.

## 3.14.3 Cumulative Impacts

The CESA for hazardous materials encompasses the permitted mine sites in the Carlin Trend (**Figure 3.1-2**). The past and present actions and RFFAs are identified in Section 3.1.

### 3.14.3.1 No Action

Quantities of hazardous materials transported and used and solid waste generated in the CESA are not expected to change appreciably in the future other than slight incremental increases (BLM 2007b,c). Quantities would be expected to decrease over the long term assuming the mineral deposits become completed and no new major mining takes place. Based on the foregoing and the fact that the likelihood of potential impacts is very remote, there would be no cumulative impacts.

### 3.14.3.2 Proposed Action

There would be no incremental annual increase in the use of hazardous materials or generation of solid waste, only an extension of the period of usage and generation. As with the No Action, there is a very low probability for potential impacts and consequently no cumulative impacts.

### 3.14.3.3 Bazza Waste Rock Facility Alternative

Potential cumulative effects under the Bazza Waste Rock Facility Alternative would be similar to the Proposed Action.

## 3.14.4 Mitigation Measures and Monitoring

Due to the legal framework that regulates the transportation, storage, use, and disposal of hazardous materials, no monitoring or mitigation measures have been identified.

## 3.14.5 Residual Impacts

Residual adverse effects from the use of hazardous materials under the Proposed Action would depend on the substance, quantity, timing, location, and response involved in the event of an accidental spill or release. Operation in accordance with the facility's SPCC Plan and the Environmental Incident Response Manual, and prompt cleanup of potential spills and releases, would minimize the potential of residual adverse effects due to accidental spills or releases of hazardous materials. Reagents such as sodium cyanide can be acutely toxic, but they do not persist in the environment for long periods of time. Modern regulations that govern the transportation, storage, use, and disposal of hazardous materials have greatly reduced the potential for residual adverse effects due to hazardous materials.

## 3.15 Energy Requirements

The estimated fuel and electrical power consumption for the Proposed Action and alternatives are provided in **Table 3.15-1**. Barrick Gold Corporation has adopted a Climate Change program, which is applicable to BGMI and includes a commitment to improve energy efficiency by 8 percent from its 2006 baseline model by 2012. In accordance with Nevada law, 15 percent of the electrical power consumed by BGMI would come from renewable energy sources. These reductions are not reflected below.

Recent scientific evidence suggests there is a direct correlation between global warming and emissions of GHG (IPCC 2007). GHGs include $CO_2$, methane, $NO_X$, and $O_3$. Although many of these gases occur naturally in the atmosphere, man-made sources have substantially increased the emissions of GHGs over the past several decades. Of the man-made GHGs, the greatest contribution currently comes from $CO_2$ emissions.

At present, there is no regulatory program which requires reductions in greenhouse emissions. However, in response to a Supreme Court decision interpreting the CAA, USEPA has announced that it will soon publish an advance notice of proposed rulemaking addressing regulatory mechanisms for regulating GHG emissions for purposes of addressing climate change. Congress also is debating legislation that would impose regulatory controls or incentives for reducing GHG emissions.

GHG emissions associated with the proposed project would be associated primarily with the consumption of energy for mining and ore processing over the 23-year project life. Operations that would contribute to GHG emissions would include:

- Fuel consumption (vehicles and machinery); and
- Electricity consumption (machinery, milling, dewatering).

The current national annual emissions of GHGs are approximately 8 billion tons (USEPA 2008). Under the Proposed Action, the project would emit approximately 972,594 tons per year of GHGs, or approximately 0.01 percent of the national annual emissions.

*$CO_2$ Emissions*

The Proposed Action would not change the present annual emission rate of $CO_2$ at the mine; however, it would extend the period of mining by 4 years over the No Action Alternative and generate 5 more years of $CO_2$ emissions. This extension of $CO_2$ emissions would not materially impact state, national, or global climate change.

## Table 3.15-1 BGMI Estimated Fuel and Electrical Power Consumption

| Case | Diesel Consumption (gallons) | Diesel Consumption ($m^3$) | Propane Consumption (gallons) | Propane Consumption ($m^3$) | Power Consumption (MW-hour) | Diesel-related GHG (tons) | Propane-related GHG (tons) | | | Indirect Power-related GHG (tons) | | | Green House Gas (tons) | GHG/Yr (tons) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2$ | | |
| No Action Alternative | 49,990,211 | 189,268 | 1,025,450 | 3,882 | 18,884,232 | 569,404 | 27 | 17 | 6,418 | 0 | 0 | 19,152,367 | 19,728,234 | 1,096,013 |
| Proposed Alternative | 116,643,725 | 441,625 | 1,305,627 | 4,943 | 20,738,316 | 1,328,610 | 63 | 39 | 8,171 | 0 | 1 | 21,032,777 | 22,369,662 | 972,594 |
| Bazza Waste Rock Facility Alternative | 119,293,825 | 451,658 | 1,305,627 | 4943 | 20,738,316 | 1,358,795 | 65 | 40 | 8,171 | 0 | 1 | 21,032,777 | 22,399,848 | 973,906 |

Source: BGMI 2008a.

## 3.16 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

As described in the introduction to Chapter 3.0, short-term is defined as the 19-year operational life of the project and the 4-year reclamation period; long-term is defined as the future following reclamation (i.e., beyond 23 years). This section identifies the tradeoffs between the short-term impacts to environmental resources during operation and reclamation versus the long-term impacts to resource productivity that would extend beyond the end of reclamation.

The short-term use of resources during the expansion, operation, and reclamation of the proposed project would result in beneficial impacts in the form of an extension of local employment and the generation of revenue.

The proposed project would result in various short-term adverse impacts, such as the temporary loss of soil and vegetation productivity and the associated loss of wildlife habitat, possible wildlife avoidance and displacement, and temporary increases in fugitive dust. These impacts are expected to end upon completion of operations and would be minimized through implementation of applicant committed environmental protection measures.

The short-term adverse visual impacts would last a few years beyond mine closure and gradually would be reduced as vegetation becomes more established. The scale and extent of the facilities would continue to alter the local landscape and views in the long term.

Impacts to long-term productivity (i.e., following project reclamation) primarily would depend on the effectiveness of the proposed reclamation of the disturbance areas. Successful reclamation would provide for post-mining wildlife and self-sustaining plant communities. Revegetation also is expected to stabilize disturbed surfaces and control erosion.

There would be a long-term loss in soil and vegetation productivity and associated terrestrial wildlife habitat that would not be reclaimed.

## 3.17 Irreversible and Irretrievable Commitment of Resources

The Proposed Action could result in the irreversible commitment of resources (e.g., the loss of future options for resource development or management, especially of nonrenewable resources such as minerals or cultural resources) or the irretrievable commitment of resources (e.g., the lost production or use of renewable natural resources during the life of the operations). Irreversible and irretrievable impacts of the Proposed Action are summarized for each resource in **Table 3.17-1**.

**Table 3.17-1 Irreversible and Irretrievable Commitment of Resources by the Proposed Action**

| Resource | Irreversible Impacts | Irretrievable Impacts | Explanation |
|---|---|---|---|
| Geology and Minerals | Yes | Yes | Approximately 12.44 million tons of gold ore would be mined during operations. This would result in the irreversible and irretrievable commitment of this resource. |
| Groundwater Resources and Geochemistry | Yes | Yes | Evaporation from the pit lake is an irreversible and irretrievable impact. |
| Surface Water Resources | No | No | No irreversible or irretrievable commitment of resources or impact is anticipated. |
| Soils | Yes | Yes | Suitable growth media would be salvaged from the mine disturbance areas for use in reclamation. There would be a loss of soil productivity during operations on approximately 1,051 acres, resulting in an irretrievable commitment of this resource. There would be an additional irreversible commitment of the resource on approximately 129 acres associated with the Betze Pit expansion, which would not be reclaimed. |
| Vegetation | Yes | Yes | There would be an irretrievable commitment of vegetation resources on approximately 1,180 acres during operations. Vegetation subsequently would be re-established on all areas except approximately 129 acres that would be irreversibly lost as a result of development of the Betze Pit expansion. |
| Wildlife and Aquatic Resources | Yes | Yes | Approximately 1,180 acres of habitat would be irretrievably lost until vegetation has re-established following reclamation. Approximately 129 acres of the total habitat disturbance would be irreversibly lost for wildlife species as a result of development of the Betze Pit expansion.<br>Approximately 2.3 miles of intermittent stream habitat in Rodeo Creek would be removed. A new section of Rodeo Creek would be constructed and potentially routed to the pit lake. |
| Cultural Resources | Yes | Yes | Although data recovery has been conducted at five historic properties, irreversible and irretrievable impacts to these sites would occur because the sites ultimately would be destroyed by project construction and some of their data would be lost. Irreversible and irretrievable indirect and cumulative impacts to sites not undergoing data recovery would occur. |
| Native American Traditional Values | No | No | No TCP or place of cultural or religious importance has been identified through inventory or by the contacted tribes. |
| Air Quality | No | No | Project emissions would not exceed federal or state AAQS. Air quality would return to existing conditions after completion of the project. |
| Social and Economic Values | No | Yes | Labor and some capital resources, once committed and expended, would not be retrievable. |
| Visual Resources | Yes | No | Impacts to visual resources would be reduced through successful reclamation procedures and implementation of the environmental protection measures. However, permanent changes would result. |
| Hazardous Materials and Solid Waste | No | No | No irreversible or irretrievable commitment of resources or impact is anticipated. However, if a spill were to affect a sensitive resource, an irretrievable impact could occur pending the recovery of the resource. |