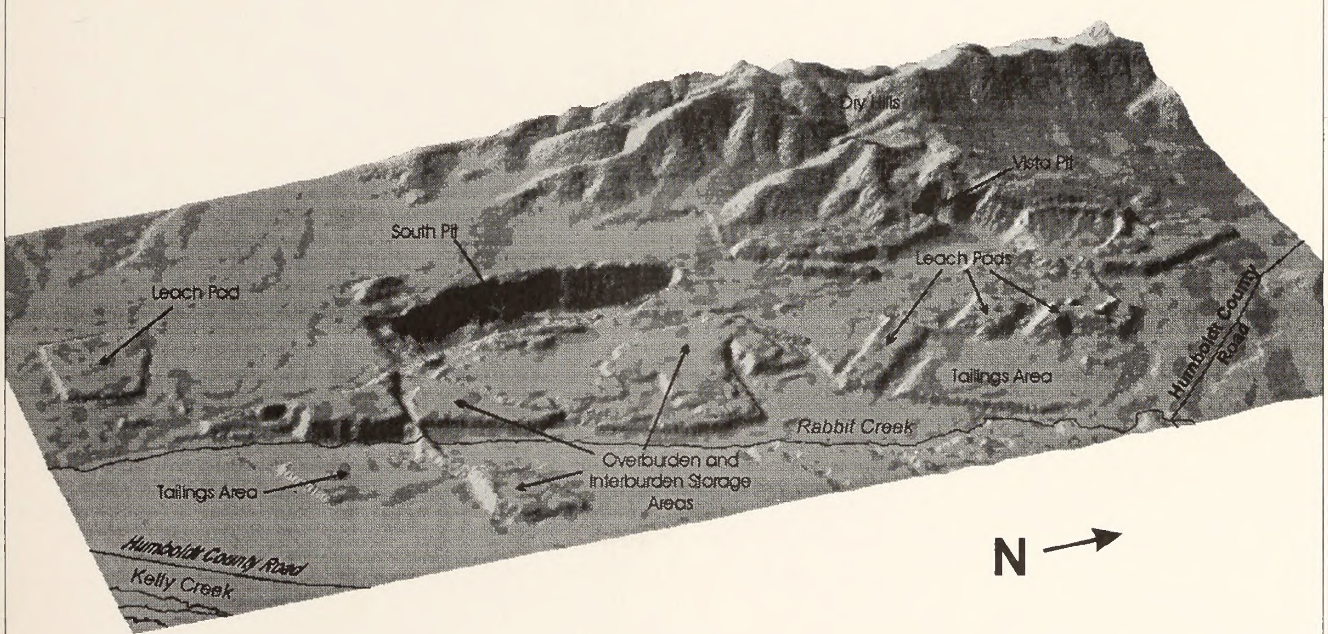
United States Department of the Interior
Bureau of Land Management

Winnemucca District Office
Winnemucca, Nevada

July 1996

Draft
Environmental Impact Statement

Twin Creeks Mine



Existing Twin Creeks Mine

MISSION STATEMENT

The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times. Management is based upon the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include recreation, rangelands, timber, minerals, watershed, fish and wildlife, wilderness, air and scenic, scientific and cultural values.

BLM/WN/PL-96/004+1610

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Winnemucca District Office
5100 East Winnemucca Boulevard
Winnemucca, Nevada 89445
702-623-1500

1793/3809
(NV-932.8)
(NV-020)

June 21, 1996

Dear Reader:

Enclosed for your review and comment is the Draft Environmental Impact Statement for Santa Fe Pacific Gold Corporation's Twin Creeks Mine, prepared by the Bureau of Land Management (BLM), Winnemucca District Office.

The Draft Environmental Impact Statement is based on the plan of operations submitted to the BLM under 43 Code of Federal Regulations 3809. This Draft Environmental Impact Statement analyzes the direct, indirect and cumulative impacts associated with continued mining and expansion of the South Pit, overburden and interburden storage areas, ore processing facilities, expanded dewatering system and water disposal facilities, divesion of Rabbit Creek and tributaries, and ancillary facilities. The plan of operations and technical reports in support of the plan are available for review at the BLM office in Winnemucca.

The BLM is interested in your review and comment on the adequacy and accuracy of this document. Public comments will be accepted during a 60-day comment period. Written comments on the Draft Environmental Impact Statement must be postmarked by September 3, 1996, and should be sent to : **Gerald Moritz, EIS Project Manager, Bureau of Land Management, Winnemucca District Office, 5100 E. Winnemucca Boulevard, Winnemucca, Nevada 89445**.

In addition, a public meeting to accept verbal comments is scheduled for the following date, time and location:

August 15, 1996, 7:00-9:00 p.m., at the Winnemucca District Office, Winnemucca, Nevada.

A Final Environmental Impact Statement will be prepared that will consider the comments received after the public review and comment period. This Final Environmental Impact Statement may be in an abbreviated format; therefore, you should retain this Draft as a reference. For additional information, please contact Gerald Moritz at the above address or at (702) 623-1500.

Sincerely,

Ron Wenker

Ron Wenker
District Manager

Enclosure as stated

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
TWIN CREEKS MINE

Lead Agency:	U.S. Department of the Interior Bureau of Land Management Winnemucca District Office
Project Location:	Humboldt County, Nevada
Comments on this EIS Should be Directed to:	Gerald Moritz, EIS Project Manager Bureau of Land Management Winnemucca District Office 5100 East Winnemucca Boulevard Winnemucca, Nevada 89445 (702) 623-1500
Date Draft EIS Filed with EPA:	July 5, 1996
Date by Which Comments Must Be Received by the BLM:	September 3, 1996

ABSTRACT

Santa Fe Pacific Gold Corporation (SFPG) has submitted a *Revised Final BLM Plan of Operations and NDEP Reclamation Plan and Permit Application* for the Twin Creeks Mine, which encompasses the former Rabbit Creek and Chimney Creek Mines. The proposed project would include South Pit expansion; overburden and interburden storage areas; additional milling, flotation, and tailings facilities; additional heap leaching and processing facilities; expanded dewatering system and water disposal facilities; diversion of Rabbit Creek and tributaries; utility corridors; ancillary facilities; and Humboldt County road relocation. The proposed expansion would affect 4,866 acres of public land administered by the Bureau of Land Management. All of this acreage occurs within the existing SFPG permit boundary. Construction is scheduled to begin upon approval, which is anticipated to be in late 1996, and be completed in early 1998; operation of the expanded facilities would begin thereafter and continue through the year 2011.

This Draft Environmental Impact Statement (EIS) analyzes the environmental impacts associated with the proposed mine consolidation and expansion (Proposed Action), the No Action alternative, the Partial Vista Pit Backfill Alternative, the Selective Handling of Overburden and Interburden Alternative, and the Overburden and Interburden Storage Area Alternatives.

Responsible Official for EIS:

Ron Wenker
Winnemucca District Manager

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SUMMARY

Santa Fe Pacific Gold Corporation (SFPG) has submitted a *Revised Final BLM Plan of Operations and NDEP Reclamation Plan and Permit Application* for the Twin Creeks Mine (SFPG 1995a) to the Winnemucca District Office of the Bureau of Land Management (BLM) to consolidate and expand existing mining and processing facilities, and to construct new facilities at the Twin Creeks Mine. The Twin Creeks Mine, which encompasses the former Rabbit Creek Mine and the former Chimney Creek Mine, is located approximately 35 miles northeast of Winnemucca in Humboldt County, Nevada. The former Chimney Creek Mine was located entirely on public lands administered by the BLM, while the former Rabbit Creek Mine was located entirely on private lands owned by SFPG.

Because of the potential for the proposed project to result in significant environmental impacts, the BLM determined that an environmental impact statement (EIS) would be necessary. The BLM is serving as the lead agency for preparing the EIS in compliance with the National Environmental Policy Act of 1969, the Council on Environmental Quality regulations for Implementation of Procedural Provisions of the National Environmental Policy Act (40 Code of Federal Regulations 1500-1508), and the BLM's National Environmental Policy Act Handbook (H-1790-1).

This EIS describes the proposed consolidation and expansion of the mine (Proposed Action), the No Action alternative, and other project alternatives. It also describes the environmental consequences of implementing these alternatives.

Existing Facilities and Operations

Existing mine facilities and operations consist of three open-pit mines (Vista Pit, West Pit, and South Pit), four overburden and interburden storage areas, five heap leaching facilities, two milling and tailings storage facilities, and ancillary facilities. There are currently 970 employees working at the Twin Creeks Mine. The existing facilities encompass approximately 5,094 acres of surface disturbance on a combination of private lands owned by SFPG and public lands administered by the BLM. For purposes of this EIS, the existing disturbance associated with the two former mining operations was calculated as of December 31, 1994.

No Action Alternative

The proposed project would involve the consolidation and expansion of two former mining operations: the Rabbit Creek Mine and the Chimney Creek Mine. The No Action alternative comprises the facilities and operations that are currently authorized by the BLM and/or the State of Nevada for these two operations, but were not constructed or implemented as of December 31, 1994. Upon implementation of the No Action alternative, total surface disturbance would include the existing disturbance plus the additional disturbance associated with the currently permitted facilities and activities. This alternative is addressed and its impacts disclosed in this EIS between the description of the existing conditions (Affected Environment) and the Proposed Action, as this is where it occurs sequentially (i.e., SFPG would continue to develop these facilities).

SFPG anticipates that the construction work force would total approximately 150 people to construct Phase 1 of the sulfide (Sage) mill. Construction is expected to last approximately 12 months. SFPG estimates that no additional operations workers would be needed under the No Action alternative above the current operations work force of 970.

The following facilities and activities are associated with the No Action alternative:

- Exploration, development, and condemnation drilling necessary for future operations
- Open-pit expansion
- Development and expansion of overburden and interburden storage areas
- Development of sulfide ore stockpiles
- Construction of Phase 1 of the sulfide (Sage) mill
- Development and expansion of tailings storage areas

- Development of an additional heap leaching facility
- Development of a limestone storage area
- Development of dewatering wells, water distribution pond, and water treatment plant
- Development of reinfiltration basins
- Construction of haul and access roads
- Construction of ancillary facilities
- Development of a bioremediation site

Proposed Action

SFPG anticipates that the construction work force would total approximately 300 people to construct Phase 2 of the sulfide (Sage) mill, tailings, and heap leach facilities. Construction is expected to last approximately 12 months. SFPG estimates that no additional workers would be needed to operate the proposed mine, mill, tailings, and heap leach facilities above the current operations work force of 970. SFPG's proposed consolidation and expansion project includes the following facilities and activities:

- Consolidation of the two former mining operations, including rights-of-way (i.e., the former Chimney Creek and Rabbit Creek Mines)
- South Pit expansion
- Development of overburden and interburden storage areas
- Development of additional milling, flotation, and tailings facilities
- Development of additional heap leaching and processing facilities
- Expansion of the existing dewatering system and water disposal facilities
- Diversion of Rabbit Creek and tributaries around the mining and processing areas
- Construction of ancillary facilities
- Relocation of the county road

Other Project Alternatives

Alternatives to the Proposed Action include the partial Vista Pit backfill alternative, the selective handling of overburden and interburden alternative, and the overburden and interburden storage area reclamation alternatives.

Summary of Impacts

This section summarizes the anticipated impacts associated with the No Action alternative, Proposed Action, and other project alternatives. Where the impacts would differ for any of the other project alternatives compared to the Proposed Action, this difference is noted.

Geology and Minerals

No Action Alternative

Direct impacts of the No Action alternative on geologic and mineral resources would include (1) the generation and permanent disposal of approximately 44.5 million tons of tailings material 691.7 million tons of overburden and interburden material, and 72.2 million tons of spent heap leach material, (2) the permanent alteration of the geologic terrain and disturbance of an additional 3,136 acres on both private and public lands, and (3) the mining of approximately 5.7 million ounces of gold reserves from the South Pit and 0.8 million ounces of gold from the Vista Pit.

Continued mine expansion is not expected to inhibit future attempts to recover minerals. There are no known active or potentially active faults or landslides in the vicinity of the facilities. Ground subsidence resulting from the lowering of the regional ground water table is predicted to lower the ground surface 4 feet around the perimeter of the pit with subsidence of 1 foot or greater extending up to 1 mile from the pit. Ground subsidence would change the surface gradients. Discontinuous or irregular ground subsidence is unlikely; however, if it occurred, it could potentially damage solution-bearing facilities.

Proposed Action

For the Proposed Action, direct impacts on geologic and mineral resources would include (1) the generation and permanent disposal of approximately 131.5 million tons of tailings material, 1,731.8 million tons of overburden and interburden material, and 135.0 million tons of spent heap leach material, (2) the permanent alteration of the landscape and disturbance of an additional 5,217 acres of alluvial fan on both private and public lands, and (3) the mining of proven and probable ore reserves of approximately 11.7 million ounces of gold and a possible additional 4.1 million ounces of gold.

Ground subsidence related to dewatering is predicted to extend up to 1.4 miles from the pit with a maximum subsidence of 6 feet near the pit rim. Ground subsidence impacts would be similar to the No Action Alternative. The risk of embankment failure due to seismic loading was not determined for the tailings facilities under the Proposed Action since these facilities have not been designed; failure of any of these facilities due to inadequate design would be a significant geologic impact. However, provided these facilities are properly designed, constructed, and closed, significant geologic impacts would not be anticipated.

Storage area D and a portion of storage area B would be constructed over tailings facilities. The geotechnical stability, including seismic design, liquefaction of the substrate, settlement and deformation potential, and decommissioning of the tailings prior to construction have not been evaluated since these facilities have not been designed. Proper design, construction, and facility closure would preclude slope failure and damage to the underlying tailings containment structure, and would not result in significant geologic impacts.

Existing condemnation results indicate that the placement of leach pad E and/or storage area K, and storage area G and/or leach pad C would cover identified economic gold mineralization. Therefore, construction of these facilities as planned would potentially inhibit future attempts to recover these mineral resources on public lands, resulting in a significant impact to mineral resources.

Other Project Alternatives

The other project alternatives would have geologic and mineral resources impacts similar to the Proposed Action.

Water Quantity and Quality

No Action Alternative

Ground water pumping would continue through the year 2000 to dewater the South Pit. The estimated dewatering rate over this period is predicted to increase from approximately 5,000 to 8,000 gallons per minute. Numerical flow modeling indicates that at the end of mining, the drawdown area as defined by the 10-foot drawdown contour is predicted to extend up to 4 miles from the center of the pit. After mining, the drawdown area is predicted to extend 5 to 7 miles from the center of the pit. Water levels in wells within the drawdown area and not associated with the Twin Creeks Mine could potentially be lowered by 10 to 50 feet as a result of mine-induced drawdown. Infiltration would potentially increase the water levels in the vicinity of the reinfiltration ponds up to a maximum of approximately 30 feet. The infiltration would recharge the ground system in this area; it is not anticipated to significantly influence surface water flows.

Flows in the Little Humboldt River and Hot Springs area are predicted to be reduced for the foreseeable future. The maximum predicted baseflow reduction during mining and the 100-year postmining period is approximately 8 percent for the Little Humboldt River and 12 percent for the Hot Springs discharge area. Other perennial stream reaches or springs located within or near the mapped drawdown area could also experience a reduction or cessation of flow. Kelly Creek and other springs in the area are apparently sustained by discharge from localized aquifers and are not likely to be affected. Flows in the lower perennial reach of Jake Creek could potentially be reduced if the regional ground water table and the flows in Jake Creek are interconnected.

Ground water flow modeling indicates that after cessation of mine dewatering a pit lake would begin to develop. The pit lake is predicted to reach its final elevation of 4,580 feet approximately 130 years after mine closure. Modeling of final ground water levels, flow rates, and predicted precipitation, and evaporation rates suggest that the pit lake would have no outflow to either surface or ground water.

Geochemical modeling was used to evaluate potential concentration trends over time as the lake fills. The pH of the pit lake is predicted to rise from a median value of approximately 8.2 to a median value of approximately 8.5 standard units over the 130-year model period. Beyond 1 year after mining, the modeling indicates a greater than 90 percent probability that the pit lake would have a pH above 7. Thus, it is highly unlikely that the pit lake would be acidic. The concentrations of total dissolved solids, antimony, arsenic, and other constituents are predicted to increase over time. The predicted concentrations for aluminum, antimony, and arsenic are predicted to exceed Nevada primary and secondary maximum contaminant levels established for drinking water. However, because modeling indicates that the pit lake would not discharge to surface or ground waters, the pit lake is not expected to degrade surrounding waters of the state. Therefore, maximum contaminant levels for drinking water are not applicable.

The results of geochemical testing indicate that there is the potential for generation of acidic leachate and leachates containing constituents at concentrations in excess of maximum contaminant levels for some rock materials stored on site. However, the potential for impacts to surface water and ground water is considered minimal because of facility design, naturally existing conditions, and engineering controls that would be designed to minimize impacts. Cover material for the piles would be handled selectively to ensure that it is acid-neutralizing and that Meteoric Water Mobility Testing Procedure leachate from the cover material does not exceed the Nevada Division of Environmental Protection criteria.

Up to approximately 11.5 square miles of the Rabbit Creek watershed area would be withdrawn from contributing to surface flows; stormwater runoff and seasonal flows would pool behind overburden and interburden storage area B. Impacts to surface water yields would not be significant due to the arid conditions and the limited occurrence of streamflows. Approximately 2.24 acres of jurisdictional waters of the United States would be affected. Localized erosion and sedimentation would occur as a result of ground disturbance, subsidence and continued water discharge to Rabbit Creek.

Proposed Action

Ground water pumping would continue through the year 2011 to dewater the South Pit. The estimated dewatering rate over this period is predicted to increase from approximately 5,000 to a maximum predicted rate of 12,300 gallons per minute. As with the No Action alternative, mine dewatering would lower the regional ground water elevation. The reinfiltration of ground water southeast of the mine would tend to restrict the expansion of the cone of depression in a southeast direction during mining; however, the cone is predicted to expand during the postclosure period. At mine closure, the cone of depression resulting from the Proposed Action would extend approximately 3 to 7 miles from the center of the pit. In the postmining period, the drawdown cone is predicted to extend up to 4 to 7 miles from the center of the pit. Water levels in wells could potentially be lowered as a result of mine-induced drawdown. The magnitude of drawdown in the vicinity of these wells would be larger than for the No Action alternative.

Numerical modeling indicates that infiltration would potentially increase the water levels in the vicinity of the reinfiltration ponds up to a maximum of approximately 70 feet. This represents an increase of approximately 40 feet in the height of the ground water mound compared to the No Action alternative. As with the No Action alternative, the ground water mound is not predicted to intersect the ground surface in the vicinity of the infiltration area; therefore, an increase in stream flows as a result of reinfiltration, is not anticipated.

Drawdown associated with the Proposed Action would potentially reduce the baseflow (ground water discharge) in some perennial streams and springs, including the Little Humboldt River and the Hot Springs area. The maximum predicted baseflow reduction during mining and the 100-year postmining period is approximately 19 percent for the Little Humboldt River and 27 percent for the Hot Springs discharge area. Other perennial stream reaches, particularly Jake Creek or springs located within or near the mapped drawdown area, could also experience a reduction or cessation of flow. Potential impacts to these perennial streams and springs are potentially larger than drawdown impacts for the No Action alternative.

A pit lake would develop after dewatering ceases. The lake is predicted to reach its final elevation of 4,480 feet approximately 230 years after mine closure. The surface area of the Proposed Action pit lake is predicted to be approximately two times larger than the surface area of the No Action alternative pit lake. Modeling of final ground water levels, flow rates, and predicted precipitation and evaporation rates suggest that the pit lake would have no net outflow to either ground or surface waters.

The pH of the pit lake is predicted to rise from a median value of approximately 8.2 to a median value of approximately 8.7 standard units over the 230-year model period. Beyond 1 year after mining, the modeling indicates a greater than 90 percent probability that the pit lake would have a pH above 7. Thus, it is highly unlikely that the pit lake would be acidic. The predicted water quality of the No Action and Proposed Action pit lakes are very similar. However, at 130 years after mining ceases, the concentrations of some constituents (e.g., aluminum, antimony, nickel, sodium, sulfate, and zinc) are predicted to be higher in the No Action alternative pit lake than the Proposed Action pit lake.

Potential impacts associated with the storage of potentially acid generating materials and other mineral processing facilities would generally be the same as for the No Action alternative.

Overburden and interburden storage facilities would permanently block the Rabbit Creek drainageway. A storm water/sediment collection pond would be constructed immediately north of the storage facilities to capture and temporarily pool runoff during both the operation and post-closure periods. In most years, little if any pooling would occur because of limited precipitation and high evaporation. In the postclosure period, sedimentation into the Rabbit Creek Diversion would eventually fill or block the diversion channel such that runoff from an additional 8.3 square miles would be conveyed into the collection pond. Sediment buildup in the ponded area could potentially cause uncontrolled overflow in this area.

An additional 2.7 square miles of Rabbit Creek watershed area would be withdrawn from contributing to surface flows compared to areas affected by the No Action alternative. Impacts to surface water yields would not be significant due to arid conditions and the limited occurrence of streamflows. An additional 1.09 acres of jurisdictional waters of the United States would be affected. Localized erosion and sedimentation would occur as a result of the Rabbit Creek Diversion outfall into Kelly Creek, and from water discharges within the Rabbit Creek watershed. Additional localized erosion and sedimentation would occur as controlled breaching occurred along the Rabbit Creek Diversion, and postmining drainages evolved through the project area.

Other Project Alternatives

Selective handling of overburden and interburden consists of the segregation and encapsulation of acid-neutralizing and acid-generating mine rock material and placement on a 150-foot basal layer of carbonate alluvium. The selective handling alternative would achieve similar protection of ground water resources as the No Action alternative and Proposed Action design which includes random emplacement of overburden and interburden with a basal layer constructed of a minimum of 50 feet of acid-neutralizing alluvium or oxidized bedrock material.

In the alternative 2 configuration of the overburden and interburden storage areas, the storage areas would be closer to the Rabbit Creek Diversion. As with the Proposed Action, the diversion would be modified at closure with the construction of controlled breach weirs and soil buffer dikes and associated features to protect the storage areas from storm water runoff in the postmining period. Therefore, potential erosion and sedimentation impacts from alternative 2 would be similar to the Proposed Action. No additional water quantity or water quality impacts are expected to occur as a result of these additional alternatives.

Soils

No Action Alternative

The No Action alternative would disturb soils on approximately 3,136 acres within the existing mine permit area. Although approximately 6.4 million cubic yards of soil resources would be covered by project facilities within this area, revegetation test plots onsite have indicated that the pit alluvium proposed as a substitute growth medium provides comparable revegetation success and is less susceptible to erosion.

Proposed Action

The Proposed Action would result in the disturbance of an additional 5,217 acres, and the associated burial of approximately 10.2 million cubic yards of soil resources. As under the No Action alternative, pit alluvium is proposed as a substitute growth medium on the reclamation surfaces. This substitution is expected to produce comparable revegetation success and reduce erosional losses compared to the use of topsoil.

Other Project Alternatives

The other project alternatives would have similar impacts to soil resources as the Proposed Action.

Vegetation

No Action Alternative

The No Action alternative would disturb approximately 3,136 acres. The native vegetation communities of Wyoming sagebrush, mixed shrub, basin big sagebrush, and shadscale occupy approximately 1,307 acres of the total proposed disturbance area. The remaining area of 1,829 acres consists of parcels affected by previous disturbance or wildfires. No special status species or unique vegetation resources are known to occur within this directly affected area or in the adjoining areas that may be indirectly affected from mine dewatering.

Following completion of mining operations, most of the disturbed surfaces (excluding the mine pits) would be reclaimed with a mixture of grass, forb, and shrub species to support the current land uses of livestock grazing and wildlife habitat. It is likely that this reclamation community would remain distinct from the nearby undisturbed vegetation communities for a period of several decades.

Proposed Action

The Proposed Action would disturb an additional 5,217 acres. Approximately 2,800 acres are occupied by native communities of Wyoming sagebrush, mixed shrub, basin big sagebrush, and shadscale. The balance includes areas of previous disturbance, brush removal and seeding, and wildfires. No special status species or unique vegetation resources are known to occur within this directly affected area.

Indirect effects associated with the Proposed Action include ground water drawdown, which may extend outward far enough to affect riparian and phreatophytic vegetation communities several miles away in the Jake Creek and Kelly Creek drainages. No special status species are known to occur within these potentially affected drawdown areas.

As under the No Action alternative, the majority of the area disturbed by the Proposed Action would be reclaimed in a manner that is expected to result in the establishment of perennial vegetation communities comparable in cover and productivity to the existing native communities.

Other Project Alternatives

The other project alternatives would have impacts to vegetation resources similar to the Proposed Action.

Wildlife and Fisheries Resources

No Action Alternative

A total of 3,136 acres of wildlife habitat would be directly disturbed, of which 528 acres would not be reclaimed. Increased animal displacement and habitat fragmentation would occur. Sage grouse nesting and brooding habitat may be lost, if project activities disturb suitable habitat near an active lek. Potential indirect impacts to resident and migratory animals in the project region may occur from anticipated ground water drawdown effects to surface water availability and riparian habitat. Impacts from cyanide exposure would be low, due to the implementation of exclusion or neutralization measures. Waterfowl nesting use of the reinfiltration basins is expected to be low due to SFPG's commitment to remove emergent vegetation; impacts from foraging and resting use of the basins could include an increase in soil salinity and metals availability.

The indirect impacts described for terrestrial wildlife and fisheries would be the same for sensitive species potentially occurring in the project region that may be affected by ground water drawdown from mine dewatering activities. The burrowing owl, loggerhead shrike, and pygmy rabbit could be directly impacted by mine development and indirectly affected by habitat loss. It is unknown whether the spotted frog or springsnails occur in the project area.

Game fish species would not be adversely affected by construction or operation of the No Action alternative. There is a very low probability of a hazardous material spill affecting terrestrial and game fish species; the impact would depend on the material involved, location, magnitude, and timing of the incident.

Proposed Action

An additional 5,217 acres of habitat would be disturbed. Of these acres disturbed, 826 acres would not be reclaimed. Other impacts to wildlife and fisheries under the Proposed Action would parallel those described for the No Action alternative. These impacts include increased displacement and habitat fragmentation, decreased surface water availability and riparian vegetation, and cyanide exposure. Some increases in vehicle-related mortalities would be expected from increased construction traffic. Regional biodiversity could decrease from the additional impacts anticipated for riparian habitat and perennial flows.

There would be an increase in the area of reduced surface water flows for the Proposed Action in comparison to the No Action alternative. However, significant effects to game fish species are not anticipated. There would also be a slight increase in the probability of a hazardous material spill affecting terrestrial and aquatic species.

Potential impacts to sensitive terrestrial and aquatic species would be the same as those described for the No Action alternative.

Other Project Alternatives

Potential impacts to terrestrial and aquatic species would be the same as those described for the Proposed Action.

Potential impacts to sensitive terrestrial and aquatic species would be the same as those described for the No Action alternative.

Range Resources

No Action Alternative

Approximately 850 acres of public rangeland in the Bullhead grazing allotment would be affected by the No Action alternative. The majority of this disturbance (607 acres) would occur within the Rabbit pasture while almost all of the remainder would occur in the Dry Hills pasture (239 acres). These projected disturbances are small (3 percent or less) relative to the total acreage in the affected pastures. Along with the public lands, approximately 2,286 acres of private lands would also be removed from grazing availability.

Expansion of mining operations under the No Action alternative would not change the impacts to stock watering sources and other range improvements that have already occurred under existing operations. Grazing on the majority of these areas (excluding pit acreages) would be reestablished following completion of mining operations and successful reclamation.

Proposed Action

The Proposed Action would result in the temporary loss of grazing on 5,138 acres of public lands in the Dry Hills (1,338 acres), Rabbit (2,197 acres), and the Bullhead Seeding (1,603 acres) pastures of the Bullhead grazing allotment, and 418 acres in the adjoining Osgood grazing allotment. Approximately 43 percent of the disturbance in the Bullhead allotment would be in the Rabbit pasture, about 31 percent in the Bullhead Seeding, and 26 percent in the Dry Hills pasture. While these disturbances constitute relatively small percentages of the Dry Hills and Rabbit pastures, the expected disturbance and exclusion area would affect over 40 percent of the Bullhead Seeding, compromising its current utility as a key holding pasture. Projected mine disturbances within the Bullhead Seeding also would preclude livestock access to the Rabbit Creek drainage channel and any water flow, which is one of the current stock watering sources for this pasture, in addition to existing water troughs.

Other Project Alternatives

The other project alternatives would result in impacts to range resources similar to the Proposed Action.

Paleontological Resources

No Action Alternative

No direct impacts to known paleontological resources are anticipated. Indirect impacts could include the unauthorized collection of paleontological resources during and after construction, and during operations, although this is unlikely due to their rarity.

Proposed Action

Impacts would be the same as described for the No Action alternative.

Other Project Alternatives

Impacts would be the same as described for the No Action alternative.

Cultural Resources

No Action Alternative

Direct impacts to known cultural resources are not expected. Indirect impacts could result from erosion or improved access availability, which makes sites more vulnerable to accidental or deliberate disturbance and illegal collecting. Potential impacts to Traditional Cultural Properties and Native American values include covering of burials, disturbance of medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be covered by an overburden and interburden storage area. Known burials may also be covered by an overburden and interburden storage area. The Native American consultation process is still underway to identify impact areas as precisely as possible.

Proposed Action

No cultural sites that are unevaluated or have been determined to be eligible to the National Register of Historic Places would be directly impacted under the Proposed Action. A total of four sites that have been judged eligible by the archaeological contractor would be directly impacted; however, the final determination of eligibility for these sites is pending BLM and State Historic Preservation Office review. Potential impacts to Traditional Cultural Properties and Native American values include disturbance of burials and medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be either covered by an overburden and interburden storage area or disturbed during construction of a heap leach pad. Known burials may also be covered by an overburden and interburden storage area or disturbed by construction of a heap leach pad. The Native American consultation process is still underway to identify impact areas as precisely as possible.

Other Project Alternatives

One site that has been judged eligible by the archaeological contractor would be directly impacted under Overburden and Interburden Storage Area Reclamation alternative 2; however, the final determination of eligibility for this site is pending BLM and State Historic Preservation Office review. Impacts to cultural resources and Native American Traditional Cultural Properties under the other project alternatives would the same as described under the Proposed Action.

Air Quality

No Action Alternative

The proposed project is expected to result in increases in the levels of fugitive dust in the project vicinity, but these increases are not expected to exceed federal or state standards. Air quality modeling results indicate that the project would comply with all existing air quality standards and would not result in a significant impact to air quality.

Proposed Action

Potential air quality impacts would be the same as described for the No Action alternative.

Other Project Alternatives

Potential air quality impacts would be the same as described for the No Action alternative.

Land Use and Access

No Action Alternative

The No Action alternative is consistent with adopted land use plans and policies . The principal land uses in the vicinity of the mine, including dispersed recreation, livestock grazing, and mineral exploration and development, would not change substantially during the life of the project. Dewatering could result in drawdown of wells used to irrigate alfalfa fields in eastern Eden Valley and

Kelly Creek Valley. The No Action alternative would have no impact on existing access to public and private lands in the project area and is not expected to substantially increase average daily traffic volumes on area roadways. Closure and reclamation would return most of the public lands to their premining land uses.

Proposed Action

Impacts under the Proposed Action would be the same as described for the No Action alternative except dewatering under the Proposed Action could result in drawdown of the aquifer used to support agricultural activities in eastern Eden Valley and Kelly Creek Valley over a more extensive area than the No Action alternative . The Proposed Action would require the relocation of a portion of Humboldt County Road 513; however, construction of the new road segment would occur prior to the construction of any project facilities in order to allow uninterrupted public access . Finally, the Proposed Action would increase the volume of truck traffic on area roadways; this increase is not expected to exceed traffic volume capacities on these roads.

Other Project Alternatives

Land use and access impacts under the other project alternatives would be the same as described for the Proposed Action, with the exception of storage area alternative 2. This alternative would encroach on private lands not owned by SFPG.

Recreation and Wilderness

No Action Alternative

No parks, concentrated recreational use areas, Wilderness Study Areas, designated wilderness areas, or protected natural areas would be impacted. Developed recreational facilities are not expected to be adversely impacted. There would be no significant human health impacts from the limited exposure to the pit lake following closure.

Proposed Action

Potential recreation and wilderness impacts would be the same as described for the No Action alternative.

Other Project Alternatives

Potential recreation and wilderness impacts would be the same as described for the No Action alternative.

Social and Economic Values

No Action Alternative

Construction of the No Action alternative would require 150 additional workers. Operations under the No Action alternative would utilize the existing Twin Creeks Mine work force (970 employees); therefore, there would be no change in current employment and population levels and the current levels of demand for housing and community facilities and services during the operations phase.

During the construction phase, it is estimated that the population of Winnemucca would increase by 1.8 percent, Battle Mountain would increase by 1.4 percent, and the Humboldt County population would increase by almost 1 percent. The construction phase would generate an estimated 180 total direct and indirect jobs which would represent 2 percent of current employment levels in Humboldt County. The annual construction payroll is estimated at $3.4 million or $283,333 per month for the 12-month construction phase. The estimated demand for housing during the construction phase would exceed the current supply of available housing in the study area. The projected population increase during the construction phase would put a strain on community facilities and services, particularly schools, but the demand is not expected to exceed existing capacities.

The No Action alternative would result in the continuation of production and processing activities through the year 2000, and SFPG would continue to pay property taxes, payroll taxes, sales taxes, and net-proceeds taxes.

Proposed Action

Under the Proposed Action, the construction work force would total 300 people. SFPG estimates that no additional workers would be needed to operate the expanded mine above the current operations work force of 970; therefore, there would be no change in the current employment and population levels and the current levels of demand for housing and community facilities and services during the operations phase.

During the construction phase, it is estimated that the population of Winnemucca would increase by 3.7 percent, Battle Mountain would increase by 2.8 percent, and the Humboldt County population would increase by almost 2 percent. The construction phase would generate an estimated 360 total direct and indirect jobs which would represent 4.5 percent of current employment levels in Humboldt County. In addition, the construction phase could decrease the unemployment rate by a maximum of 1 percentage point. The annual construction payroll is estimated at $6.8 million, or $566,666 per month for the 12-month construction phase. The estimated demand for housing during the construction phase would exceed the current supply of available housing in the study area. The projected population increase during the construction phase would put a strain on community facilities and services, particularly schools, but the demand is not expected to exceed existing capacities.

A beneficial financial impact associated with the Proposed Action would be the continuation of the substantial tax contribution by SFPG to the taxing jurisdictions. The Proposed Action would contribute a net revenue increase to Humboldt County and the State of Nevada throughout its projected life span through the year 2011. Revenue increases would result primarily from greater property tax, net-proceeds-from-mines tax, and sales tax revenues.

Other Project Alternatives

Impacts to social and economic values under the other project alternatives would be the same as described for the Proposed Action.

Visual Resources

No Action Alternative

The No Action alternative would result in low visual impacts as seen from any affected viewpoint, primarily because of the already extensively modified landscape, the long viewing distances in some cases, and the Class IV visual management guidelines. Visual contrasts would not exceed the Class IV guidelines and would not be a significant impact.

Proposed Action

The Proposed Action would result in low to moderate visual impacts; however, visual contrasts would not exceed the Class IV guidelines and would not be a significant impact.

Other Project Alternatives

Impacts to visual resources would be similar to the Proposed Action for the Partial Vista Pit Backfill alternative and the Selective Handling of Overburden and Interburden alternative. The alternative reclamation configurations for the overburden and interburden storage areas would provide minor visual improvement due to the rounding of the corners in both alternatives, and the slightly lower topographical contrast in alternative 2.

Noise

No Action Alternative

Noise levels during construction and operations are not expected to increase over existing levels and would be below acceptable noise standards at the sensitive receptors. Blasting-related noise levels would be similar to existing levels and would exceed acceptable noise standards for a very limited time during the middle of the day. Blasting-related noise levels are expected to decrease as pit depth increases.

Proposed Action

Noise impacts would be similar to the impacts described for the No Action alternative. Blasting-related noise impacts under the Proposed Action are expected to be reduced because the depth of the pit would continue to increase, thereby muffling the blasting noise.

Other Project Alternatives

Noise impacts would be the same as described for the Proposed Action.

Hazardous Materials

No Action Alternative

The proposed project could result in potential impacts to environmental resources caused by an accidental release or spill of hazardous materials transported to, stored, and used at the mine. The significance of the impact would depend on the material involved, the spill location, and sensitivity of the resources present at the spill site should protective measures not contain the release.

Proposed Action

Impacts would be the same as described for the No Action alternative.

Other Project Alternatives

Impacts would be the same as described for the No Action alternative.

Agency Preferred Alternative

The BLM's preferred alternative is the Proposed Action, with the Partial Vista Pit Backfill alternative and the Overburden and Interburden Storage Area Reclamation alternative 2. Overburden and Interburden Storage Area Reclamation alternative 2 would involve private lands not owned by SFPG in Sections 22 and 27, Township 39 North, Range 43 East. If the use of these lands cannot be secured, Overburden and Interburden Storage Area Reclamation alternative 1 is the next preferred alternative. These alternatives satisfy the BLM's responsibility to protect nonmineral resources (in this case visual resources) to the extent possible, as directed by 43 Code of Federal Regulations 3809.0-2(a) and other guidance, while not placing an unreasonable burden on the project proponent. The preferred alternative provides the best balance between environmental protection and effective resource utilization.

1.0 Introduction

CHAPTER 1.0 Introduction

Santa Fe Pacific Gold Corporation (SFPG) has submitted a *Revised Final BLM Plan of Operations and NDEP Reclamation Plan and Permit Application* for the Twin Creeks Mine (SFPG 1995a) to the Winnemucca District Office of the Bureau of Land Management (BLM) to consolidate and expand existing mining and processing facilities, and to construct new facilities at the Twin Creeks Mine. The Twin Creeks Mine, which encompasses the former Rabbit Creek Mine and the former Chimney Creek Mine, is located approximately 35 miles northeast of Winnemucca in Humboldt County, Nevada (***Figure 1-1***). The site is accessed from Interstate 80 north to State Route 789 and County Road 513. The existing mining operations consist of three open-pit mines (Vista Pit, West Pit, and South Pit), overburden and interburden storage areas, heap leaching facilities, milling and tailings storage facilities, and ancillary facilities. These existing facilities encompass approximately 5,094 acres on a combination of private lands owned by SFPG and public lands administered by the Winnemucca District Office of the BLM. The former Chimney Creek Mine was located entirely on public lands administered by the BLM, while the former Rabbit Creek Mine was located entirely on private lands owned by SFPG.

The proposed expansion would affect additional public lands administered by the BLM; therefore, the review and approval of SFPG's plan of operations is subject to compliance with the Federal Land Policy Management Act and with the associated BLM surface management regulations (43 Code of Federal Regulations 3809).

Because of the potential for the proposed project to result in significant environmental impacts, the BLM determined that an environmental impact statement (EIS) would be necessary. The BLM is serving as the lead agency for preparing the EIS in compliance with the National Environmental Policy Act of 1969, the Council on Environmental Quality regulations for Implementation of Procedural Provisions of the National Environmental Policy Act (40 Code of Federal Regulations 1500-1508), and the BLM's National Environmental Policy Act Handbook (H-1790-1).

This EIS describes the proposed consolidation and expansion of the mine (Proposed Action), the No Action alternative, and other project alternatives. It also describes the environmental consequences of implementing the Proposed Action or the other project alternatives, including the No Action alternative.

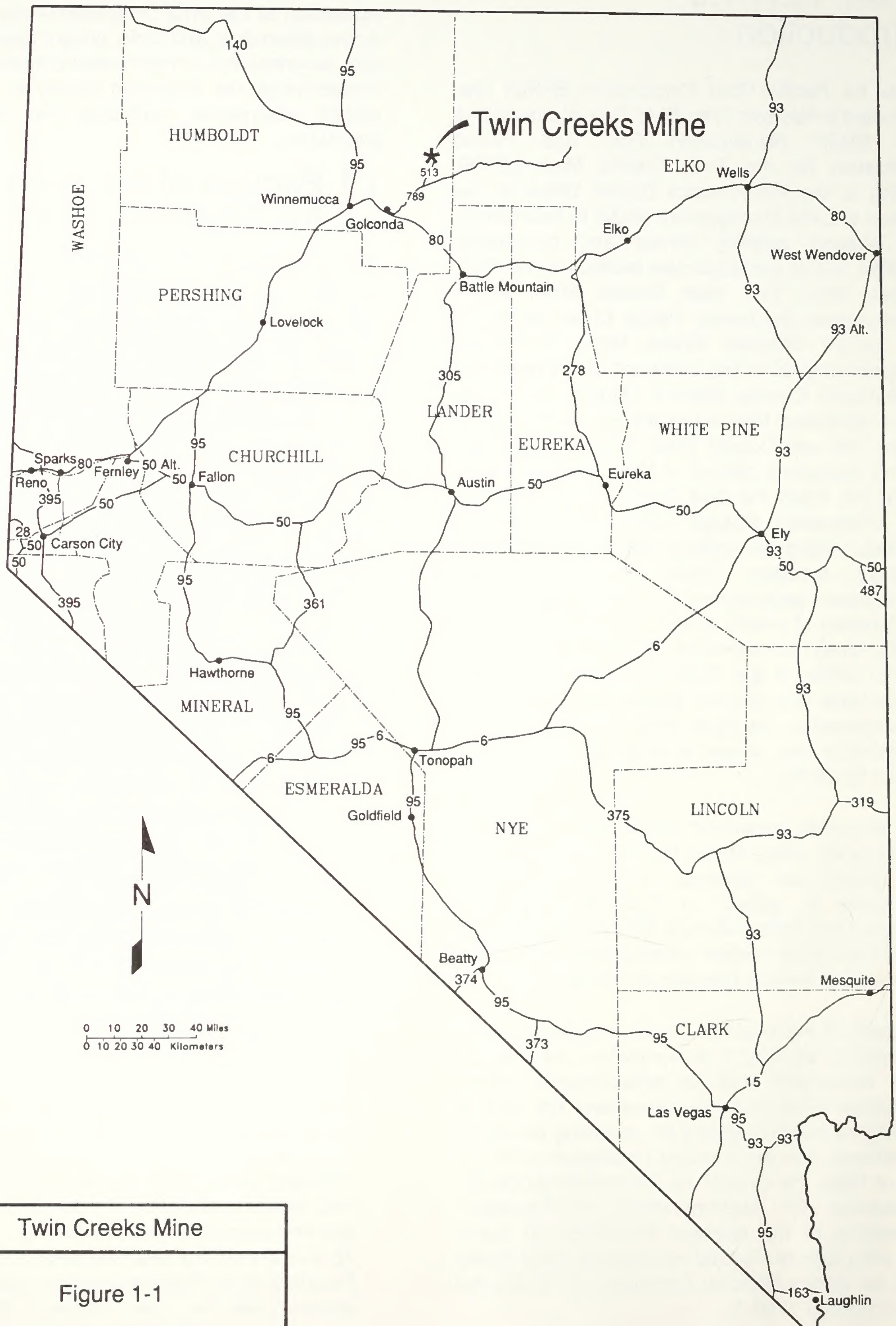
1.1 Purpose of and Need for the Proposed Action

SFPG proposes to consolidate and expand existing mining and processing facilities, and construct new facilities at the Twin Creeks Mine to extract economically recoverable gold reserves known to exist adjacent to the existing Twin Creeks Mine pit areas in an economically efficient and environmentally compatible manner (project purpose). The project need is reflected by the demand for gold that has been identified in the national and global markets. Gold is an established commodity with international markets. Uses include investments, standard for monetary systems, jewelry, electronics, and other industrial applications.

1.2 Relationship to BLM and Non-BLM Policies, Plans, and Programs

The BLM has the responsibility and authority to manage the surface and subsurface resources on public lands located within the Winnemucca District, Paradise-Denio Resource Area, and it has designated land use within the project area for mineral exploration and development. In its Paradise-Denio Management Framework Plan, the BLM states in objective M1.0 that it will "Provide the public the opportunity to acquire minerals from the public lands to meet market demands" (BLM 1982). The rationale given for this objective is as follows (BLM 1982):

> The "Mine and Mineral Policy Act of 1970" declares that it is national policy to encourage "...the orderly and economic development of domestic mineral resources, reserves...to help assure satisfaction of industrial, security, and environmental needs..." Accordingly, over 75 percent of the land contained within the Paradise-Denio Resource Area is public land administered by the Bureau of Land



Twin Creeks Mine

Figure 1-1

General Location Map

Management. Chance occurrence of mineral deposits favors the probability that a good portion of future mineral exploration and development will take place on these public lands. Unrestricted mining on public land would allow for full development of various mineral reserves and the exploration for yet undiscovered mineral deposits.

In order to use public lands in the Paradise-Denio Resource Area, SFPG must comply with BLM surface management regulations and other applicable statutes, including the Mining and Mineral Policy Act of 1970 (as amended) and the Federal Land Policy Management Act (as amended). Furthermore, the BLM must review SFPG's plans for consolidation and expansion of the Twin Creeks Mine to ensure the following:

- Adequate provisions are included to prevent unnecessary or undue degradation of federal lands and to protect the non-mineral resources of the federal lands.

- Measures are included to provide for reclamation of disturbed areas.

- Compliance with applicable state and federal laws is achieved.

In addition, the project area is zoned M-3 (Open Land Use District) by Humboldt County. This zoning classification provides for a variety of rural land uses, including mineral extraction. Mining is a principal permitted use within the zoning district and must comply with Article 10 of the Humboldt County Zoning Ordinance, which requires a Special Use Permit for temporary and permanent buildings and fences.

The conformance of the proposed project with applicable land use plans and policies is evaluated in Section 3.10, Land Use and Access.

1.3 Authorizing Actions

In addition to the EIS, implementing the proposed Twin Creeks Mine project or the alternatives would require authorizing actions from other federal, state, and local agencies with jurisdiction over certain aspects of the proposed project. ***Table 1-1*** lists the required permits or approvals and the responsible regulatory agency.

TABLE 1-1
Major Permits and Approvals Required for the Twin Creeks Mine Project

Permit or Approval	Regulatory Agency
Plan of Operations and Mine Reclamation Permit Approval	U.S. Department of the Interior, Bureau of Land Management; Nevada Department of Conservation and Natural Resources, Division of Environmental Protection
Right-of-Way Permits	U.S. Department of the Interior, Bureau of Land Management
Review of EIS and Air Permits	U.S. Environmental Protection Agency
Section 404 Permit (Predischarge Notice)	U.S. Army Corps of Engineers
Artificial Pond Permit	Nevada Department of Conservation and Natural Resources, Division of Wildlife
Air Quality Surface Disturbance Permit; Air Quality Operating Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection
Water Pollution Control Permit; Renewal of National Pollutant Discharge Elimination System Permit; General Stormwater Discharge Permit; and Ground Water Protection Permit	Nevada Department of Conservation and Natural Resources, Division of Environmental Protection
Permit for Dam Construction; Permit to Appropriate Public Waters	Nevada Department of Conservation and Natural Resources, Division of Water Resources
Review Project to Determine Impact on Cultural Resources	Nevada Division of Historic Preservation
Special Use Permit	Humboldt County

1.4 Organization of the Environmental Impact Statement

This EIS follows the Council on Environmental Quality recommended organization (40 Code of Federal Regulations 1508.9): Chapter 1.0 provides descriptions of the purpose of and need for the Proposed Action, the role of the BLM in the EIS process, and the required regulatory actions for the proposed project; Chapter 2.0 describes the Proposed Action and alternatives, including the No Action alternative; Chapter 3.0 describes the affected environment and the direct, indirect, and cumulative impacts associated with the Proposed Action and alternatives, possible mitigation to reduce or minimize impacts, and any residual adverse effects following the implementation of mitigation; Chapter 4.0 summarizes public participation and the scoping process, and the consultation and coordination for preparation of the EIS; Chapter 5.0 presents the list of preparers and reviewers; Chapter 6.0 is a list of references; Chapter 7.0 contains a glossary; and Chapter 8.0 is the index. Copies of supporting documents are on file at the BLM Winnemucca District Office in Winnemucca, Nevada, and at the BLM Nevada State Office in Reno, Nevada (see Section 3.0).

2.0 Description of the Proposed Action and the Alternatives

Chapter 2.0 Description of the Proposed Action and the Alternatives

2.1 Introduction

Santa Fe Pacific Gold Corporation (SFPG) proposes to consolidate and expand the Twin Creeks Mine, which encompasses the former Rabbit Creek Mine and the former Chimney Creek Mine. A *Revised Final BLM Plan of Operations* (plan of operations*) and NDEP Reclamation Plan and Permit Application* (reclamation plan) (SFPG 1995a) for the Twin Creeks Mine has been submitted by SFPG to the Bureau of Land Management (BLM), Winnemucca District Office, in compliance with 43 Code of Federal Regulations 3809. This chapter describes the proposed Twin Creeks Mine project as developed by SFPG in the plan of operations (Proposed Action), as well as the No Action alternative, other reasonable project alternatives analyzed in the environmental impact statement (EIS), and a list of other potential alternatives that were considered but eliminated from detailed analysis. This chapter also includes a comparative impact analysis of the project alternatives and identifies the BLM's preferred alternative.

2.2 Existing Facilities and Operations

The former Chimney Creek Mine was located entirely on public lands administered by the Winnemucca District Office of the BLM, while the former Rabbit Creek Mine was located entirely on private lands owned by SFPG. ***Figure 2-1*** illustrates the surface management status for the project area. Existing mine operations consist of three open-pit mines (Vista Pit, West Pit, and South Pit), four overburden and interburden storage areas, five heap leaching facilities, two milling and tailings storage facilities, and ancillary facilities. There are currently 970 employees working at the Twin Creeks Mine. The existing facilities (***Figure 2-2***) encompass approximately 5,094 acres of surface disturbance on a combination of private lands owned by SFPG and public lands administered by the BLM. The existing disturbance associated with the two former mining operations, as of December 31, 1994, is summarized in ***Table 2-1***. ***Table 2-2*** identifies the legal descriptions and summarizes the tonnage of material for the existing overburden and interburden storage areas, tailings storage areas, and heap leach pads.

2.2.1 Former Chimney Creek Mine

Operations at the former Chimney Creek Mine commenced in the second quarter of 1986. Current process facilities include an oxide mill and associated tailings storage facility, three heap leach pad areas and associated solution collection ponds, three overburden and interburden storage areas, a heap leach test pad, an electric power generating station, reagent storage facilities, a laboratory, an administration building, a shop/warehouse, and a preventive maintenance shop. All existing mining activities at the former Chimney Creek Mine were authorized by the BLM and are conducted under Plan of Operations N24-86-005P.

2.2.1.1 Open Pits

Open pits on the former Chimney Creek Mine include a portion of the South Pit, and the West Pit, located in Section 18, Township 39 North, Range 43 East; and the Vista Pit, located in Sections 6, 7, and 8, Township 39 North, Range 43 East (***Figure 2-2***). Material at the former Chimney Creek Mine is excavated using conventional open-pit techniques, including drilling, blasting, and loading. A total of approximately 110,000 tons of ore and overburden and interburden are excavated each day from these pits. Mining occurred above the ground water table; consequently, dewatering was not required with the former Chimney Creek Mine. The existing pits associated with the former Chimney Creek Mine disturb 392 acres (***Table 2-1***).

2.2.1.2 Overburden and Interburden Storage Areas

Overburden and interburden storage areas at the former Chimney Creek Mine are located in Sections 31 and 32, Township 40 North, Range 43 East; and Sections 5, 6, 7, 17, 18, and 20, Township 39 North, Range 43 East (storage areas B, J, and N) (***Figure 2-2***). Approximately 162 million tons of overburden and interburden could be placed in these storage areas under previous authorizations for the former Chimney Creek Mine. The amount of existing surface disturbance associated with these areas is 1,252 acres (***Table 2-1***).

TABLE 2-1
Existing, No Action Alternative, and Proposed Action Surface Disturbance

Project Component	Existing (acreage)[1]			No Action Alternative (acreage)[2]			Proposed Action (acreage)[3]			Total by Component (acreage)		
	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total
Open Pits:												
Vista Pit	0	225	225	0	51	51	0	0	0	0	276	276
West Pit[4]	0	56	56	0	0	0	0	0	0	0	56	56
South Pit[5]	425	111	536	360	117	477	197	629	826	982	857	1839
Total	425	392	817	360	168	528	197	629	826	982	1189	2171
Overburden and Interburden Storage Areas:												
Area A	0	0	0	0	0	0	0	624	624	0	624	624
Area B[6]	809	541	1350	297	0	297	0	186	186	1106	727	1833
Area C	0	0	0	0	0	0	0	321	321	0	321	321
Area D	0	0	0	0	0	0	0	526	526	0	526	526
Area E	0	0	0	0	0	0	119	0	119	119	0	119
Area F[7]	0	0	0	633	0	633	0	0	0	633	0	633
Area G[8]	0	0	0	0	0	0	0	52	52	0	52	52
Area H[9]	0	0	0	0	371	371	0	235	235	0	606	606
Area I	0	0	0	0	0	0	0	605	605	0	605	605
Area J[10]	0	187	187	0	0	0	0	7	7	0	194	194
Area K	0	0	0	0	0	0	0	50	50	0	50	50
Area L[11]	0	0	0	0	0	0	0	0	0	0	0	0
Area M[7]	0	0	0	197	0	197	0	0	0	197	0	197
Area N	0	524	524	0	0	0	0	0	0	0	524	524
Area O	23	0	23	0	0	0	0	0	0	23	0	23
Total	832	1252	2084	1127	371	1498	119	2606	2725	2078	4229	6307
Sulfide Ore Stockpile[12]	0	0	0	0	0	0	0	0	0	0	0	0
Flotation Grade Ore Stockpile[12]	0	0	0	0	0	0	0	0	0	0	0	0
Limestone Stockpile	0	0	0	0	64	64	0	0	0	0	64	64
Process Facilities	35	66	101	0	21	21	0	0	0	35	87	122
Tailings Storage Areas:												
Area A[13]	0	231	231	0	52	52	0	297	297	0	580	580
Area B	0	0	0	0	0	0	0	626	626	0	626	626
Area C	0	0	0	93	0	93	0	0	0	93	0	93
Area D[14]	0	0	0	0	0	0	0	0	0	0	0	0
Area E	126	0	126	0	0	0	0	0	0	126	0	126
Total	126	231	357	93	52	145	0	923	923	219	1206	1425
Reinfiltration Basin System	0	0	0	318	0	318	0	0	0	318	0	318
Heap Leach Pads:												
Leach Pad A	0	0	0	0	0	0	0	503	503	0	503	503
Leach Pad B[15]	0	0	0	154	0	154	0	0	0	154	0	154
Leach Pad C[16]	0	0	0	0	0	0	0	53	53	0	53	53
Leach Pad D	0	0	0	0	0	0	0	55	55	0	55	55
Leach Pad E[17]	0	0	0	0	0	0	0	0	0	0	0	0
Leach Pad F[11]	0	0	0	0	0	0	0	0	0	0	0	0
Leach Pad G	186	0	186	0	0	0	0	0	0	186	0	186
Leach Pad H	0	242	242	0	0	0	0	0	0	0	242	242
Leach Pad I	0	60	60	0	0	0	0	0	0	0	60	60
Leach Pad J	0	172	172	0	0	0	0	0	0	0	172	172
Leach Pad K	0	15	15	0	0	0	0	0	0	0	15	15
Total	186	489	675	154	0	154	0	611	611	340	1100	1440

TABLE 2-1 (continued)
Existing, No Action Alternative, and Proposed Action Surface Disturbance

Project Component	Existing (acreage)[1]			No Action Alternative (acreage)[2]			Proposed Action (acreage)[3]			Total by Component (acreage)		
	Private	Public	Total	Private	Public	Total	Private	Public	Total	Private	Public	Total
Rabbit Creek Diversion	0	0	0	0	0	0	20	70	90	20	70	90
West Side Diversion	0	0	0	0	0	0	[illegible]	14	21	8	14	21
Far West Side Diversion	0	0	0	0	0	0	8	13	21	8	13	21
Ponds	4	17	21	0	0	0	0	0	0	4	17	21
Ancillary Facilities	134	589	723	0	0	0	0	0	0	134	589	723
Exploration Activities	0	0	0	100	100	200	0	0	0	100	100	200
Well Pads and Pipeline Corridors	0	0	0	0	40	40	0	0	0	0	40	40
Access/Haul Roads	1[illegible]0	146	316	11	34	45	0	0	0	181	180	361
Bioremediation Site	0	0	0	123	0	123	0	0	0	123	0	123
TOTAL BY ALTERNATIVE	**1912**	**3182**	**5094**	**2286**	**850**	**3136**	**351**	**4866**	**5217**	**4549**	**8898**	**13447**

1 As of December 31, 1994.
2 The acreage of disturbance for the No Action alternative would comprise an incremental addition to the existing disturbance.
3 The acreage of disturbance for the Proposed Action would comprise an incremental addition to the existing disturbance and the No Action alternative.
4 Disturbance associated with the West Pit for the No Action alternative and Proposed Action is included with the South Pit.
5 The portion of the South Pit expansion in Section 13 would require a land agreement with First Miss Gold.
6 Portions of this area are already disturbed. Acreage shown is new disturbance.
7 Overburden in interburden storage areas F and M would require a land agreement with First Miss Gold.
8 The area within Section 30 and outside of the ultimate South Pit boundary was split between overburden and interburden storage area G and leach pad C.
9 Total disturbance for overburden and interburden storage area H for the No Action alternative is 428 acres. 57 acres of this total have been included in diversion channels and South Pit disturbance acreage.
10 Portions of overburden and interburden storage area J are included in the existing overburden and interburden storage area disturbance. Acreage shown is new disturbance.
11 This optional use area is already disturbed. There would be no new disturbance associated with this facility.
12 Sulfide and flotation grade ore stockpiles would either be located on top of existing overburden and interburden storage areas or on previously disturbed ground; therefore, no new surface disturbance would occur.
13 Tailings storage area A is an expansion of the existing Juniper storage area. Acres shown are new disturbance only.
14 No acreage disturbance has been calculated for this optional use area. The acreage disturbance for this area is included in overburden and interburden storage area D.
15 123 acres of this optional use area have been included in the disturbance associated with the bioremediation site.
16 The area within Section 30 and outside of the ultimate South Pit boundary was split between overburden and interburden storage area G and leach pad C.
17 Acres for this optional use area are included in the disturbance for overburden and interburden storage area K.

TABLE 2-2
Legal Descriptions and Tonnage of Material by Project Component
Existing Conditions[1]

Project Component	Legal Description (Township, Range, Section)	Total Existing Surface Disturbance (acres)	Tonnage of Existing Material (ktons)
Overburden and Interburden Storage Areas			
B	39 North, 43 East, 17, 19, 20, 21, 29	1,350	247,004
J	39 North, 43 East, 5, 6; 40 North, 43 East, 31, 32	187	23,898
N	39 North, 43 East, 7, 18	524	40,537
O	39 North, 43 East, 19	23	3,322
TOTAL		**2,084**	**314,761**
Tailings Storage Areas			
A	39 North, 43 East, 8, 9	231	6,576
E	39 North, 43 East, 29	126	13,300
TOTAL		**357**	**19,876**
Heap Leach Pads			
G[2]	39 North, 43 East, 31	186	12,947
H[2]	39 North, 43 East, 8, 17	242	17,949
I[2]	39 North, 43 East, 8	60	12,250
J[2]	39 North, 43 East, 4, 5, 8	172	17,232
K[2]	39 North, 43 East, 8	15	835
TOTAL		**675**	**61,213**

[1] As of December 31, 1994.
[2] "G" = existing Osgood pad; "H" = existing Izzenhood pad; "I" = existing Snowstorm pad; "J" = existing Sonoma pad; "K" = existing Test pad.

2.2.1.3 Process Facilities

Process facilities include a crusher, an oxide ore mill facility (Juniper Mill), a ready line, a laboratory, mine offices, an administration building, a test facility, a core shed, and an electric power generating station. These facilities are located in Sections 5, 8, 9, and 18, Township 39 North, Range 43 East (***Figure 2-2***). Existing surface disturbance associated with these process facilities totals 66 acres (***Table 2-1***).

The Juniper Mill processes oxide ore in a conventional cyanide carbon-in-pulp process. Gold is recovered on activated carbon, stripped in a low pressure and temperature circuit, passed through the Merrill-Crowe circuit, and refined into doré bars.

2.2.1.4 Heap Leach Facilities

Existing heap leach facilities associated with the former Chimney Creek Mine are located in Sections 4, 5, 8, and 17, Township 39 North, Range 43 East (heap leach pads H, I, J, and K) (***Figure 2-2***). These facilities include heap leach pads, piping, solution ponds, and carbon columns for gold recovery. A test leach facility (which includes heap leach pad K) is located in Section 8, Township 39 North, Range 43 East (***Figure 2-2***). Existing disturbance associated with the heap leach facilities totals 489 acres (***Table 2-1***).

2.2.1.5 Tailings Facility

The existing tailings facility associated with the former Chimney Creek Mine is located in Sections 8 and 9, Township 39 North, Range 43 East (tailings area A) (***Figure 2-2***). The facility includes an embankment, a tailings impoundment, tailings slurry and reclaim solution pipelines, and an underdrain seepage collection system. Existing disturbance associated with the tailings facility totals 231 acres (***Table 2-1***).

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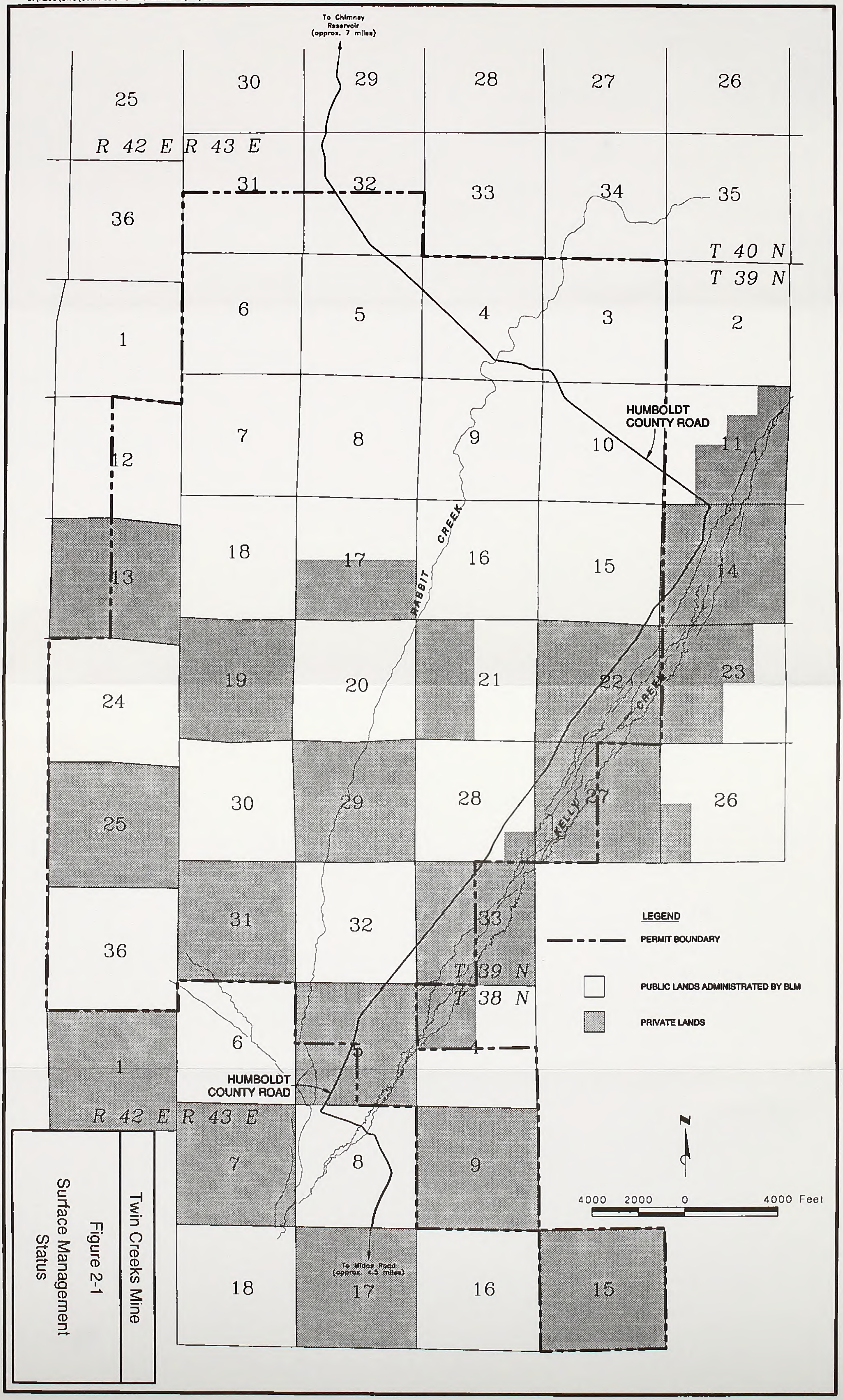

Twin Creeks Mine

Figure 2-1
Surface Management Status

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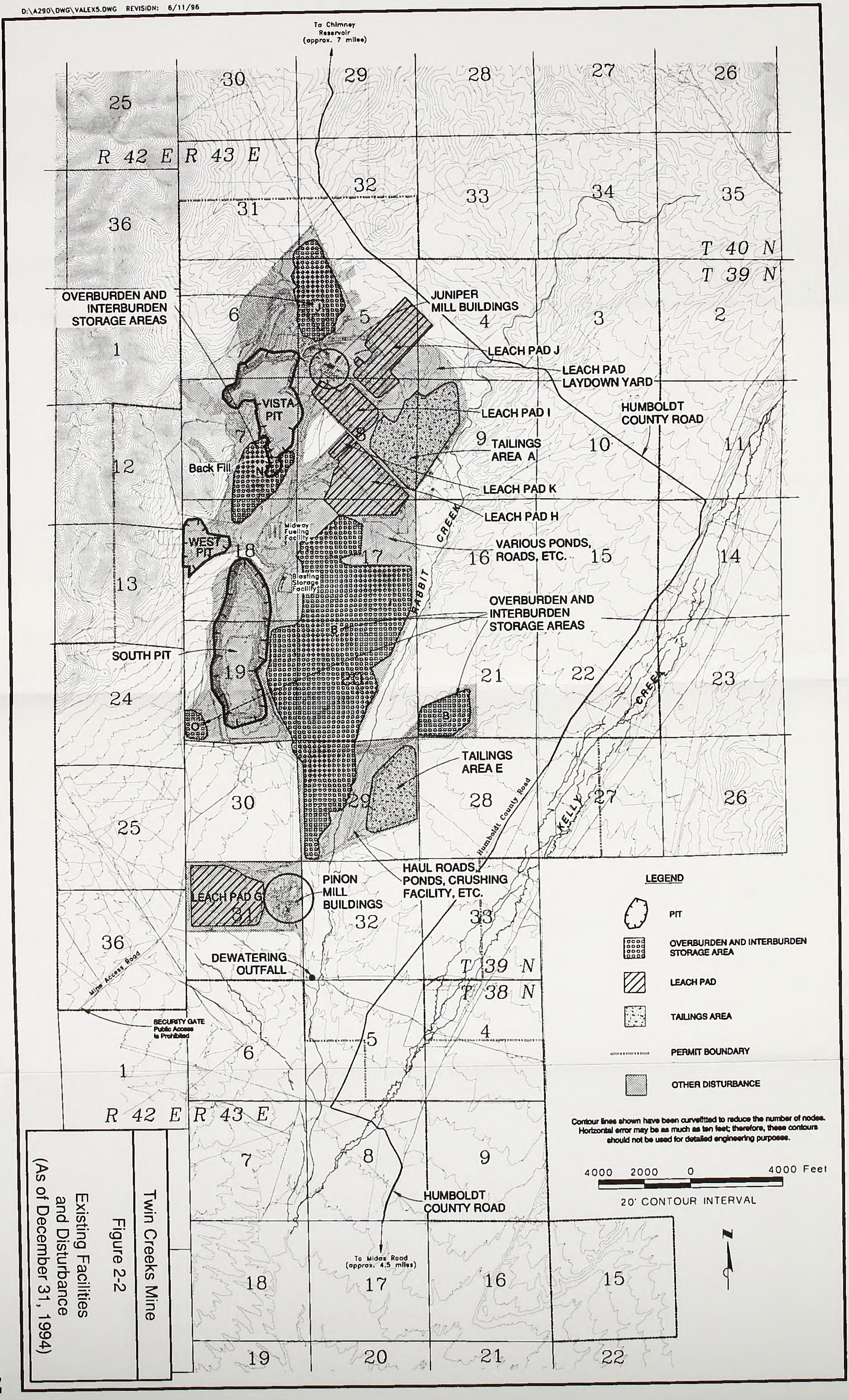


Twin Creeks Mine

Figure 2-2
Existing Facilities and Disturbance
(As of December 31, 1994)

2.2.1.6 Ponds

Solution ponds include pregnant, barren, and intermediate solution ponds, seepage collection ponds, major and minor storm event ponds, the test facility pond, and reclaim ponds. The solution ponds at the former Chimney Creek Mine are located in Sections 5, 8, 9, and 17, Township 39 North, Range 43 East (included within 'other disturbance' in ***Figure 2-2***). Existing disturbance totals 17 acres (***Table 2-1***).

2.2.1.7 Roads

The haul roads and access roads throughout the former Chimney Creek Mine are located in Sections 4, 5, 6, 7, 8, 9, 17, 18, and 20, Township 39 North, Range 43 East; and Sections 31 and 32, Township 40 North, Range 43 East (included within 'other disturbance' in ***Figure 2-2***). Haul roads disturb 91 acres, while access and exploration roads disturb 42 and 13 acres, respectively. Roads account for a total of 146 acres of existing surface disturbance (***Table 2-1***).

2.2.1.8 Ancillary Facilities

Ancillary facilities associated with the former Chimney Creek Mine include laydown yards and miscellaneous disturbance around mining and processing facilities, and total 589 acres (included within 'other disturbance' in ***Figure 2-2***).

2.2.2 Former Rabbit Creek Mine

Exploration drilling at the former Rabbit Creek Mine commenced in 1986. The decision to develop the north-central oxide zone of the former Rabbit Creek Mine was made in 1989, and overburden and interburden removal began in March 1989. Gold was first poured on August 13, 1990. The mine employs two methods of gold extraction: oxide milling and heap leaching. The method of extraction processing is determined by ore grade and the type of host rock.

2.2.2.1 Open Pit

The open pit at the former Rabbit Creek Mine includes the southern portion of the South Pit located in Section 19, Township 39 North, Range 43 East (***Figure 2-2***). Mining in this portion of the South Pit is accomplished using conventional open-pit techniques, including drilling, blasting, and loading. Approximately 220,000 tons per day of ore and overburden and interburden are excavated from this area. The pit associated with the former Rabbit Creek Mine disturbs a total of 425 acres (***Table 2-1***).

2.2.2.2 Dewatering Activities

SFPG was authorized by the Nevada State Engineer to dewater at a rate of 3,794 gallons per minute using both wells and sumps. Additional appropriations for the Twin Creeks Mine include 10,010 gallons per minute for dewatering and 2,601 gallons per minute leased from a local rancher.

Ferric sulfate is added to the water from dewatering operations at the water treatment plant to remove the soluble arsenic to meet drinking water standards. The arsenic is precipitated out of solution and filtered or settled with the addition of flocculant. The arsenic precipitate is slurried with water and then pumped to the existing Piñon tailings storage area (tailings area E in ***Figure 2-2***). The precipitate has been analyzed and found to be stable.

The treated dewatering water is discharged into a natural drainage (see ***Figure 2-2***) where it flows downgradient to Rabbit Creek, an ephemeral drainage. Rabbit Creek discharges into Kelly Creek. Kelly Creek is a tributary of the Humboldt River. During periods of high precipitation or runoff, treated water combined with meteoric waters may reach the Humboldt River. The treated water complies with the conditions of SFPG's existing National Pollutant Discharge Elimination System Permit NV0021725 for the discharge of dewatering water.

2.2.2.3 Overburden and Interburden Storage Areas

The existing overburden and interburden storage areas at the former Rabbit Creek Mine disturb 832 acres (***Table 2-1***). Approximately 416 million tons of overburden and interburden could be placed in these storage areas, located in Sections 17, 19, 21, and 29, Township 39 North, Range 43 East (storage areas B and O) (***Figure 2-2***).

2.2.2.4 Process Facilities

Process facilities including an oxide mill (Piñon Mill), process plant, buildings, and other similar structures are located in Section 31, Township 39 North, Range 43 East (***Figure 2-2***). These existing facilities disturb a total of 35 acres (***Table 2-1***).

2.2.2.5 Heap Leach Facility

The heap leach facility includes a pad, piping, and solution ponds. This facility (leach pad G) is located in Section 31, Township 39 North, Range 43 East (***Figure 2-2***) and disturbs 186 acres (***Table 2-1***).

2.2.2.6 Tailings Facility

The tailings facility includes an embankment, a tailings impoundment, tailings slurry and reclaim solution pipelines, and a seepage collection system. This facility (tailings area E) is located in Section 29, Township 39 North, Range 43 East (***Figure 2-2***) and disturbs 126 acres (***Table 2-1***).

2.2.2.7 Ponds

The ponds include pregnant, barren, and intermediate solution ponds, two water treatment ponds, and a seepage collection pond. These ponds disturb a total of 4 acres and are located in Sections 19, 29, and 31, Township 39 North, Range 43 East (included within 'other disturbance' in ***Figure 2-2***).

2.2.2.8 Roads

The haul roads and access roads at the former Rabbit Creek Mine are located in Sections 17, 19, 29, 30, and 31, Township 39 North, Range 43 East (included within 'other disturbance' in ***Figure 2-2***). These roads total 57 acres of surface disturbance. In addition, the former Rabbit Creek Mine operates several BLM rights-of-way, which total 113 acres.

2.2.2.9 Ancillary Facilities

Ancillary facilities associated with the former Rabbit Creek Mine include diversion channels located in Sections 29 and 31, Township 39 North, Range 43 East; these facilities disturb a total of approximately 134 surface acres (included within 'other disturbance' in ***Figure 2-2***).

2.3 No Action Alternative

The proposed project would involve consolidating and expanding two former mining operations: the Rabbit Creek Mine and the Chimney Creek Mine. The No Action alternative comprises the facilities and operations that are currently authorized by the BLM and/or the State of Nevada for these two operations, but were not constructed or implemented as of December 31, 1994. The proposed disturbance in Section 13 (South Pit and overburden and interburden storage area M) and Section 25 (overburden and interburden storage area F) would require a land agreement with First Miss Gold. Upon implementation of the No Action alternative, total surface disturbance would include the existing disturbance plus the additional disturbance associated with the currently permitted facilities and activities. This alternative is addressed and its impacts disclosed in this EIS between the description of the existing conditions (Affected Environment) and the Proposed Action, as this is where it occurs sequentially (i.e., SFPG would continue to develop these facilities). The following key reference documents describe the No Action alternative and are available for review at the BLM's Winnemucca District Office:

- Gold Fields Operating Company Plan of Operations and Amendments (1986 through 1988)
- Rabbit Creek and Chimney Creek Mine Reclamation Permit Applications (1993)
- Twin Creeks Mine Reclamation Permit (March 1995 - as approved by the State of Nevada, Division of Environmental Protection)
- South Pit Expansion (Sections 24 and 30) Environmental Assessment approval (1995)
- BLM administrative approvals for Overburden and Interburden Storage Area J (Township 40 North, Range 43 East, Sections 31 and 32), Phase 1 sulfide (Sage) mill construction (not operation), and the Midway Ready Line

The following facilities and activities are associated with the No Action alternative (***Figure 2-3, Table 2-1***):

- Exploration, development, and condemnation drilling necessary for future operations
- Open-pit expansion
- Development and expansion of overburden and interburden storage areas
- Development of sulfide ore stockpiles
- Construction of Phase 1 of the sulfide (Sage) mill
- Development and expansion of tailings storage areas
- Development of an additional heap leaching facility
- Development of a limestone storage area
- Development of dewatering wells, water distribution pond, and water treatment plant
- Development of reinfiltration basins
- Construction of haul and access roads
- Construction of ancillary facilities
- Development of a bioremediation site

These No Action alternative activities are discussed in more detail in the following sections. The facilities associated with the No Action alternative would be reclaimed in the same manner as the Proposed Action; see Section 2.4.11 for a detailed description of the reclamation plan for the Twin Creeks Mine.

2.3.1 Exploration, Development, and Condemnation Drilling

Under the No Action alternative, SFPG would continue geologic evaluations to define additional ore reserves, better define current reserves, collect metallurgical samples, collect geotechnical data, and condemn areas for various facilities and stockpiles. This work would be conducted within the permit boundary shown in ***Figure 2-3***. The disturbance associated with exploration activities would not exceed 200 acres at any one time. For planning purposes, the disturbance has been equally divided between public and private lands (***Table 2-1***).

2.3.2 Open Pit Expansion

SFPG would lay back the existing South Pit into Section 30, Township 39 North, Range 43 East, and extend the pit dimensions within Sections 13, 18, and 19, Township 39 North, Range 43 East (***Figure 2-3***). The pit expansion would disturb 477 acres, including 117 acres on public lands administered by the BLM (***Table 2-1***). The portion of the South Pit expansion in Section 13 would require a land agreement with First Miss Gold. The Vista Pit would be expanded to the north in Sections 5 and 6, Township 39 North, Range 43 East to the ultimate pit boundary (***Figure 2-3***). The Vista Pit expansion would disturb approximately 51 additional acres of public lands administered by the BLM (***Table 2-1***).

SFPG would construct 10 dewatering well sites outside the South Pit disturbance in Section 30 (included within “other mining-related disturbance” in ***Figure 2-3***). Each well site would disturb approximately 1 acre. The accompanying pipeline access roads and corridors are projected to disturb approximately 14 acres. The Section 30 dewatering system would not exceed 30 acres of surface disturbance. The surface disturbance associated with the Section 30 dewatering system is included within the total disturbance for well pads and pipeline corridors in ***Table 2-1***. The exact locations of the dewatering well sites may vary pending further hydrological studies to optimize dewatering efforts. The Vista Pit is dry and would not require dewatering.

2.3.3 Development and Expansion of Overburden and Interburden Storage Areas

Additional overburden and interburden storage areas developed or expanded under the No Action alternative are shown in ***Figure 2-3.*** The storage areas would disturb 1,498 acres, including 371 acres on public lands administered by the BLM (***Table 2-1***). ***Table 2-3*** identifies the legal descriptions and summarizes the tonnage of new material that would be placed on the overburden and interburden storage areas under the No Action alternative. Portions of the storage areas would be located on top of existing overburden and

TABLE 2-3
Legal Descriptions and Tonnage of Material by Project Component
No Action Alternative

Project Component	Legal Description (township, range, section)	Total New Surface Disturbance (acres)	Tonnage of New Material (ktons)
Overburden and Interburden Storage Areas			
B	39 North, 43 East, 17, 19, 20, 21, 29	297	393,106
F[1]	39 North, 42 East, 25	633	50,000
H	39 North, 42 East, 24	371	139,828
J	39 North, 43 East, 5, 6; 40 North, 43 East, 31, 32	0[2]	44,107
M[1]	39 North, 42 East, 13	154	18,750
N	39 North, 43 East, 7, 18	0[2]	45,883
TOTAL		**1,498**	**691,674**
Tailings Storage Areas			
A	39 North, 43 East, 8, 9	52	29,659
C	39 North, 43 East, 29	93	8,872
E	39 North, 43 East, 29	0[2]	6,000
TOTAL		**145**	**44,531**
Heap Leach Pads			
B	39 North, 43 East, 31	154	2,871
C	39 North, 43 East, 31	0[2]	31,244
H	39 North, 43 East, 8, 17	0[2]	17,399
J	39 North, 43 East, 4,5,8	0[2]	20,699
TOTAL		**154**	**72,213**

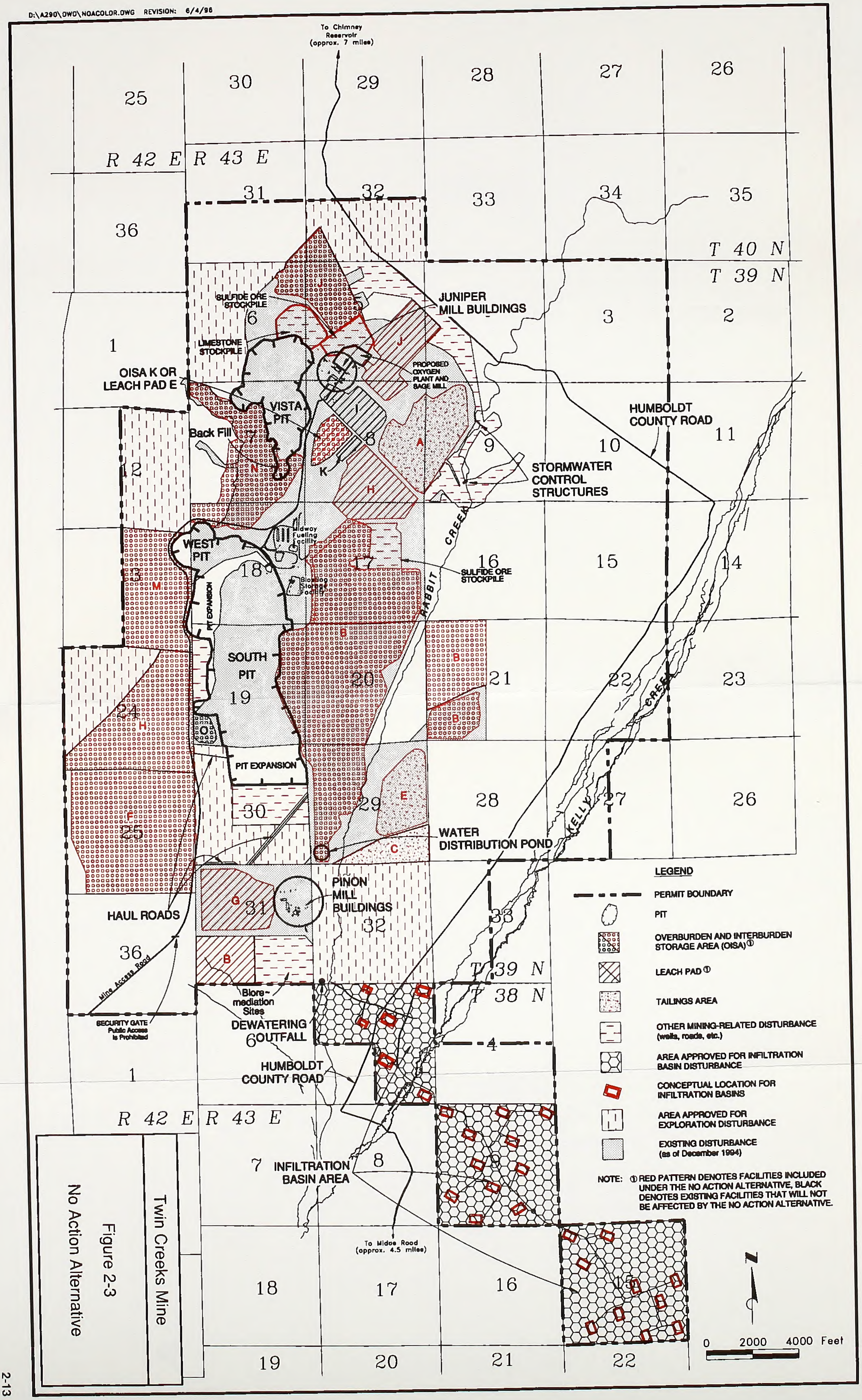
[1] Overburden and interburden storage areas F and M would be available only through a land agreement with First Miss Gold.

[2] These areas are already disturbed and in use. Additional tonnage of material would be placed over the existing disturbance.

interburden storage areas and would not result in any new surface disturbance. For example, under the No Action alternative, a portion of the new material deposited on overburden and interburden storage areas J and N would be placed over existing disturbance. Overburden and interburden storage areas F (Section 25) and M (Section 13) would require a land agreement with First Miss Gold.

Overburden and interburden storage areas would be constructed by end-dumping from mine haul trucks; active storage area faces would be at angle of repose, which is approximately 36 degrees (1.4 horizontal: 1.0 vertical). SFPG's *Twin Creeks Mine Materials Handling Plan* (PTI and WESTEC 1996) proposes the selective handling of net-neutralizing material to serve as a basal layer and cover material for overburden and interburden storage areas; the plan proposes the random emplacement of net acid-neutralizing and net acid-generating material between the basal and cover layers. In addition, cover material for the storage areas would be selectively handled to ensure that Meteoric Water Mobility Testing Procedure leachate from the material does not exceed the Nevada Division of Environmental Protection criteria. For the No Action alternative, it is estimated that 90 percent of the Twin Creeks overburden and interburden material would be net acid-neutralizing and 10 percent would be net acid-generating (PTI and WESTEC 1996). The random emplacement of overburden and interburden within the storage areas is designed to blend and microencapsulate net acid-generating material within net acid-neutralizing material.

The general design of the overburden and interburden storage facilities is presented in ***Figure 2-4***. Each storage area would consist of a 50-foot basal layer of net-neutralizing material, overlain with 50-foot lifts of randomly emplaced net acid-neutralizing and net acid-generating overburden and interburden.



Twin Creeks Mine

Figure 2-3

No Action Alternative

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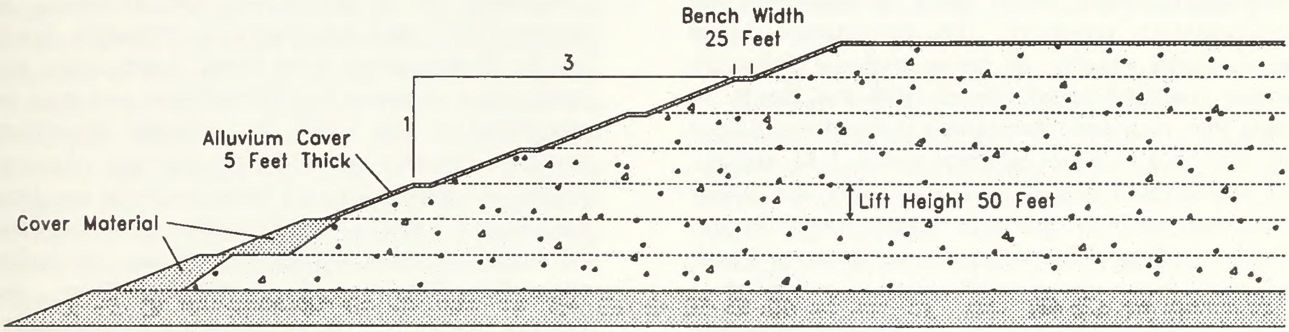
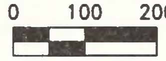
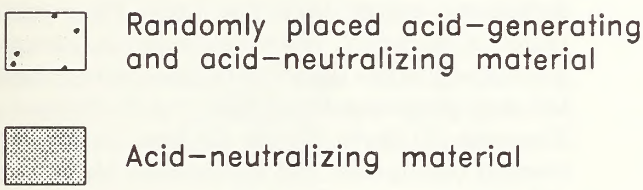


Reclaimed Side-slope Configuration



Legend



Note: The side-slope for each 50-foot lift would be graded to the final reclaimed slope configuration (2.5:1) and covered with acid-neutralizing material, as shown, prior to placement of subsequent lifts at the slope face.

Twin Creeks Mine

Figure 2-4

Overburden and Interburden Storage Area Side-slope Configuration

The soil and bedrock conditions beneath the overburden and interburden storage areas are variable. The basal layer design for the facilities would vary depending on the site conditions and proximity to the two open pits. Where facilities are underlain by a minimum of 50 feet of carbonate alluvium (alluvium derived from Paleozoic sedimentary rocks, which has a relatively high net neutralization potential), the constructed basal layer would consist of oxide material (alluvium and/or oxidized rock) mined from the South or Vista Pits. In areas where there is less than 50 feet of carbonate alluvium (storage areas J, M, and N), the basal layer would be constructed with either carbonate alluvium, oxide material mined from the South or Vista Pits, or a combination of these materials to provide a similar level of protection to ground water resources for all facilities (PTI and WESTEC 1996). Storage area M would be constructed with 50 feet of carbonate alluvium mined from the South or Vista Pits; storage area J would be constructed with a 100-foot basal layer of oxide material mined from the Vista Pit; and storage area N would be constructed with a 100-foot basal layer of either carbonate alluvium or oxide material mined from the South or Vista Pits.

The side slopes of each 50-foot lift would be graded to the final internal reclaimed slope configuration of 2.5:1 (horizontal to vertical) and covered with acid-neutralizating material prior to the placement of subsequent lifts at the slope face. Each lift would be separated by a 25-foot-wide bench designed to collect and convey runoff from the slopes and reduce erosion. The storage areas would reach maximum heights of 400 feet. With 2.5:1 intermediate slopes and 25-foot benches, the overall gradient of the side slopes for the storage facilities would be 3.0:1.

As shown in ***Figure 2-4***, the first two lifts of randomly placed material (i.e., above the 50-foot basal material) would be covered with net acid-neutralizing material ranging in horizontal thickness from approximately 50 feet at the top of a lift to 100 feet at the bottom. The vertical thickness of the net acid-neutralizing material on these two lifts would range from approximately 10 to 40 feet. Above the first two blended lifts, the side slopes of the remaining lifts would be covered with a minimum of 5 feet of net acid-neutralizing material (***Figure 2-4***). The top lift would be covered with a minimum of 5 feet of net acid-neutralizing material, and both the side slopes and top would be revegetated to reduce infiltration and erosion. See Section 2.4.11.6 for a more detailed discussion of SFPG's proposed reclamation of overburden and interburden storage areas.

Flotation grade ore is gold-bearing material that either does not meet the present gold cutoff for processing or is not considered amenable to existing gold recovery methods. Flotation grade ore is distinguished from other overburden and interburden because it is mineralized and may be processed in the future if economic conditions and/or recovery technologies warrant. Approximately 40 million tons of flotation grade ore from the South Pit and 0.46 million tons from the Vista Pit would be removed as part of the No Action alternative. Because it contains sulfides, the flotation grade ore is potentially acid-generating and would be handled accordingly. The flotation grade ore storage areas would be located on top of existing or proposed overburden and interburden storage areas and would be underlain by at least 50 feet of acid-neutralizing alluvium (PTI and WESTEC 1996; PTI 1996b). Flotation grade ore would be placed in two 50-foot lifts within overburden and interburden storage areas (SFPG 1995a; PTI and WESTEC 1996).

2.3.4 Sulfide Ore Stockpiles

Sulfide ore mined from the South Pit would be stored in Section 5, Township 39 North, Range 43 East, immediately adjacent to the existing Juniper Mill and proposed Sage Mill, and in Section 17, Township 39 North, Range 43 East, on top of an existing overburden and interburden storage area (***Figure 2-3*** and ***Table 2-1***). No new surface disturbance would be associated with the proposed sulfide ore stockpiles. The sulfide ore in these stockpiles would be processed prior to closure.

The ore to be stored would be assumed to be potentially acid-generating and would be handled accordingly. The storage area for the sulfide ore in Section 5 would consist of a 5-foot layer of finer grained acid-neutralizing overburden and interburden, compacted to achieve a hydraulic conductivity of 10^{-5} centimeters per second or less (SFPG 1995a). The storage area would either be graded to drain to a collection ditch that would route any stormwater runoff to the expanded Juniper tailings, collected in a pond and allowed to evaporate, or be introduced into the processing circuit. As appropriate, based on field conditions, diversion structures may be constructed upgradient from the ore storage areas to preclude surface runoff from contacting the ore material (SFPG 1995a).

2.3.5 Construction of Phase 1 of the Sulfide (Sage) Mill

Under the No Action alternative, Phase 1 of an additional mill (the Sage Mill) would be constructed adjacent to the existing Juniper Mill in Section 5, Township 39 North, Range 43 East to handle the increased mine production, and would share some of the process components with that facility (***Figure 2-3***). Phase 1 would comprise installation of the first autoclave; the construction of this facility would require approximately 300 workers. The Sage Mill would encompass 8 acres of BLM-administered land; however, all of the area is already disturbed. Approval under the No Action alternative covers construction of Phase 1 of the Sage Mill; construction of Phase 2 and operation of the new mill are addressed under the Proposed Action.

2.3.6 Development and Expansion of Tailings Storage Areas

Additional tailings storage areas developed or expanded under the No Action alternative are shown in ***Figure 2-3***. The tailings areas would disturb 145 acres, including 52 acres on public lands administered by the BLM (***Table 2-1***). ***Table 2-3*** identifies the legal descriptions and summarizes the tonnage of new material to be placed on the tailings storage areas under the No Action alternative.

The No Action alternative would include the construction of one new tailings storage area (storage area C) and the expansion of two existing tailings storage areas (A and E). Tailings area A would receive tailings from the existing Juniper Mill; areas C and E would receive tailings from the existing Piñon Mill.

The expansion at tailings area A would be constructed in a manner similar to the existing Juniper tailings storage facility except that centerline and downstream construction techniques would be employed instead of upstream techniques, which were used in the past. The southern portion of the tailings embankment would be constructed in five stages to an ultimate height of 163 feet, providing an additional capacity of approximately 25 million tons.

Impoundment areas that would host a solution pool and areas of natural drainage "fingers" would be lined with a composite geosynthetic/soil liner system. The balance of the impoundment at tailings area A would be constructed with a clay liner; the clay would be obtained from existing on-site or off-site sources. A gravel drainage layer would be placed over the entire impoundment area to increase drainage of the tailings and to reduce hydraulic head on the liner. Perforated pipes in the drainage layer would collect tailings water and convey it to an under-drainage tank from which it would be pumped back to the reclaim pond. Tailings water would be recovered directly from the solution pool to the reclaim pond using a decant system and pump.

The tailings impoundment and solution pond facilities would be designed for zero discharge to surface water or ground water, and would be designed to contain (without release) precipitation and runoff resulting from the 24-hour, 25-year storm event combined with normal operating volumes. In addition, the tailings impoundment and solution pond facilities would be designed to withstand runoff from the 24-hour, 100-year storm event.

SFPG would monitor the tailings slurry prior to discharging into the tailings impoundment to maintain free cyanide levels at or below 50 parts per million. The discrete tailings samples would be taken at regular intervals during mill operation. If the cyanide level in the tailings slurry, before leaving the mill, is greater than 50 parts per million free cyanide, SFPG would reduce the cyanide level in the milling circuit.

Tailings storage areas C and E are proposed to accommodate future tailings from the existing Piñon Mill. Tailings area C would be constructed adjacent to the existing tailings storage area E in Section 29, Township 39 North, Range 43 East. This storage area would disturb a total of 93 acres of private land. Tailings area C would be constructed by adding another cell and raising the existing embankment to an ultimate height of 92 feet using downstream construction techniques. The new storage area would have a total capacity of 11.6 million tons.

Tailings area E is an existing tailings storage area. Under the No Action alternative, additional tailings would be placed over the existing disturbance, resulting in no new surface disturbance (***Table 2-3***).

Tailings area C may or may not be synthetically lined depending upon the chemistry of the tailings. Coarse drain fill would be used in the natural drainage pattern of the storage area to collect tailings water and transmit it to solution pools from which it would be decanted to tailings reclaim ponds. The tailings reclaim ponds near the outside toe of each tailings embankment would capture storm flows and normal tailings solution from the decant systems. Fluids in the reclaim ponds would be pumped back to the Piñon Mill for reuse within the mill or in leach pad G.

Aboveground pipelines would be constructed in support of each of the three tailings storage areas. For each tailings area, one or more pipelines would carry tailings slurry to the storage area, while additional pipelines would return reclaim water to the process areas. To the extent possible, the pipelines would be laid together to keep surface disturbance to a practicable minimum and to facilitate visual inspections. Pipelines located outside of existing or future lined areas would be placed in synthetically-lined ditches to control potential spills and leaks. The ditches would be graded toward the tailings storage areas and/or provided with an emergency storage pond, or they would use existing pond capacity so that any spills would be contained.

2.3.7 Development of an Additional Heap Leaching Facility

An additional heap leach facility (heap leach pad B) would be developed under the No Action alternative to allow the continued recovery of gold from low-grade oxide reserves and possibly from low-grade unoxidized ore using conventional or developing technologies. The proposed heap leach facility would be located in Section 31, Township 39 North, Range 43 East (***Figure 2-3***), and would disturb 154 acres of private land owned by SFPG (***Table 2-1***). Existing heap leach pads also would be used under the No Action alternative. Additional material would be placed on existing heap leach pads G, H, and J, resulting in no new surface disturbance. ***Table 2-3*** identifies the legal descriptions and summarizes the tonnage of new material to be placed on the heap leach pads under the No Action alternative.

Leach pads would be designed with geo-synthetic/soil liner systems and would be equipped with leak detection systems in areas of high solution flows. Leachate would be collected from the lined pads using a perforated pipe and drain rock network. Leachate collection systems would be designed to minimize hydraulic head on the liners.

Existing solution ponds would be used with future leach pads where practical. Where additional solution ponds are needed to provide the required solution storage capacity or to optimize operations, they would be designed to meet appropriate regulatory requirements. Ponds that would impound process solutions on a regular basis would be double-lined and equipped with leak detection systems. Emergency storage ponds intended to be used only under unusual operating conditions such as large storm events may be single-lined.

These heap leach facilities would be operated similarly to existing leaching facilities at the Twin Creeks Mine. Run-of-mine or crushed ore would be loaded onto the pads in 10- to 50-foot lifts to an ultimate height not to exceed 200 feet, except for the leach pad in Section 5 (leach pad J), which has an ultimate height of 250 feet. Each lift would be leached by irrigation with a diluted cyanide solution (approximately 0.3 pound cyanide/ton of solution) applied by drip emitters or sprinklers at the rate of 0.0006 to 0.004 gallon per minute per square foot. Pregnant solution would be collected in the perforated piping network on top of the liner and conveyed to collection ponds. Pregnant solutions from the additional heaps would be processed using existing facilities to the extent possible. Satellite carbon column facilities may need to be constructed at some of the remote heap leach pad facilities. Carbon from these facilities would be transported to the Juniper Mill or Piñon Mill for stripping and regeneration. The solution ponds would be netted to preclude wildlife access.

2.3.8 Development of Limestone Storage Area

Limestone used in the proposed Sage Mill would be mined from the existing Vista Pit and stored in

Sections 5 and 6, Township 39 North, Range 43 East (***Figure 2-3***). Present plans call for the mining of approximately 10 million tons of limestone. The limestone stockpile would encompass approximately 64 acres of BLM-administered land (***Table 2-1***).

2.3.9 Development of Dewatering Wells, Water Distribution Pond, and Water Treatment Plant

Under the No Action alternative, dewatering water could continue to be used in the processing facilities and for dust control; a portion of the water would require disposal. Excess water would be treated for arsenic in a water treatment plant prior to discharge. Ferric sulfate would be used to precipitate arsenic as an insoluble ferric arsenate compound.

Sediment-laden water from in-pit sumps and horizontal drains would be pumped to a clarifier. Solids from the clarifier would be pumped to the milling circuit, or placed in an overburden and interburden storage area or tailings impoundment, and the clarified water would proceed to the water treatment plant.

The dewatering rate under the No Action alternative is estimated to range from 5,000 to 8,000 gallons per minute (HCI 1996). Approximately 4,300 gallons per minute would be consumed in the mining and milling process. The excess 700 to 3,700 gallons per minute would be treated and discharged to Rabbit Creek or to both Rabbit Creek and the reinfiltration basins (see Section 2.3.10). SFPG plans to maintain a minimum discharge to Rabbit Creek of 500 to 700 gallons per minute. However, under the current National Pollutant Discharge Elimination System permit, up to 5,000 gallons per minute could be discharged to Rabbit Creek. Therefore, based on the estimated dewatering rates and minimum discharge to Rabbit Creek, the amount of water discharged to the reinfiltration basins would range from 0 to 3,200 gallons per minute.

In addition, SFPG would construct a 7-million-gallon water distribution pond within the southwest portion of Section 29, Township 39 North, Range 43 East. The 1.6-acre pond would be constructed in an area already disturbed by the development of overburden and interburden storage area B (***Figure 2-3***). The pond would be constructed with an 80-mil high-density polyethylene geomembrane liner to minimize leakage and reduce sediment uptake.

The purpose of the water distribution pond would be to:

- Collect water pumped from the South Pit dewatering wells
- Collect South Pit sump water after clarification
- Provide deaeration, holding time, and surge capacity of dewatering water prior to delivery to the water treatment facility
- Provide water for operations at the Piñon Mill by gravity supply
- Provide water for operations in the Juniper Mill from a pump station constructed at the pond

Construction of the pond would allow SFPG to reduce the use of deep ground water currently being pumped from the south wells for mill operations and dust control. One well would provide potable water, and one well would remain in service as a supplemental water supply well.

2.3.10 Development of Reinfiltration Basins

Under the No Action alternative, a portion of the treated dewatering water would be discharged to reinfiltration basins (***Figure 2-3***). SFPG's Groundwater Protection Permit allows treatment and reinfiltration of up to 17,360 gallons per minute. SFPG would periodically rip, grade, or use other methods to preclude the emergence of vegetation on the surface and banks of the reinfiltration basins and to improve infiltration rates. The reinfiltration basins would disturb 318 acres of private land (***Table 2-1***).

2.3.11 New Haul and Access Roads

New haul and access roads would disturb approximately 45 acres, of which 34 acres would be on lands administered by the BLM. Water would be applied to the haul roads and magnesium chloride would be applied to the access roads for dust control.

2.3.12 Construction of Ancillary Facilities

The existing potable water system would be upgraded. Septic systems have been constructed to service the Sage Mill building and the Midway production lineout building. Spurs from existing power lines would be constructed as needed to supply power to the Sage Mill and other facilities. There would be no new surface disturbance under the No Action alternative related to ancillary facilities. ***Table 2-4*** summarizes the estimated fuel and energy requirements for the Twin Creeks Mine.

2.3.13 Development of a Bioremediation Site

The Nevada Division of Environmental Protection, under authority of Nevada Revised Statute 445.223, issued a General Permit which allows mining operations to construct, operate, and close bioremediation facilities to actively remediate hydrocarbon-contaminated soils and hydrocarbon-contaminated material from sumps in maintenance buildings, vehicular wash areas, and oil/water separators. The Twin Creeks Mine is currently conducting bioremediation of hydrocarbon-contaminated soils on an existing lined leach pad in Section 8, Township 39 North, Range 43 East (***Figure 2-3***). Approximately 6,000 cubic yards of hydrocarbon-contaminated soils have been treated at this test facility.

SFPG has proposed to develop a new bioremediation facility to replace the existing test pad process. The new facility would consist of 15 bioremediation cells located in Section 31, Township 39 North, Range 43 East (***Figure 2-3***). The proposed bioremediation facility can be permitted at this time under the guidelines of the General Permit. The bioremediation facility would disturb 123 acres of private land owned by SFPG (***Table 2-1***).

2.3.14 Employment

SFPG anticipates that the construction work force would total approximately 300 people to construct Phase 1 of the sulfide (Sage) mill. Construction is expected to last approximately 12 months. SFPG estimates that no additional operations workers would be needed under the No Action alternative above the current operations work force of 970.

2.4 Proposed Action

SFPG submitted a plan of operations and a reclamation plan (SFPG 1995a) to the BLM in September 1994 and updated these plans in September 1995 for the following facilities and activities associated with the proposed mine consolidation and expansion (***Figure 2-5***):

- Consolidation of the two former mining operations, including rights-of-way (i.e., the former Chimney Creek and Rabbit Creek Mines)
- South Pit expansion
- Development of overburden and interburden storage areas
- Development of additional milling, flotation, and tailings facilities
- Development of additional heap leaching and processing facilities
- Expansion of the existing dewatering system and water disposal facilities
- Diversion of Rabbit Creek and tributaries around the mining and processing areas
- Construction of ancillary facilities
- Relocation of the county road

These proposed activities are discussed in more detail in the following sections. ***Figure 2-6*** illustrates the incremental change in surface disturbance from the existing conditions to the No Action alternative to the Proposed Action.

2.4.1 Consolidation of Former Rabbit Creek Mine and Former Chimney Creek Mine

The proposed plan of operations and reclamation plan for the Twin Creeks Mine serve to consolidate existing documentation regarding the operation and reclamation of the former Rabbit Creek Mine and the former Chimney Creek Mine. All existing plans of operations and amendments prepared in support of the Chimney Creek Mine, and reclamation plans prepared for the Rabbit Creek Mine are incorporated by reference. Consolidation

TABLE 2-4
Fuel[1] and Energy Requirements
No Action Alternative and Proposed Action

Description and Year	No Action Alternative		Proposed Action	
	Mining[2]	Processing[3]	Mining	Processing
Electric Power: MWH Used				
1995	35,303	34,032		
1995	30,953	93,747		
1997	39,390	100,000	369,469	
1995	42,024	100,000	316,525	
1995	42,688	100,000	367,797	
2000	41,806	100,000	367,889	
2001			42,000	367,797
2002			42,000	367,797
2003			42,000	367,797
2004			42,000	367,889
2005			42,000	365,961
2006			39,436	365,961
2007			36,775	365,961
2008			30,097	358,252
2009			30,044	320,078
2010			30,920	320,078
2011			31,804	258,601
SUBTOTAL	**232,164**	**527,779**	**1,830,756**	**3,826,172**
TOTALS	**No Action =759,943**		**Proposed Action =5,656,928**	

Description and Year	No Action Alternative		Proposed Action	
	Mining[2]	Processing[3]	Mining	Processing
Diesel & Gasoline: Gallons Used				
1995	6,871,786	350,000		
1999	14,514,735	350,000		
1997	14,788,667	350,000		
1999	15,655,539	350,000		
1999	15,711,106	350,000		
2000	15,706,282	350,000		
2008			15,700,000	350,000
2002			15,700,000	350,000
2003			15,700,000	350,000
2003			15,700,000	350,000
200[illegible]			15,700,000	350,000
2006			13,817,224	350,000
2007			12,873,176	350,000
2008			8,596,320	350,000
2009			6,798,401	350,000
2010			6,802,699	350,000
2011			6,782,060	350,000
SUBTOTAL	**83,248,115**	**2,100,000**	**134,169,880**	**3,850,000**
TOTALS	**No Action = 85,348,115**		**Proposed Action = 138,019,880**	

1 Fuel consumption is based on reclamation activities beginning once mining ceases (2012). However, SFPG plans concurrent reclamation to the extent possible. The reclamation schedule and the fuel and energy requirements for these activities are included in the Plan of Operations.

2 Mining:
Values for years 1995 - 2000 and 2006 - 2011 were developed from the 1996 Profit Plan. This plan uses proven reserves only; therefore, mining would cease in the year 2006. Values for years 2001 - 2005 were inserted assuming peak demand conditions. This was necessary to represent the Proposed Action where mining would cease in the year 2011.

3 Processing:
Values for electric power for all years were developed from the 1996 Profit Plan, and no adjustments were necessary. Values for diesel and gasoline were estimated assuming approximately 1,000 gallons per day usage.

of existing mining and processing activities is necessary to improve current operations and to facilitate the proposed expansion. Consolidation activities will include, but may not be limited to, the following:Storing overburden and interburden in the most economical location(s)

- Using existing mine equipment and all existing haul roads, regardless of location
- Processing ore at either of the two existing mills (Juniper and Piñon)
- Heap leaching ore at any of the heap leach facilities
- Integrating ancillary and administrative facilities

SFPG proposes to consolidate and expand the existing operations through pit expansion, increased dewatering and diversion of Rabbit Creek, additional overburden and interburden storage areas, operation of a new mill, and development of additional tailings storage facilities and heap leaching facilities. These expansion activities are discussed below and are shown in ***Figure 2-5.*** The estimated acreage of new surface disturbance associated with the proposed expansion is shown in ***Table 2-1***.

In addition, the existing corner crossings associated with the Rabbit Creek Mine would no longer be necessary with the consolidation of the former Rabbit Creek Mine and the former Chimney Creek Mine. Accordingly, all Federal Land Policy Management Act rights-of-way would be terminated, and the reclamation responsibilities would be transferred to the Twin Creeks Mine plan of operations and reclamation plan.

2.4.2 South Pit Expansion

The existing South Pit would be expanded and deepened to allow the mining of oxidized and sulfide mill-grade ore, leach-grade ore, and subgrade material. As proposed, the pit would encompass a maximum area of approximately 15,000 feet by 6,000 feet and would have a bottom elevation of approximately 3,700 feet. Working benches would be between 10 and 50 feet high and approximately 100 to 1,500 feet wide. Pit slopes would range from 30 to 55 degrees depending upon the location within the pit. The South Pit would disturb a total of 1,839 acres in its ultimate configuration, including 826 acres of new disturbance under the Proposed Action; of the new disturbance, 629 acres would be located on public lands administered by the BLM. The proposed pit limits also would extend onto private lands not controlled by SFPG; disturbance of the 82 acres included on such lands would require a land agreement with First Miss Gold. Mining would proceed 24 hours per day, 365 days per year, at the average life-of-mine rate of 400,000 (total) tons per day with daily maximums up to 550,000 tons per day. At the proposed mining rate, the South Pit would be mined through the year 2011.

Conventional open-pit mining techniques, including drilling, blasting, loading, and hauling, would continue to be employed at the South Pit. Ore, overburden, and interburden would be blasted using ammonium nitrate, fuel oil, and emulsion explosives and loaded into haul trucks using front-end loaders and hydraulic or electric shovels. Ore would be hauled to one of the active heap leach pads or to one of the ore stockpiles. Overburden and interburden would be hauled to the most economical storage area. Existing mining equipment would continue to be used, although additional equipment might be needed to supplement or to replace the current fleet.

2.4.3 Overburden and Interburden Storage Areas

Continued mining would result in more overburden and interburden material than can be stored in existing, approved storage areas. Proposed additional storage areas are shown in ***Figure 2-5***. The associated surface disturbance of each proposed overburden and interburden storage area is presented in ***Table 2-1***. ***Table 2-5*** identifies the legal descriptions and summarizes the tonnage of new material that would be deposited on the proposed overburden and interburden storage areas under the Proposed Action. Portions of the storage areas would be located on top of existing overburden and interburden storage areas and existing or proposed tailings areas, and would not result in any additional surface disturbance. For example, under the Proposed Action, overburden and interburden storage area B would overdump tailings storage areas C and E (Section 29, Township 39 North, Range 43 East, shown as a 'multiple use area' in ***Figure 2-5***); overburden and

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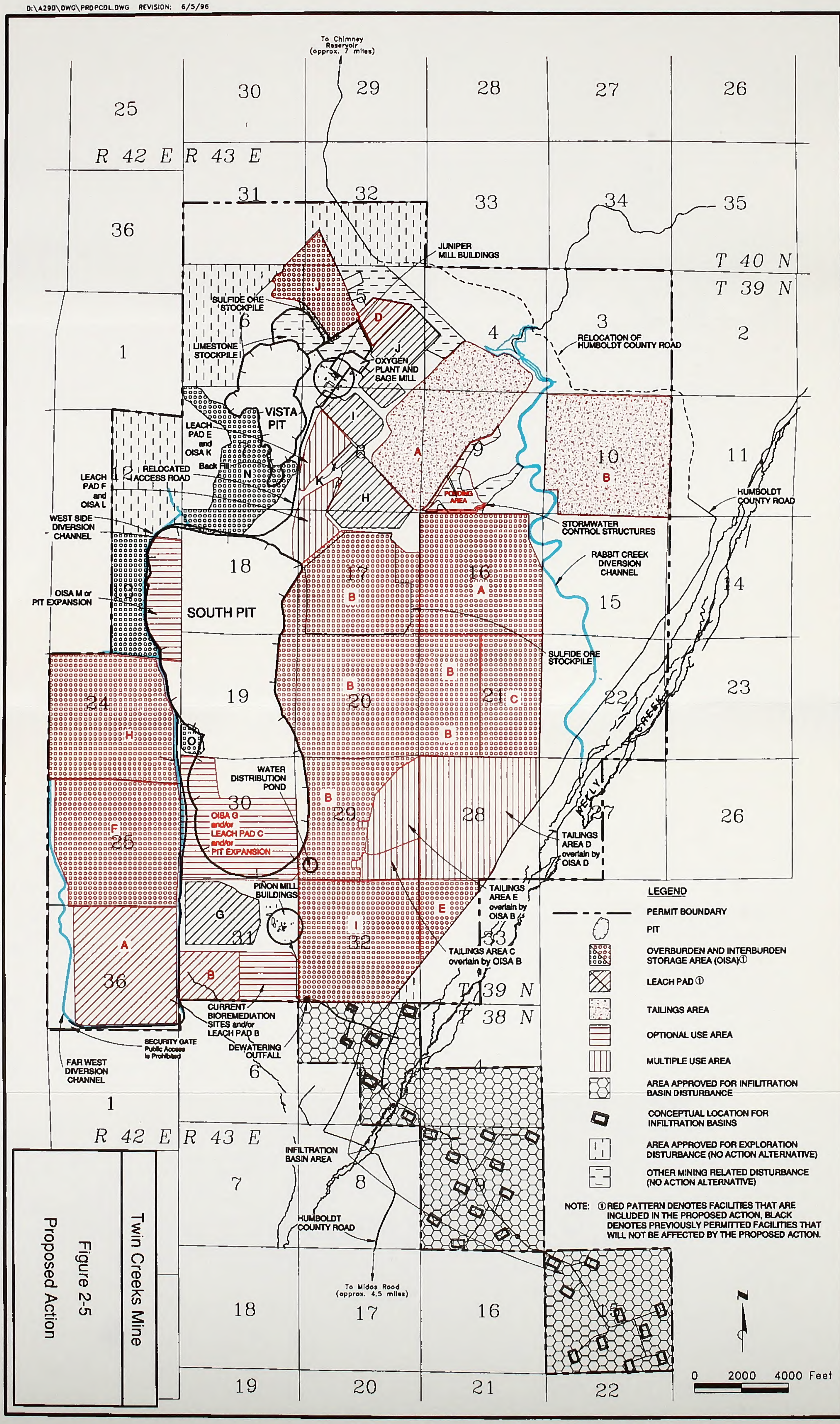
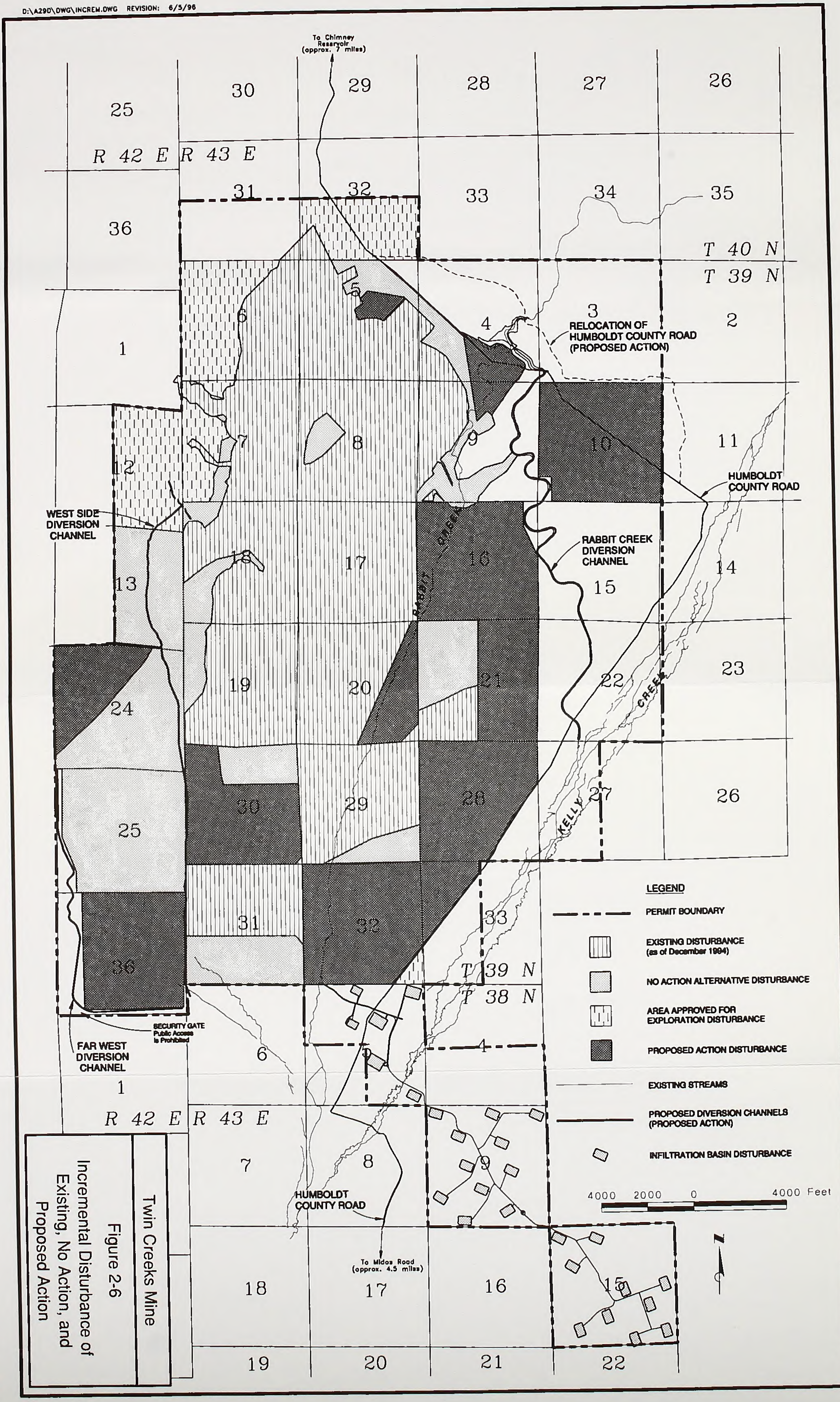


Twin Creeks Mine

Figure 2-5
Proposed Action



Twin Creeks Mine

Figure 2-6
Incremental Disturbance of Existing, No Action, and Proposed Action

TABLE 2-5
Legal Descriptions and Tonnage of Material by Project Component
Proposed Action

Project Component	Legal Description (township, range, section)	Total New Surface Disturbance (acres)	Tonnage of New Material (ktons)
Overburden and Interburden Storage Areas			
A	39 North, 43 East, 16	624	226,444
B[1]	39 North, 43 East, 17, 18, 19, 20, 21, 29	186	362,647
C	39 North, 43 East, 21	321	186,374
D[2]	39 North, 43 East, 28	526	166,497
E	39 North, 43 East, 33	119	55,646
F[3]	39 North, 42 East, 25	503	236,250
G[4,5]	39 North, 43 East, 30	52	25,000
H	39 North, 42 East, 24	235	165,196
I	39 North, 43 East, 3[illegible]	605	275,614
J	39 North, 43 East, 5, 6; 40 North, 43 East, 31, 32	7	1,364
K[6]	39 North, 43 East, 8	50	13,812
L[7]	39 North, 43 East, 7, 8, 17, 18	503	16,988
TOTAL		**2,725**	**1,731,832**
Tailings Storage Areas			
A	39 North, 43 East, 4, 5, 8, 9	297	25,000
B	39 North, 43 East, 10	626	50,000
D[8,9]	39 North, 43 East, 28	0	56,537
TOTAL		**5[illegible]3**	**131,537**
Heap Leach Pads			
A	39 North, 42 East, 36	503	73,050
C[4,5]	39 North, 43 East, 30	53	25,000
D	39 North, 43 East, 5	55	6,175
E[10, 6]	39 North, 43 East, 8	0	13,813
F[7]	39 North, 43 East, 7, 8, 17, 18	0[11]	16,989
TOTAL		**611**	**135,027**

[1] Overburden and interburden storage area B would ultimately overdump tailings storage areas C and E.
[2] Overburden and interburden storage area D would ultimately overdump tailings storage area D.
[3] Overburden and interburden storage area F would be available only through a land agreement with First Miss Gold.
[4] The new surface disturbance within Section 30 and outside the ultimate South Pit boundary was split between overburden and interburden storage area G and heap leach pad C.
[5] Tonnages are subject to fluctuations due to revised pit designs affecting the southern portion of Section 30. Any positive or negative fluctuations would be applied to overburden and interburden storage area B.
[6] Tonnages are estimated assuming a 50/50 split in area (200 feet high). Configuration on map reflects a combination of overburden and interburden storage area K and heap leach pad E.
[7] Tonnages are estimated assuming a 50/50 split in area (200 feet high). Configuration on map reflects a combination of overburden and interburden storage area L and heap leach pad F.
[8] No acreage disturbance was calculated for this optional use area. The acreage disturbance for this area is already included in the total for overburden and interburden storage area D.
[9] Ultimately covered by overburden and interburden storage area D.
[10] Acres for this optional use area are already included in the total new surface disturbance for overburden and interburden storage area K.
[11] These areas are already disturbed and in use. Additional tonnage of material would be placed over the previous disturbance. Refer to ***Table 2-1*** for identification of the specific disturbance.

interburden storage area D would overdump proposed tailings storage area D (Section 28, Township 39 North, Range 43 East, shown as a 'multiple use area' in ***Figure 2-5***); and the new material deposited on overburden and interburden storage areas F and L would be placed over existing disturbance.

Portions of overburden and interburden storage areas G and M are shown as 'optional use' areas in ***Figure 2-5*** and are within the ultimate South Pit boundary. The portions of storage areas G and M within the ultimate pit boundary would be developed only if SFPG determined that the ore reserves in these areas are non-economical to mine at this time. Storage area M would require a land agreement with First Miss Gold.

Although designated as 'multiple use areas' in ***Figure 2-5***, storage areas K and L, located in Sections 8, 17, and 18, Township 39 North, Range 43 East, would be located adjacent to heap leach pads E and F respectively, within the footprints identified in ***Figure 2-5***.

Overburden and interburden storage areas would be constructed by end-dumping from mine haul trucks; active storage area faces would be at angle of repose, which is approximately 36 degrees (1.4 horizontal:1.0 vertical).

The overburden and interburden storage areas for the Proposed Action would be constructed in the same manner as for the No Action alternative (see Section 2.3.3). Net acid-generating and acid-neutralizing material would be randomly emplaced between basal and cover layers of selectively handled net acid-neutralizing material. In addition, cover material for the storage areas would be selectively handled to ensure that Meteoric Water Mobility Testing Procedure leachate from the material does not exceed the Nevada Division of Environmental Protection criteria. For the Proposed Action, it is estimated that 92 percent of the Twin Creeks overburden and interburden material would be net acid-neutralizing, and 8 percent would be net acid-generating (PTI and WESTEC 1996).

The soil and bedrock conditions beneath the proposed overburden and interburden storage areas are variable. The basal layer design for the facilities would vary depending on the site conditions and proximity to the two open pits. Where facilities are underlain by a minimum of 50 feet of carbonate alluvium (alluvium derived from Paleozoic sedimentary rocks, which has a relatively high net neutralization potential), the constructed basal layer would consist of oxide material (alluvium and/or oxidized rock) mined from the South or Vista Pits. For storage areas underlain by less than 50 feet of carbonate alluvium (storage areas J, M, and the northwest one-half of storage area H), the constructed basal layer would vary to provide a similar level of protection to ground water resources for all facilities (PTI and WESTEC 1996). Storage areas H and M would be constructed with 50 feet of carbonate alluvium mined from the South Pit; storage area J would be constructed with a 100-foot basal layer of oxide material mined from the Vista Pit.

Under the Proposed Action, storage area D and a portion of storage area B would be constructed over existing or proposed lined tailings facilities. The overburden and interburden material would be placed directly on the tailings facility without an additional basal layer. Approved closure plans for the tailings and associated facilities would be approved for the Nevada Division of Water Resources, Dam Safety Permit(s) and the Nevada Division of Environmental Protection, Water Pollution Control Permit(s) prior to placement of the overburden and interburden material on the tailings (PTI and WESTEC 1996). Seepage generated from the tailings would be captured by the tailings subdrain system and/or other approved seepage collection/ control systems. Any collected seepage would be discharged to other process facilities (i.e., leach pads or tailings facilities), evaporated, or treated prior to discharge (PTI and WESTEC 1996).

2.4.4 Additional Milling, Flotation Circuit, and Tailings Facilities

The proposed operations would include three different milling circuits:

- Oxide ore would be processed using a conventional cyanide carbon-in-leach circuit.
- Sulfide ore would be oxidized through a pressure oxidation circuit (autoclave process) and then combined with oxide ore in the carbon-in-leach circuit.

Flotation grade sulfide material would be concentrated prior to processing in the autoclave in the mill.

2.4.4.1 Sage Mill Operations

Construction of Phase 1 of the Sage Mill was addressed under the No Action alternative (see Section 2.3.5). Construction of Phase 2 (the second autoclave) and operation of the Sage Mill would occur under the Proposed Action. The Sage Mill would have a process capacity of 11,000 tons per day. Both the existing Juniper Mill (6,000 tons per day) and the Piñon Mill (6,000 tons per day) would continue to operate under existing environmental permits.

The new Sage Mill would use a pressure oxidation circuit to prepare the sulfide ore for gold recovery through conventional cyanide leaching processes. The sulfide ore would be finely ground, thickened, and acidified with sulfuric acid, as required. The slurry would be oxidized in a continuous-feed autoclave vessel at high temperatures and pressures with nearly pure oxygen gas. The oxidized ore would be neutralized using a combination of oxide ore, lime, or limestone and combined with feedstock from the Juniper Mill. The combined ore would be cyanide-leached in a carbon-in-leach circuit where gold would be recovered on activated carbon, stripped in a low-pressure and temperature circuit, and passed through the electrowinning process prior to refining to doré bars. Oxygen required for the autoclave process would be produced on the site using a cryogenic oxygen plant to be located adjacent to the Sage Mill.

2.4.4.2 Flotation Grade Ore Stockpiles and Flotation Circuit

Flotation grade ore is gold-bearing material that does not meet the present gold cutoff for processing without flotation. Flotation grade ore is distinguished from sulfide ore in that it must be concentrated prior to processing through the Sage Mill. Potentially acid-generating flotation grade ore from the South Pit would be stockpiled in areas constructed in accordance with specifications in the materials handling plan (PTI and WESTEC 1996). The height of the flotation grade ore would be restricted to 100 feet upon closure. These flotation grade ore storage areas would not result in any additional surface disturbance since they would be located on top of existing or proposed overburden and interburden storage areas.

SFPG proposes to add a sulfide flotation process that would be located within existing disturbance either at the Juniper Mill or the Piñon Mill as shown in ***Figures 2-2*** and ***2-5***. The location(s) may vary depending upon finalization of engineering plans. Both sites are examined in this EIS. Flotation grade ore would be transported directly from the pit and either placed in a stockpile or sent directly to the mill. Flotation grade material would be fed from the stockpiles to a grizzly/hopper using a front-end loader. Oversize material would be crushed in the existing crushing plant, as necessary. Screened undersize material would be conveyed into the semi-autogenous grinding mill/ball mill grinding circuit.

After discharge from the ball mill, the slurry would be sent to a conditioner tank where reagents would be added. After conditioning, the slurry would be sent to the rougher flotation circuit where the sulfide material would be separated from the non-sulfide material. The rougher concentrate, consisting of the sulfide material, would be sent to the autoclaves through a slurry pipeline or would be dewatered and trucked to the autoclaves. Pipelines would be located within existing, already disturbed, pipeline/utility corridors.

The rougher tailings would be sent to the scavenger circuit to collect additional sulfide material. The scavenger concentrate would be conditioned with reagents as needed and refloated in the scavenger cleaner circuit. Concentrate from the scavenger cleaner circuit would be added to the rougher concentrate stream. The scavenger cleaner tailings would again be conditioned and refloated in the scavenger circuit. Concentrate from the scavenger circuit would be pumped back to the scavenger cleaner circuit; tailings from the scavenger circuit would be pumped back to the tailings impoundment.

Depending on the location of the flotation circuit, the tailings would be sent to either tailings areas A and B, if the flotation circuit is constructed at the existing Juniper Mill; or tailings area D, if the flotation circuit is constructed at the existing Piñon Mill. The sulfide flotation circuit would operate 24 hours per day, 365 days per year, and would process 6,000 tons per day of flotation grade material.

2.4.4.3 Additional Tailings Storage Facilities

Tailings from the Sage Mill would be discharged to lined tailings storage areas, and tailings seepage and reclaim solutions would be stored in double-lined collection ponds to prevent impacts to waters of the state. The tailings would have a naturally low cyanide level or would be subjected to conventional cyanide destruction methods to ensure that cyanide levels are not harmful to wildlife.

The proposed mine expansion would include the construction or expansion of up to three additional tailings storage areas. These proposed tailings impoundments are shown in ***Figure 2-5***. The surface disturbance associated with each facility is shown in ***Table 2-1***. Tailings areas A and B would receive tailings from the Sage Mill, the existing Juniper Mill, or the proposed flotation circuit; tailings area D would receive tailings from the existing Piñon Mill or the proposed flotation circuit. ***Table 2-5*** identifies the legal descriptions and summarizes the tonnage of new material to be placed on tailings storage areas A, B, and D.

The expansion at tailings area A would be constructed in a manner similar to the existing Juniper tailings storage facility except that centerline and downstream construction techniques would be employed instead of upstream techniques, which were used in the past. The northern portion of the tailings embankment would be constructed in five stages to an ultimate height of 163 feet, providing an additional capacity of approximately 25 million tons.

Impoundment areas that would host a solution pool and areas of natural drainage "fingers" would be lined with a composite geosynthetic/soil liner system. The balance of the impoundment at tailings area A would be constructed with a clay liner. A gravel drainage layer would be placed over the entire impoundment area to increase drainage of the tailings and to reduce hydraulic head on the liner. Perforated pipes in the drainage layer would collect tailings water and convey it to an underdrainage tank from which it would be pumped back to the tailings pond. Tailings water would be recovered directly from the solution pool to the reclaim pond using a decant system and pump.

The tailings impoundment and solution pond facilities would be designed for zero discharge to surface water or ground water, and would be designed to contain (without release) precipitation and runoff resulting from the 24-hour, 25-year storm event combined with normal operating volumes. In addition, the tailings impoundment and solution pond facilities would be designed to withstand runoff from the 24-hour, 100-year storm event.

Tailings area B would be developed in the future as additional capacity is needed to receive tailings from the proposed flotation circuit and the Juniper or Sage Mills. Tailings area B would be located in Section 10, Township 39 North, Range 43 East (***Figure 2-5***). If developed, the tailings area would disturb a total of 626 acres of BLM-administered lands (***Table 2-1***). Current plans for facility development at this site involve embankment construction in five stages to an ultimate height of 168 feet. This facility would provide a total capacity of 50 million tons. A synthetic liner may be used at this site. Development of tailings area B also would require the relocation of the Humboldt County road around Section 10, Township 39 North, Range 43 East (***Figure 2-5***) (see Section 2.4.9).

Tailings area D is proposed to accommodate future tailings from the existing Piñon Mill or the proposed flotation circuit. Tailings area D would be located in Section 28, Township 39 North, Range 43 East, and would be a 'multiple use' area (i.e., tailings area D would ultimately be covered by overburden and interburden storage area D) (***Figure 2-5***). If developed, the tailings area would disturb a total of 526 acres of BLM-administered lands (***Table 2-1***). Current design plans for tailings area D are similar to those for area B except that the ultimate height of the area D embankment would be 124 feet.

Tailings area D may or may not be synthetically lined depending upon the chemistry of the tailings. Coarse drain fill would be used in the natural drainage pattern of the storage area to collect tailings water and transmit it to solution ponds from which it would be decanted to tailings reclaim ponds. The tailings reclaim ponds near the outside toe of each tailings embankment would capture storm flows and normal tailings solution from the decant systems. Fluids in the reclaim ponds would be pumped back to the Piñon Mill or flotation circuit for reuse.

Aboveground pipelines would be constructed in support of each of the proposed tailings storage areas. For each tailings area, one or more pipelines would carry tailings slurry to the storage area, while additional pipelines would return reclaim water to the process areas. To the extent possible, the pipelines would be laid together to keep surface disturbance to a practicable minimum and to facilitate visual inspections. Pipelines located outside of existing or future lined areas would be placed in synthetically-lined ditches to control potential spills and leaks. The ditches would be graded toward the tailings storage areas and/or provided with an emergency storage pond, or they would use existing pond capacity so that any spills would be contained.

2.4.4.4 Transport and Processing of Mule Canyon Mine Ore

Beginning in approximately January 1997, SFPG would transport whole ore from the Mule Canyon Mine to the Twin Creeks Mine for processing. SFPG would transport approximately 2,200 tons per day of sulfide ore, requiring 55 dump trucks per day hauling 40 tons per load. The ore would be shipped 7 days per week, 350 days per year, from 1997 through 2002. The ore would be combined with Twin Creeks Mine ore in the sulfide ore stockpile and processed in the Sage Mill.

The truck route would be west along Interstate 80 for approximately 52 miles from Mule Canyon to the Golconda exit, then north approximately 35 miles on State Route 789 and County Road 513 to the Twin Creeks Mine (see ***Figure 1-1***).

2.4.4.5 Transport and Processing of Lone Tree Mine Flotation Concentrate

Beginning in approximately April 1997, SFPG would transport flotation concentrate from the Lone Tree Mine to the Twin Creeks Mine for processing. The flotation concentrate would be shipped as a slurry at the rate of approximately 450 tons per day of concentrate contained in a slurry composed of 60 percent solids. Approximately 750 tons of slurry would be shipped daily in 20 tanker trucks. The flotation concentrate would be shipped 7 days per week, 350 days per year, from 1997 through 2008. The slurry would be stored in tanks located adjacent to the Juniper Mill or the Sage Mill. The Lone Tree Mine slurry would be combined with the Twin Creeks Mine flotation concentrate after the grinding circuit for processing in the autoclave at the Sage Mill. The chemical composition of the Lone Tree Mine flotation concentrate is presented in ***Table 2-6***. The combined flotation material from both mines would comprise approximately 1 to 3 percent of the total tailings material at the Twin Creeks Mine.

TABLE 2-6
Lone Tree Mine Concentrate Composition

Lone Tree Mine Concentrate	
pH	6.0
Copper (%)	0.284
Iron (%)	20.4
Lead (%)	0.04
Zinc (%)	0.107
Calcium (%)	0.324
Manganese (%)	0.080
Total Carbon (%)	0.39
Carbonate (%)	0.08
Organic Carbon (%)	0.37
Mercury (parts per million)	198.00
Arsenic (%)	1.07
Antimony (%)	0.075
Aluminum (%)	1.58
Chloride (%)	<0.001
Fluoride (%)	0.07
Diphosphorus pentoxide (%)	0.862
Silica (%)	51.4

The truck route would be west along Interstate 80 for approximately 17 miles from the Lone Tree Mine to the Golconda exit, then north approximately 35 miles on State Route 789 and County Road 513 to the Twin Creeks Mine (see ***Figure 1-1***).

2.4.5 Additional Heap Leaching and Processing Facilities

Additional heap leach facilities are proposed to allow the continued recovery of gold from low-grade oxide reserves and possibly from low-grade sulfide ore using conventional or developing technologies. The proposed heap leach facilities are shown in ***Figure 2-5,*** and the estimated acreages of surface disturbance for these facilities are presented in ***Table 2-1***. ***Table 2-5*** identifies the legal descriptions and summarizes the tonnage of new material to be placed on proposed heap leach pads A, C, D, E, and F.

Proposed leach pad A, located in Section 36, Township 39 North, Range 42 East, is situated on public domain land on claims not owned or controlled by SFPG. An agreement with the current claimant and/or a change in the claim status would be necessary for SFPG to implement this facility.

A portion of proposed heap leach pad C is shown as an 'optional use' area in ***Figure 2-5*** and is within the ultimate South Pit boundary. Heap leach pad C would be developed only if SFPG determined that the ore reserves in this area are non-economical to mine at this time, and if this area is not developed as overburden and interburden storage area G (***Figure 2-5***).

Leach pads would be designed with geo-synthetic/soil liner systems and would be equipped with leak detection systems in areas of high solution flows. Leachate would be collected from the lined pads using a perforated pipe and drain rock network. Leachate collection systems would be designed to minimize hydraulic head on the liners.

Existing solution ponds would be used with future leach pads where practical. Where additional solution ponds are needed to provide the required solution storage capacity or to optimize operations, they would be designed to meet appropriate regulatory requirements. Ponds that would impound process solutions on a regular basis would be double-lined and equipped with leak detection and collection systems. Emergency storage ponds intended to be used only under unusual operating conditions such as large storm events may be single-lined.

Additional heap leach facilities would be operated similarly to existing leaching facilities. Run-of-mine or crushed ore would be loaded onto the pads in 20- to 50-foot lifts to an ultimate height not to exceed 200 feet, except for the leach pad in Section 5 (heap leach pad D), which has an ultimate height of 250 feet. Each lift would be leached by irrigation with a diluted cyanide solution (approximately 0.3 pound/ton cyanide) applied by drip emitters or sprinklers at the rate of 0.0006 to 0.004 gallon per minute per square foot. Pregnant solution would be collected in the perforated piping network on top of the liner and conveyed to collection ponds. Pregnant solutions from the additional heaps would be processed using existing facilities to the extent possible. Satellite carbon column facilities may need to be constructed at some of the remote heap leach pad facilities. Carbon from these facilities would be transported to the Juniper Mill or Piñon Mill for stripping and regeneration. The solution ponds would be fenced, netted, or other methods would be used to preclude wildlife access.

2.4.6 Dewatering System and Water Disposal Facilities

As the South Pit expands, additional dewatering would be required. Projected dewatering rates required for the expanded South Pit operations under the Proposed Action would gradually increase to a maximum rate of approximately 12,300 gallons per minute in the year 2011 (projected end of mining life). Water would be removed from the pit using a combination of in-pit sumps and wells, perimeter wells, and horizontal drains. As presently anticipated, 15 to 20 additional dewatering wells may be required along with the 5 existing wells.

Dewatering water would continue to be used in the processing facilities and for dust control; a portion of the water would require disposal. Excess water would continue to be treated for arsenic in an existing water treatment plant prior to discharge. Ferric sulfate would be used to precipitate arsenic as an insoluble ferric arsenate compound; this material would be disposed of in a tailings facility.

Sediment-laden water from in-pit sumps and horizontal drains would be pumped to a clarifier. Solids from the clarifier would be pumped to the milling circuit, or placed in an overburden and interburden storage area or tailings impoundment, and the clarified water would proceed to the water treatment plant.

The dewatering rate under the Proposed Action is estimated to range from 5,300 to 12,300 gallons per minute (HCI 1996). Approximately 4,300 gallons per minute would be consumed in the mining and milling process. The excess 1,000 to 8,000 gallons per minute would be treated and discharged to Rabbit Creek or to both Rabbit Creek and the reinfiltration basins (see Section 2.3.10). SFPG plans to maintain a minimum discharge to Rabbit Creek of 500 to 700 gallons per minute. However, under the current National Pollutant Discharge Elimination System permit, up to 5,000 gallons per minute could be discharged to Rabbit Creek. Therefore, based on the estimated dewatering rates and minimum discharge to Rabbit Creek, the amount of water discharged to the reinfiltration basins would range from 300 to 7,500 gallons per minute.

2.4.7 Surface Water Control Features

2.4.7.1 Rabbit Creek Diversion

In order to accommodate the expansion of existing mining and processing components and the construction and operation of new components, SFPG proposes to divert Rabbit Creek from its existing natural course approximately 1,200 feet to the east. The diverted creek would traverse Sections 3, 4, 9, 10, 15, 16, 22, and 27 of Township 39 North, Range 43 East as shown in ***Figure 2-5***. The diversion structure would be approximately 22,740 feet long and would have a maximum bottom width of approximately 8 feet and an average depth of approximately 4.5 feet. The diversion structure would be trapezoidal in shape with sideslopes of 3 horizontal:1 vertical, and would be riprapped, as necessary, to control erosion.

The Rabbit Creek Diversion is sized to accommodate runoff resulting from the 100-year, 24-hour storm event. The diversion would be operated throughout the active life of the mine and through the closure and reclamation period. The diversion structure would not be reclaimed, but would be revegetated after construction. Maintenance of the diversion structure would be limited to periodical removal of deposited sediments and repair of any damage from erosion. The diversion structure was designed so that long-term maintenance requirements would be minimal. A system for controlled breaching of the diversion and gradual drainageway re-establishment would be implemented for the postclosure phase (WESTEC 1996c).

The maximum disturbance corridor for the Rabbit Creek Diversion is estimated to be 160 feet wide with an average disturbance corridor of 80 feet. Using the maximum disturbance corridor width to estimate surface disturbance, the Rabbit Creek Diversion would disturb a total of approximately 90 acres, of which 70 acres would be located on public lands administered by the BLM.

The channel profile slopes of the Rabbit Creek Diversion would be relatively flat in comparison to the natural drainage. Consequently, the diversion would slowly aggrade (fill with sediment) after reclamation efforts and the diversion maintenance program ceased. If allowed to proceed indefinitely, such aggradation would affect the ability of the diversion to convey flow. Therefore, SFPG would provide for a controlled breaching of the Rabbit Creek Diversion structure over time to protect the integrity of downgradient reclaimed facilities. The re-created drainage courses would be established on previously disturbed ground; therefore, no new surface disturbance would be associated with this approach.

Channel aggradation would likely occur just below the inlet weirs along the Rabbit Creek Diversion due to the change in channel gradient between the natural drainage course and the Rabbit Creek Diversion. Due to the change in channel gradient and the subsequent channel aggradation, the flow velocity would decrease as stormwater runoff enters the diversion channel, and sediments would drop out just downstream from the inlet weirs. In anticipation of this situation occurring, SFPG would construct controlled breach weirs as part of the reclamation effort. The controlled breach weirs would be located across from and just upstream of the inlet weirs, and would function after the diversion channel completely aggrades downstream of the inlet weirs. Through long-term overtopping and eventual erosion, the controlled breach weirs would direct runoff back to the natural tributary drainages after the Rabbit Creek Diversion completely fills with sediments and ceases to operate.

The development of portions of overburden and interburden storage areas across natural drainage courses would create small retention areas downgradient of the Rabbit Creek Diversion. After the Rabbit Creek Diversion aggrades and the controlled breach weirs begin to downcut, stormwater runoff and the associated sediment load would collect in these retention areas. Overflow spillways would be constructed at the retention areas downgradient of overburden and interburden storage area A to further manage storm flows and direct their passage around the reclaimed areas. In addition, compacted soil buffer dikes would be constructed between the overburden and interburden storage area and the retention areas to minimize infiltration into the storage area, and to minimize the possibility of slope failure due to seepage at the toe of the storage area. These engineered dikes would be a minimum of 20 feet wide along the outer edge of the overburden and interburden storage area. The outslopes of the soil buffer dikes would be constructed at 3 horizontal:1 vertical for stability purposes. The top elevation of a soil buffer dike would be designed to be above the overflow spillway elevation. The overflow spillways would be sized to accommodate flow from the natural tributaries, and would eventually function as outlet channels to the south, if the upgradient retention area overflows or fills with sediment. Over a long period of time, the system of natural drainageways, retention areas, and overflow spillways would link up in sequence to pass flows and re-create a drainageway around the project components.

2.4.7.2 West Side Diversion

SFPG would construct the West Side Diversion across Section 30, Township 39 North, Range 43 East and Sections 12, 13, 24, 25, and 36, Township 39 North, Range 42 East. This diversion would be designed to minimize surface water runoff entering the South Pit, or contacting overburden and interburden storage areas and processing facilities within the southwest portion of the permit boundary (***Figure 2-5***). The diversion structure would be approximately 18,840 feet long and 50 to 53 feet wide. The surface disturbance is estimated to be approximately 21 acres, of which 14 acres would be located on BLM-administered lands (***Table 2-1***). The West Side Diversion structure would be revegetated after construction.

2.4.7.3 Far West Diversion

The Far West Diversion, traversing Sections 25 and 36, Township 39 North, Range 42 East, is proposed to minimize surface water runoff contacting overburden and interburden, and heap leaching facilities in the far western portion of the project area (***Figure 2-5***). This diversion structure would be approximately 15,500 feet long and 70 feet wide. The surface disturbance associated with this diversion is estimated to be approximately 21 acres, of which 13 acres would be located on BLM-administered lands. The Far West Diversion structure would be revegetated after construction.

2.4.7.4 Other Storm Water Control Features

A storm water/sediment collection pond would be constructed in the southcentral corner of Section 9, Township 39 North, Range 43 East, as shown in ***Figure 2-5***. The collection pond would be constructed with an earthen embankment sized to adequately contain the 100-year, 24-hour storm event. The collection pond would serve to capture runoff (and sediment) originating in portions of Sections 4, 5, 6, 8, and portions of Section 9 located downgradient from the Rabbit Creek Diversion during both the operation and postclosure periods.

2.4.8 Ancillary Facilities

Ancillary facilities associated with the expansion of the Twin Creeks Mine would include expansion of the existing water supply system, power line spurs, and natural gas distribution system. Additional support buildings would also be needed. These facilities would cause no new surface disturbance.

2.4.8.1 Water Supply System

The Twin Creeks Mine currently uses three wells located in Section 32, Township 39 North, Range 43 East (one well for potable water and two backup wells), and dewatering sumps and wells in the vicinity of the South Pit to supply fresh water for processing, potable, dust control, and irrigation uses. Most of SFPG's current water supply is obtained from the dewatering system. With the proposed mine expansion, the water supply system would be expanded with additional water supply lines to service ancillary facilities, the Sage Mill, and proposed heap leach facilities. The existing potable water system has recently been upgraded.

2.4.8.2 Electricity

Spurs from existing power lines would be constructed as needed to supply power to the South Pit, Sage Mill, and ancillary facilities. Currently, the primary source of power for the Juniper Mill area is supplied by a tie into Sierra Pacific Power Company's power lines. Backup power is an existing, permitted, on-site power plant. After commissioning of the Sage Mill and oxygen plant, Sierra Pacific Power Company would be the primary supplier of electricity for both the Juniper Mill and Sage Mill. Sierra Pacific is also the primary power source for the Piñon Mill. ***Table 2-4*** summarizes the estimated fuel and energy requirements for the Twin Creeks Mine.

2.4.8.3 Natural Gas Distribution System

The existing natural gas distribution system would be expanded to supply the Sage Mill and other ancillary facilities.

2.4.8.4 Solid and Hazardous Waste Disposal

Non-hazardous waste associated with the proposed Twin Creeks Mine expansion would be disposed of in the two approved on-site Class III landfills. One of the landfills is located in Sections 5 and 6, Township 39 North, Range 43 East. The second landfill is located in Section 29, Township 39 North, Range 43 East. No additional landfill facilities would be constructed in association with the proposed project. Hazardous waste generated from the proposed expansion would be transported to approved treatment, storage, or disposal facilities by approved waste transporters.

2.4.8.5 Other Ancillary Facilities

Other ancillary facilities would include modifications to existing administration, laboratory, shop/warehouse, and maintenance buildings.

2.4.9 Relocation of Humboldt County Road

SFPG is coordinating with Humboldt County officials regarding the relocation of the county road (Kelly Creek Road) within Sections 2, 3, 4, and 11, Township 39 North, Range 43 East, and Sections 32 and 33, Township 40 North, Range 43 East (***Figure 2-5***). Humboldt County has obtained a new right-of-way grant from the BLM for the proposed relocation of the county road in the SW1/4 SW1/4 Section 3 and across Section 4, Township 39 North, Range 43 East, and Sections 32 and 33, Township 40 North, Range 43 East. This portion of the proposed road relocation is approximately 2.23 miles long, 60 feet wide, and encompasses almost 17 acres, all of which would be across public lands administered by BLM. The road would accommodate two-way traffic and would carry a minor maintenance classification by the county. SFPG would construct the new road prior to any disturbance to the existing road in order to maintain public access through this area.

Humboldt County would obtain the remaining portion of the new right-of-way around Section 10, Township 39 North, Range 43 East (***Figure 2-5***) if tailings area B is constructed (see Section 2.4.4.3). This portion of the road relocation would be approximately 2 miles long, 60 feet wide, and would encompass approximately 15 acres, all across public lands.

2.4.10 Employment

SFPG anticipates that the construction work force would total approximately 150 people to construct Phase 2 of the sulfide (Sage) mill, tailings, and heap leach facilities. Construction is expected to last approximately 12 months. SFPG estimates that no additional workers would be needed to operate the proposed mine, mill, tailings, and heap leach facilities above the current operations work force of 970.

2.4.11 Reclamation

2.4.11.1 Objectives

SFPG's reclamation plan was developed for the Twin Creeks Mine to achieve the following reclamation objectives:

- Protect public safety
- Reduce or eliminate potential environmental impacts
- Minimize visual impacts consistent with the BLM's visual resource management guidelines
- Return the mine site to a condition which would support an ecosystem similar to that which existed prior to the onset of mining activities
- Control infiltration, erosion, sedimentation, and related degradation of existing drainages in an effort to minimize off-site impacts
- Employ reclamation practices using proven engineering methods which do not require ongoing maintenance.

The following reclamation goals have been developed to meet the reclamation objectives:

- Reclaimed areas would be covered with 6 inches (nominal) of growth media.
- Current reclamation seed mixture and rates would be used. The mixture and rate may be altered based on test plot results, with the concurrence of the Winnemucca District Office of the BLM and the Nevada Division of Environmental Protection. Testing of other mixtures on small areas (test plots or small

pilot plantings) would be done in consultation with the BLM and the Nevada Division of Environmental Protection.

- The goal ranges for final grass/forb/shrub diversity would be developed in consultation with the BLM and the Nevada Division of Environmental Protection based on test plot results, comparison areas, and range sites.

- The goal for final (perennial) vegetation cover would be developed in consultation with the BLM and the Nevada Division of Environmental Protection based on test plot results.

- Enhance establishment of wildlife habitat on the mine site by:

  - Placing boulders and large rocks on reclaimed slopes to create perching areas for raptors and habitat for small mammals and reptiles.

  - Producing irregularities in reclaimed slopes (subtle benches and depressions) to create habitat variety through changes in microclimate and vegetation.

  - Establishing cooperative agreements with the Nevada Division of Wildlife, the BLM, and groups such as Chukar Unlimited to improve availability of water after reclamation by installing watering devices. Numbers and locations would be determined in consultation with these agencies/groups.

  - Maintaining the project perimeter fence to prevent livestock grazing on the project area for at least 2 years after completion of reclamation seeding.

  - Working with the Winnemucca District Office of the BLM to transfer the project perimeter fence to them, so that the project area may be maintained as a separate pasture within the Bullhead Allotment.

- Reshaped slopes would approximate nearby existing natural slopes in steepness and morphology, consistent with the BLM's Visual Resource Management Class IV objectives.

- Mine facilities would be designed so that any effluent produced would comply with applicable water quality statutes and regulations. Any effluent would not degrade the waters of the state nor create adverse health effects.

The reclamation plan describes the procedures that would be utilized to reclaim facilities associated with the Twin Creeks Mine expansion. The reclamation plan also addresses the disposition of facilities that would remain in place following the completion of all reclamation activities. These facilities include the South Pit, Vista Pit, Rabbit Creek Diversion, the West Side Diversion, and the Far West Diversion.

2.4.11.2 Postmining Land Use and Reclamation Goals

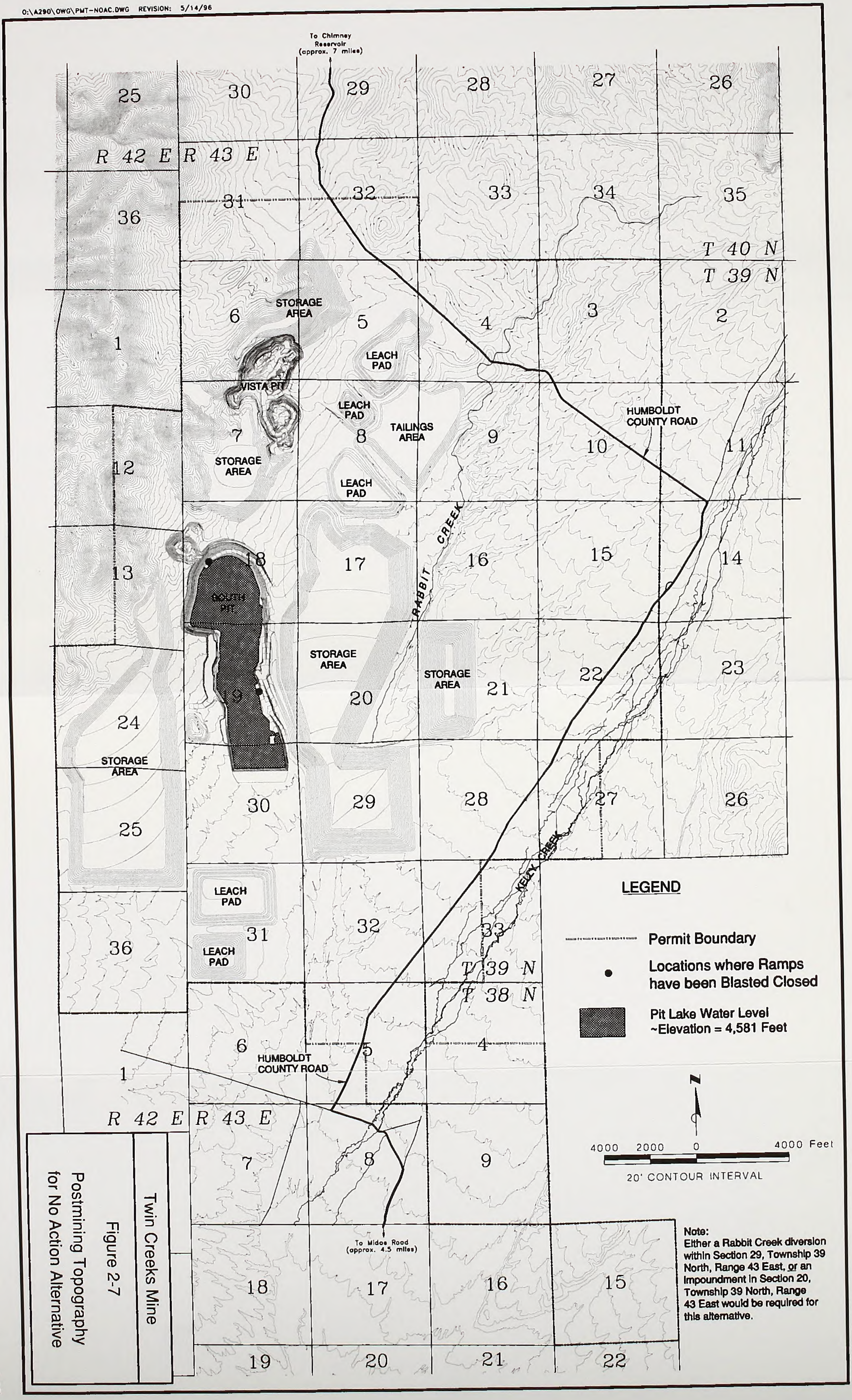
Reclamation of the Twin Creeks Mine is designed to achieve postmining land uses similar to those uses prior to mining. These uses include domestic livestock grazing, wildlife habitat, open space, and mineral exploration and development. This objective would be accomplished by ensuring that mined areas and associated disturbances are reclaimed to a geotechnically, geochemically, and erosionally stable condition that is capable of supporting a diversity of plant communities similar to those existing prior to mining use.

2.4.11.3 Postmining Topography

Figures 2-7 and ***2-8*** present the proposed postmining topography for the No Action alternative and the Proposed Action, respectively. Both figures would be revised and updated, as necessary, during the 3-year reclamation plan reviews.

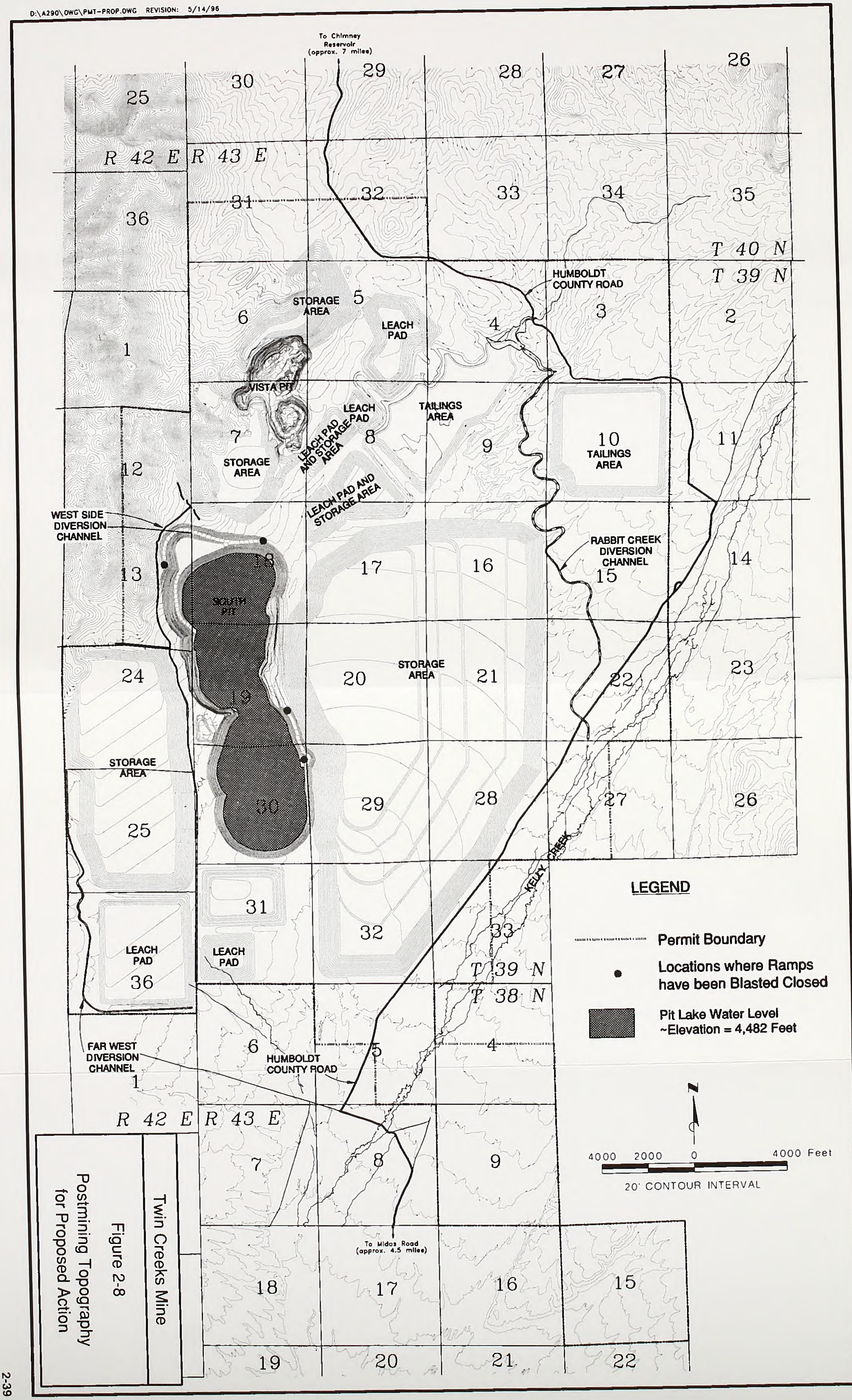
2.4.11.4 Growth Media Management

Alluvium would be placed on the areas to be reclaimed either directly from the pit during operations or stockpiled and placed at the end of the operational life of the facility. If the necessary quantity of alluvium is not available, the alluvium stored in the overburden and interburden storage



Twin Creeks Mine

Figure 2-7
Postmining Topography
for No Action Alternative



Twin Creeks Mine

Figure 2-8
Postmining Topography
for Proposed Action

area in Section 29, Township 39 North, Range 43 East would be used. A small stockpile may be established, if necessary, near the end of mining activities to provide an adequate supply of growth media for the final reclamation effort. This stockpile would be signed to prevent disturbance and would be seeded to reduce loss due to erosion.

2.4.11.5 Tailings Storage Area Reclamation

Regrading

The final surfaces of the tailings storage areas would be configured to promote free drainage and reduce infiltration. Slope configurations would provide adequate drainage. The required final slope would be obtained by several facility management methods. Two of those methods are discussed below.

- During final mill operations, tailings deposition would be managed to produce a final storage area surface that is free-draining. If necessary, the surface would be graded to obtain the required slope configuration.

- A sufficient amount of acid-neutralizing overburden or interburden material would be placed over the final storage area surface. This material would be graded to form a free-draining dome or cap.

Temporary ponding should not occur on any of the final graded surfaces. In the event of an unusual meteoric event, standing water would remain for only a short period of time due to the high evaporation rate of the area.

SFPG would determine the most efficient and effective method for developing the final storage area surfaces based on the individual facility design and tailings management. The selected method would be included in the detailed permanent closure plan for the tailings storage areas which would be submitted to the Nevada Division of Environmental Protection 2 years prior to closure, as required by Nevada Administrative Code 445.24386 and Nevada Administrative Code 445.14388.

Covering with Overburden/Interburden Material or Growth Media

A water pool would be created during operations through tailings deposition management that would allow solutions and meteoric waters to evaporate naturally. This water pool area and other noted subsidence areas in the storage area would be backfilled with growth media. The tailings storage area surfaces would then be revegetated.

Revegetation

The tailings storage areas would be revegetated to assist in stabilizing the facility and reduce the erosion potential by precipitation and wind. The surface would be contour scarified to prepare a suitable seed bed and reduce surface erosion potential. Seed would be applied by either broadcast methods, a rangeland drill, or hydroseeding. Site conditions would determine the optimum “seeding window.”

Proposed reclamation seed mixes are presented in ***Tables 2-7*** and ***2-8***. The mixes consist of a combination of shrubs, forbs, and grasses which would establish a desired reclaimed plant community. The final seed mix species selection and the revegetation techniques employed would be based on test plot results and other suitable ecological or range-site data. The revegetation standards for the project area would be based on current guidelines issued by the BLM and the Nevada Division of Environmental Protection.

Diverting Run-On

Diversion ditches would be constructed upgradient from the proposed tailings storage areas to prevent run-on and infiltration of meteoric waters into the storage areas. These ditches would be built on an as-needed basis. Diversion ditches are currently in place around the existing tailings storage area facilities. These ditches are designed to divert the 100-year, 24-hour storm event.

In addition to the individual tailings storage area ditches, the Rabbit Creek Diversion, the West Side Diversion, and the Far West Diversion would be constructed to divert runoff around the northeastern and western portions of the mine site.

The diversion structures would be revegetated after construction and would remain in place following the completion of reclamation activities. These structures would be monitored regularly to

TABLE 2-7
Reclamation Test Plot Program
Seed Mix #1

Species Common Name and (*botanical name*)	Pure Live Seed (pounds/acre)	Pure Live Seed (square foot)
"Hycrest" crested wheatgrass (*Agropyron desertorum*)	3.0	15
"Sodar" streambank wheatgrass (*Agropyron dasystachyum riparium*)	3.0	12
"Ranger" dryland alfalfa (*Medicago sativa*)	3.0	15
"Magmar" Great Basin wildrye (*Elymus cinereus*)	3.0	9
"Eski" sainfoin (*Onabrychis viciaefolia*)	1.0	3
Sandberg bluegrass (*Poa sandbergii*)	1.0	21
White yarrow (*Achillea millefolium*)	0.5	31
Tailcup lupine (*Lupinus caudatus*)	5.0	1
California poppy (*Eschscholzia californica*)	1.0	6
Blue flax (Linium lewisii)	1.0	7
Wyoming big sagebrush (Artemisia tridentata wyomingensis)	0.5	29
Shadscale (*Atriplex confertifolia*)	5.0	9
Spiny hopsage (*Grayia spinosa*)	4.0	15
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	1.0	9
TOTAL	**36.0**	**182**

TABLE 2-8
Reclamation Test Plot Program
Seed Mix #2

Species Common Name and (*botanical name*)	Pure Live Seed (pounds/acre)	Pure Live Seed (square foot)
Annual ryegrass (*Lolium perenne multiflorum*)	1.0	8
"Ephraim" crested wheatgrass (*Agropyron cristatum*)	1.0	20
"Critana" thickspike wheatgrass (*Agropyron dasystachyum*)	1.0	16
"Rosana" western wheatgrass (*Agropyron smithii*)	1.0	16
"Nezpar" indian ricegrass (*Oryzopsis hymenoides*)	1.0	16
Bottlebrush squirreltail (*Sitanion hystrix*)	2.0	8
Yellow sweetclover (*Melilotus officinalis*)	2.0	12
Firecracker penstemon (*Penstemon eatonii*)	1.0	13
White Tufted Evening Primrose (*Oenothera cespitosa*)	1.0	20
"Lutana" Cicer Milkvetch (*Astragalus spp.*)	1.0	3
Fourwing saltbrush (*Atriplex canescens*)	3.0	16
Flattop buckwheat (*Eriogonum fasciculatum*)	1.0	16
Prostrate summer cypress (*Kochia prostrata*)	1.0	9
TOTAL	**40.0**	**161**

ensure their functional and structural integrity. This monitoring obligation would cease upon final approval of site reclamation by the BLM and the Nevada Division of Environmental Protection.

2.4.11.6 Tailings Dam Reclamation

Each of the existing and proposed tailings dams would be regraded from its operating configuration to a reclaimed slope configuration that ranges between 2.5 horizontal:1.0 vertical and 3.0 horizontal:1.0 vertical. The final slope configurations would be determined based on several factors including aspect, test plot results, and long-term stability.

Covering with Overburden/Interburden Material or Growth Media

SFPG's proposed reclamation cover for the tailings dams would be based on the results of an ongoing revegetation test plot program. If the tailings dam material proves unsuitable for plant growth, an adequate thickness of growth media material would be applied to promote establishment of the reclaimed disturbed plant community.

Revegetation

Site preparation and revegetation of the tailings dams would be consistent with the techniques described in Section 2.4.11.5.

Rendering the Dam Incapable of Storing any Mobile Fluid in a Quantity which Could Pose a Threat to the Stability of the Dam or to Public Safety

During final mill operations, tailings would be deposited to form a final, free-draining storage area surface which, with minimal regrading as necessary, would direct any mobile fluids into diversion ditches and away from the dam.

Tailings Reclaim Ponds

Underdrain solutions from the storage areas would be collected in the reclaim ponds. Depending on the continuing flow rate and solution chemistry, the individual tailings storage area underdrain systems may be decommissioned. Solutions in these ponds would be allowed to evaporate. Following evaporation, any synthetic liners would be folded around the residue material in the ponds or disposed of in accordance with applicable federal, state, and local regulations. The ponds would be backfilled or breached to prevent the containment of meteoric waters and blended into the existing topography in accordance with the requirements of Nevada Administrative Code 445.242 through 445.24388.

2.4.11.7 Overburden and Interburden Storage Area Reclamation

Regrading

During reclamation, angle-of-repose slopes would be regraded to a final stable slope configuration, with intermediate slopes of 2.5 horizontal:1.0 vertical and overall slopes of approximately 3.0 horizontal:1.0 vertical. The final slope configuration would be determined based on several factors, including aspect, revegetation test plot results, and long-term stability, as addressed in the materials handling plan (PTI and WESTEC 1996).

Proposed storage areas would be constructed in 50-foot lifts separated by broad terraces. During operation, the face of the lifts would be at approximately the angle of repose. During reclamation, each lift face would be regraded down onto the lower terrace to achieve slopes of approximately 2.5 horizontal:1.0 vertical. The result would be an overall 3.0 horizontal:1.0 vertical slope from the crest to the toe with intermediate slopes of 2.5 horizontal:1.0 vertical.

Revegetation

The overburden and interburden storage areas would be revegetated to reduce the erosion potential by precipitation and wind. Site preparation and revegetation would be consistent with the techniques described in Section 2.4.11.5.

Diverting Run-On

Upgradient diversion ditches would be constructed where necessary to prevent run-on of meteoric waters. Construction of the Rabbit Creek Diversion, West Side Diversion, and Far West Diversion would also minimize impacts to storage areas located in the northeastern and western portions of the mine site.

2.4.11.8 Heap Leach Pad Reclamation

Each of the heap leach pads would be reclaimed in a manner similar to that described below.

Regrading

The heap leach pads are designed and constructed in lifts to stable configurations. After rinsing and deactivation, the lifts would be regraded from their operating configurations to develop an overall final slope configuration with 2.5 horizontal:1.0 vertical intermediate slopes and an overall slope of 3.0 horizontal:1.0 vertical. The final slope configurations would be determined based on several factors, including aspect, test plot results, and long-term stability. The tops of the heap leach pads would be graded to prevent ponding. These grading activities would inhibit surface ponding and infiltration of meteoric waters, and reduce the erosion potential of the reclaimed pads.

The BLM and the Nevada Division of Environmental Protection criteria require the con struction of facilities with both seismic and erosional stability and revegetation suit able for site-specific postmining land uses. SFPG's designs meet the aforementioned criteria.

Covering with Overburden/Interburden Material or Growth Media

Placement of growth media would be determined based on the results of planned revegetation test plots. Additional growth media would not be applied if results indicate the heap leach pads can be successfully revegetated. If the leach pads do not support the establishment of a desirable reclaimed plant community, then adequate growth media would be applied to promote successful revegetation.

Revegetation

The heap leach pads would be revegetated to reduce erosion resulting from precipitation and wind, and infiltration of meteoric waters. Revegetation would be consistent with the techniques described in Section 2.4.11.5.

Soil Stabilization

The neutralized heap leach pads would be stabilized by regrading the tops and lifts and revegetating according to the guidelines issued by the BLM and the Nevada Division of Environmental Protection.

Diverting Run-On

Run-on would be diverted around the heap leach facilities by the Rabbit Creek Diversion, the West Side Diversion, and the Far West Diversion, as well as existing diversion structures. All diversion structures are designed to carry the 100-year, 24-hour storm event. These diversion structures would remain in place following the completion of reclamation activities. They would be monitored and maintained on a regular basis to ensure their functional and structural integrity. This monitoring and maintenance obligation would cease upon approval of final site reclamation by the BLM and the Nevada Division of Environmental Protection.

Cyanide Stabilization/Neutralization

Neutralization of the heap leach pads would begin after the economic gold values have been recovered. Pads would first be allowed to drain freely. Solutions would be collected and the volume reduced through evaporation in the process ponds and on the leach pads. Fresh water would be added to the reduced solutions. This rinsate would be recirculated through the dumps to flush out residual leach solution until the weak acid dissociable cyanide level of the rinsate is 0.2 milligrams/liter or less, the pH of the draindown solution stabilizes between 6 and 9, and the solution meets or exceeds primary drinking water standards.

If neutralization by rinsing does not achieve the required closure criteria, then SFPG would submit a proposal to the Nevada Division of Environmental Protection for an alternative heap leach pad closure method.

Detailed closure plans for the heap leach pads associated with the Twin Creeks Mine project are contained in the appropriate water pollution control permit applications for the former Rabbit Creek Mine (Permit NEV89035) and former Chimney Creek Mine (Permit NEV86018) which are on file with the Nevada Division of

Environmental Protection. A detailed permanent closure plan for the heap leach facilities would be submitted to the Nevada Division of Environmental Protection two years prior to closure, as required by Nevada Administrative Code 445.24386 and Nevada Administrative Code 445.14338.

Treatment of Outflows, Residual Chemicals, or Fluids

Residual solutions would be treated as per Water Pollution Control Permit NEV89035 (former Rabbit Creek Mine) and Permit NEV86018 (former Chimney Creek Mine).

2.4.11.9 Pond Reclamation

Backfilling and Regrading

Solutions in the process ponds, sediment ponds, water treatment ponds, and tailings reclaim ponds would be disposed of by evaporation. Based on analytical results, precipitates and sludges in the bottoms of these storage area structures would be analyzed and disposed of in accordance with appropriate regulations. The pond liners would be perforated, folded into the pond sites, and buried. If necessary, they would be removed to an appropriate storage area. Pond areas would then be backfilled and regraded for free drainage and to blend in with the surrounding topography. These sites would be revegetated according to techniques described in Section 2.4.11.5.

Solution collection ditches would be reclaimed in the same manner as the process ponds. The liners would be removed to an appropriate storage area, or perforated and covered during the ditch backfilling. Residues would be tested and either removed to an appropriate storage area or buried in the ditches. The ditches would be back-filled and regraded to promote free drainage.

Restoring the Pre-Disturbance Surface Water Regime in Accordance with the Designated Postmining Land Use

The pond sites would be backfilled and regraded for free drainage and to blend with the surrounding topography. These sites would be revegetated according to the techniques described in Section 2.4.11.5.

Cyanide Stabilization/Neutralization

Solutions in the process ponds would be neutralized during the dump neutralization process. The solution ponds would remain in operation until all dump neutralization procedures have been completed. Once dump neutralization is completed, pond solutions would be allowed to evaporate. Residues would be analyzed and disposed of in accordance with appropriate regulations.

Reinfiltration Basin Reclamation

The reinfiltration basin areas would be reclaimed when dewatering has ceased and all water has infiltrated. The basin surfaces would be allowed to dry and consolidate to allow equipment access. The ponds would be backfilled and regraded to prevent ponding of meteoric waters and to blend with the surrounding topography. Site preparation and revegetation would be consistent with the techniques described in Section 2.4.11.5.

2.4.11.10 Roadway Reclamation

Recontouring or Regrading

All roads, with the exception of the main access road, would be reclaimed following the closure of the mine. The main access road would not be reclaimed in order to maintain access to the site for long-term monitoring and access to SFPG's private land. Roads would be recontoured and regraded to blend into surrounding topography. Berms, sidecast material, and road ditches would be reclaimed at this time. Drainages would be re-established to a stable configuration. The goal of road reclamation would be to control erosion and assist with establishing the postmining land use.

Culvert Removal

Culverts would be removed as roads are no longer needed. As culverts are removed, the site would be reclaimed and the drainage re-established to blend with surrounding topography.

Ripping/Scarifying

Ripping and scarifying of roads to a depth of 2 feet would be undertaken, if necessary, to develop a friable seed bed with a minimum depth of 6 inches.

Waterbars

Waterbars would be installed in reclaimed roadways, if necessary, to prevent erosion. The roads would be reclaimed to minimal grades and would be designed to minimize surface runoff and erosion.

Revegetation

Roadways would be revegetated according to the techniques described in Section 2.4.11.5. Roads that have been chemically treated would have growth media applied prior to revegetation.

Restoring or Stabilizing Drainage Areas or Streambeds

Drainage sites affected by road construction would be restored to a stable, free-draining configuration to the extent possible. These sites would be stabilized to prevent erosion using stabilization techniques that include revegetation or the placement of riprap in erosion-prone places of the drainage.

Other Road Reclamation Activities

Signs would be located on reclaimed roads to discourage postreclamation travel in order to promote the re-establishment of vegetation.

2.4.11.11 Sediment Control

Comparisons between reclaimed areas and undisturbed areas showed higher rates of erosion for areas using reclaimed soil versus natural areas but lower rates of erosion for areas using alluvium versus natural areas.

The following measures would be utilized to reduce sediment loading of surface waters:

- Revegetation of disturbed sites
- Construction and regrading of heap leach pads and overburden and interburden storage areas with intermittent slope breaks
- Construction of diversion ditches to divert run-on away from reclaimed sites
- Installation of silt fences and straw bale dams in areas requiring sediment and erosion control
- Installation of riprap in erosion-prone areas of diversion ditches and channel outlets

The location and installation of mine sediment controls, including straw bale dikes and silt fences, would be coordinated with the BLM and the Nevada Division of Environmental Protection. The Rabbit Creek Diversion, West Side Diversion, and Far West Diversion structures would remain in place following final site reclamation.

2.4.11.12 Disposition of Mill Facilities, Reagents, Scrap Materials, Hazardous and Toxic Materials, and Equipment

The existing natural gas powered generating facility for the Twin Creeks Mine would be removed at the end of the mine life. Sufficient bonding is maintained in the Twin Creeks Mine reclamation plan for removal of the facility and associated transmission lines. The ends of the gas pipelines would be capped and the line closed in place.

All other buildings and structural materials, equipment, and hazardous or toxic materials would be removed from public and private land as required by Nevada Revised Statute 519A, Nevada Administrative Code 519A, and 43 Code of Federal Regulations 3809 and disposed of in accordance with federal and state regulations.

Materials at the site would be disposed of as follows:

- Any non-hazardous or non-toxic materials such as scrap lumber, metal, and high-density polyethylene liners would be disposed of in a state-approved Class III landfill.
- All buried piping and conduits would be left in place after being drained and disconnected at access points. Pipes would be securely plugged or capped prior to final abandonment.
- Reagents, petroleum products, solvents, and other hazardous or toxic materials would be resold or disposed of according to federal and state regulations or utilized at other SFPG projects.
- All equipment that has contained process solution would be neutralized and either

utilized at other SFPG projects, removed and sold for salvage values, or disposed of in accordance with federal and state regulations.

- The septic/leach field would be managed and closed according to state regulations.

Disposition of Concrete Foundations

Exposed concrete foundations, pads, and sumps would be broken up and hauled to a Class III landfill or would be flattened and buried. These areas would be covered with growth media and graded for free drainage and to blend with the existing topography. These sites would be revegetated according to the guidelines described in Section 2.4.11.5.

All buildings and structural materials located on public and private land would be removed according to Nevada Revised Statute 519A, Nevada Administrative Code 519A, and 43 Code of Federal Regulations 3809.

Disposal Off-Site in Conformance with Applicable Solid Waste Disposal Requirements

The following disposal procedures would be followed as applicable:

- Any non-hazardous or non-toxic materials such as scrap lumber or metal would be disposed of in the state-approved Class III landfill.

- Reagents, petroleum products, solvents, and other hazardous or toxic materials would be resold or disposed of according to federal and state regulations or utilized at other SFPG projects.

- All equipment that contained process solutions would be neutralized and either utilized for salvage values or disposed of in accordance with federal and state regulations.

Continuing Use in a Manner Consistent with the Postmining Use of the Land

The main access road right-of-way to the mine site would remain in place for maintenance purposes and for access to surrounding ranches. The Rabbit Creek Diversion, the West Side Diversion, and the Far West Diversion would be revegetated shortly after construction but would not be reclaimed. These structures would remain as permanent features to maintain the integrity of reclaimed mine facilities.

2.4.11.13 Open Pit Reclamation

Pursuant to Nevada Administrative Code 519A.250, SFPG requested an exemption from the open pit reclamation requirements of Nevada Administrative Code 519A, inclusive. This request was based on the following discussion. The proposed operational mine plan does not presently include pit backfilling. Backfilling would require a significant investment in manpower, equipment, and fuel, and a considerably extended project life. The extended time period required for backfilling may also contribute to continued impacts to other resources, including air quality, ground water consumption, wildlife and livestock grazing, and to an increased consumption of non-renewable petroleum products. However, if mine scheduling and economics allow, SFPG may consider using a portion of the Vista Pit during active mining operations as an overburden and interburden storage area (see Section 2.5.1.1).

At the completion of mining, mineral reserves which are considered sub-economic at the time would remain in place. An increase in gold prices or new metallurgical processes could render these reserves economic. The cost to remove overburden and interburden from partially or completely backfilled pits would prevent future mining of these reserves. In addition, backfilling would remove evidence of remaining mineralization. Maintaining this evidence is allowed by the BLM's surface management regulations contained in 43 Code of Federal Regulations 3809.

Public Safety

Closed mine sites are rated by the Nevada Department of Minerals according to the requirements contained in Nevada Administrative Code 513.330 through 513.360. Utilizing these requirements, the Twin Creeks Mine sites rate (a) "2 points" for the location of the mine site and (b) "1 point" for the degree of danger of the mine site. The total rating of "3 points" places the mine site in the minimal hazard category. In order to secure a minimal hazard, SFPG would, within 180 days of cessation of operation, secure the open pits with a combination of soil/rock berms and/or four-strand barbed wire fence, blast closed and reclaim all pit access roads, and post the pit areas with warning signs. The berms would be designed to preclude access by the public and grazing animals. These berms would be constructed by end-dumping run-of-mine material from haul trucks. The resulting berms would be approximately 6 feet high. The berms would be set back from the proposed pit at a distance to ensure long-term stability.

These procedures are consistent with the requirements for securing abandoned mine sites as contained in Nevada Administrative Code 513.330 through 513.360. These closure procedures would provide adequate public safety following final site closure.

Stabilization of Pit Walls

Stabilization of the pit walls and rock faces is not proposed. Access to the pits would be controlled by the berms and/or fences. The berms and/or fences would be located so that any potential postclosure pit slope failure would not affect their integrity.

Public Access Restriction

SFPG maintains strict security procedures to prevent public access to the existing mine site. These procedures would remain in place until all reclamation monitoring activities cease. In addition, all methods of preventing access and protecting public safety at the Twin Creeks Mine, including fences, signs, and berms would be maintained on an as-needed basis. Maintenance would take place on a quarterly basis.

Creating a Lake for Recreational, Wildlife, or Other Use

The only pit that would intercept ground water is the South Pit. It is not conducive to utilize the South Pit as a recreational lake due to the steepness of the pit walls. Wildlife, such as raptors, may use the walls in the open pits for nesting.

Revegetation

There would be no revegetation of the open pits themselves. However, flat surfaces large enough to accommodate the operation of equipment that would be located above the projected postmining pit lake water level would be revegetated if revegetation can be undertaken in a safe and efficient manner. Disturbances along the pit perimeters would be revegetated according to the guidelines described in Section 2.4.11.5.

2.4.11.14 Post-Reclamation Maintenance and Monitoring

Ground Water Monitoring

Monitoring would continue as specified under Water Pollution Control Permit NEV86018 and Permit NEV89035. The monitoring results would be evaluated to identify potential impacts from the mining operations to surface water and ground water. Monitoring efforts would be discontinued upon the Nevada Division of Environmental Protection's decision that closure criteria have been achieved.

Fence/Sign Maintenance

To ensure public safety, all fences and signs would be monitored and maintained on a quarterly basis.

Rabbit Creek Diversion, West Side Diversion, and Far West Diversion Maintenance

The Rabbit Creek Diversion, the West Side Diversion, and the Far West Diversion would be monitored and maintained on a regular basis to ensure their functional and structural integrity. This obligation would cease upon approval of final site reclamation by the BLM and the Nevada Division of Environmental Protection.

Erosion Monitoring

Surface erosion would be monitored annually. Erosion control structures would be monitored to assess their functional and structural integrity and would be maintained accordingly. Headcutting, rills, gullies, and other erosional features would be repaired in a timely manner. Appropriate measures would be undertaken to prevent erosion as needed. These obligations would cease upon final reclamation approval by the BLM and the Nevada Division of Environmental Protection.

<u>Revegetation Monitoring</u>

Revegetation monitoring of the reclaimed facilities would be conducted annually and coordinated with the regulatory agencies. This obligation would cease upon the approval of site revegetation by the regulatory agencies.

2.4.11.15 Effect of Reclamation on Future Mineral Activities

Future exploration or mining activities would not be affected by the proposed reclamation of the Twin Creeks Mine. An ongoing exploration and condemnation drilling program is conducted to ensure economic ore reserves amenable to open-pit extraction methods are not located beneath project facilities.

2.4.11.16 Drill Hole Plugging

Drill holes at the site would be closed in accordance with Nevada Annotated Code 534.425 through 534.428. Holes which encounter water would be closed by sealing the surface with a 10-foot seal within 15 feet of the ground surface. This seal would consist of cement grout, concrete grout, neat cement, or an approved engineering equivalent. Bentonite fluid would be circulated to the full depth of the hole to prevent water entry. A Marsh funnel would be used to determine the viscosity of the make-up fluid. The viscosity would be raised at least 20 seconds to a minimum of 50 seconds per quart by the addition of a bentonite product specifically formulated for hole abandonment. The fluid would be weighed and the weight raised a minimum of 9 pounds per gallon. Barite may be added for weight if necessary. Alternatively, the holes may be sealed with other methods, such as cement.

Holes which do not encounter water would be plugged by sealing the surface using the method specified for wet holes. Ten feet of granular bentonite would be placed in the bottom of the hole and at 100-foot intervals up the hole to the surface or to the bottom of the surface cement seal. Where the surface cement seal is waived, the top 10 feet of the hole would be filled with granular bentonite.

The general mine site well would also be plugged according to the requirements of Nevada Annotated Code 534.425 through 534.428.

2.4.11.17 Concurrent Reclamation

SFPG would continue to conduct concurrent reclamation of those facilities no longer required for operational purposes. This reclaimed acreage would be reported to the regulatory agencies on an annual basis.

2.4.11.18 Interim Reclamation

The project is designed to operate year-round. Should any unforeseen periods of non-operation occur, SFPG would coordinate appropriate interim reclamation activities with the regulatory agencies.

2.4.11.19 Project Fence Disposition

The project boundary fence would remain in place for a minimum of 2 years following completion of reclamation. SFPG would make the fences on public lands available to the BLM for continued use.

2.5 Other Project Alternatives

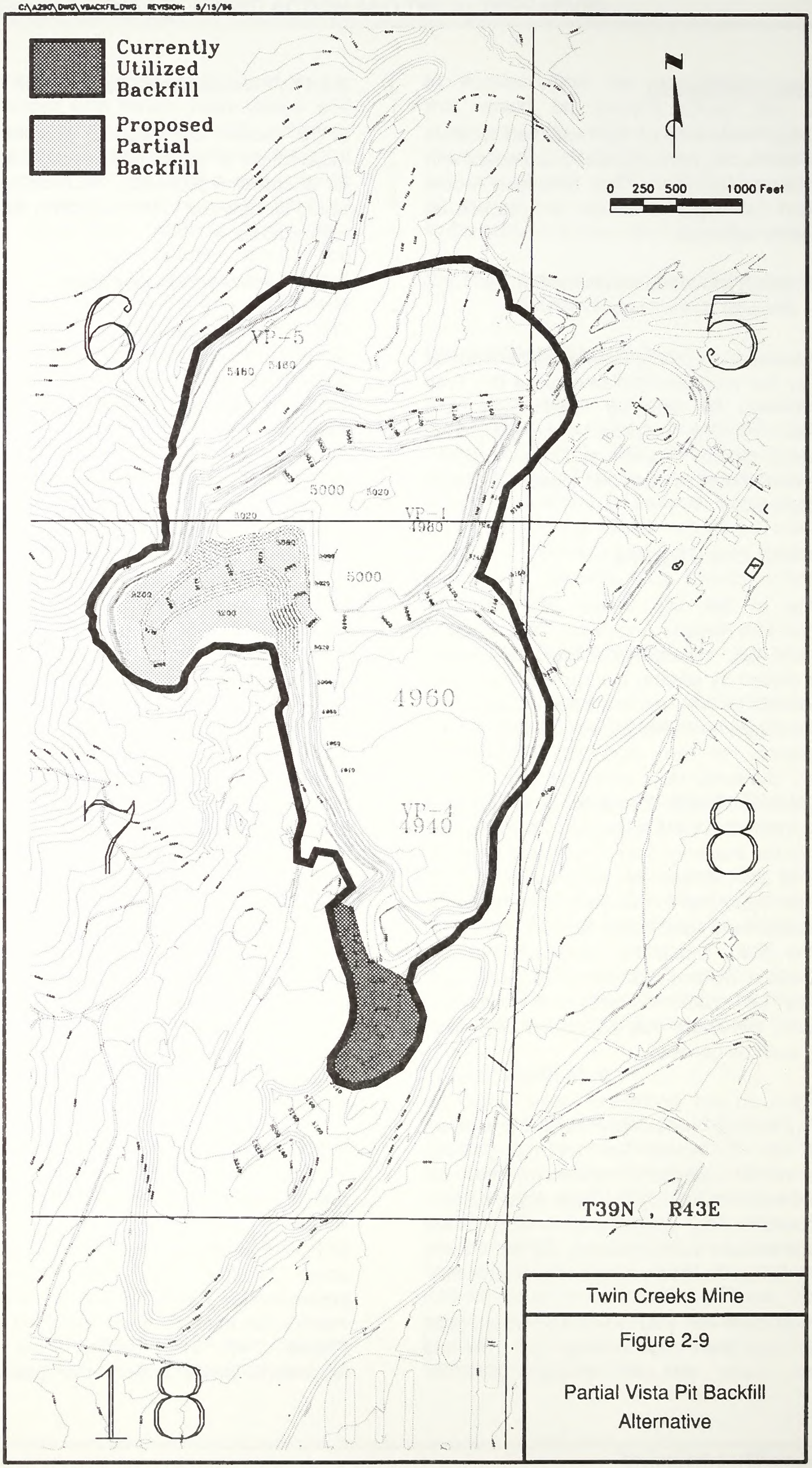
The No Action alternative has been described in Section 2.3. It comprises the facilities and activities currently permitted for construction and/or operation at the Twin Creeks Mine but not implemented as of December 31, 1994. It is evaluated in detail in this EIS.

The issues and concerns identified during the scoping process focused primarily on potential water quantity and water quality impacts associated with the Proposed Action and the proposed reclamation plan. Therefore, the BLM focused on these issues in the identification of alternatives to be evaluated in the EIS. Other issues have been considered in the identification of mitigation measures.

2.5.1 Alternatives Considered in Detail

2.5.1.1 Partial Vista Pit Backfill

SFPG is currently backfilling approximately 12 acres of the Vista Pit (***Figure 2-9***) with approximately 2,839,200 tons of overburden and interburden material to an elevation of 5,200 feet (***Table 2-9***). The Partial Vista Pit Backfill alternative would involve the placement of an



Twin Creeks Mine

Figure 2-9

Partial Vista Pit Backfill Alternative

TABLE 2-9
Partial Vista Pit Backfill Alternative

Bench	Currently Utilized Backfill (tons)	Proposed Partial Backfill (tons)
5[illegible]60	65,900	462,500
5180	84,900	490,700
5[illegible]60	105,300	495,900
51[illegible]0	127,700	473,800
51[illegible]0	354,400	482,000
5100	389,300	464,800
5080	396,900	341,000
5060	405,100	243,600
5040	436,200	150,600
5020	284,900	66,900
5000	188,600	23,200
TOTAL TONS	**2,839,200**	**3,695,000**

additional 3,695,000 tons of overburden and interburden material in the Vista Pit (***Figure** 2-9*). The additional backfill material would cover an area of approximately 26 acres within the pit. The material would be stored at an elevation between 5,000 feet and 5,200 feet (***Table 2-9***).

2.5.1.2 Selective Handling of Overburden and Interburden

Prior to the development of the materials handling plan (PTI and WESTEC 1996) included in the Proposed Action, SFPG considered an alternative plan for the handling of overburden and interburden material for the Twin Creeks Mine. This alternative plan would involve the selective handling and storage of acid-neutralizing material and acid-generating material, based on the geochemical characterization of the material types. Samples with a ratio of acid-neutralizing potential to acid-generating potential of less than 1.2 were considered to be acid-generating and would require special handling and storage procedures under this plan.

The selective material handling alternative includes:

- Separate handling and storage of acid-neutralizing and acid-generating materials
- Encapsulation of acid-generating material within cells of acid-neutralizing material
- Placement of acid-generating material within overburden and interburden storage areas in Sections 17, 20, and 32, Township 39 North, Range 43 East; and Section 24, Township 39 North, Range 42 East
- Minimum of three 50-foot lifts (150 feet) of acid-neutralizing material (i.e., carbonate alluvium) below the first lift containing acid-generating material
- Placement of acid-generating material on a slight grade, sloping downward from the center of the storage area, to decrease infiltration of meteoric water
- Capping the top and face of each lift of the storage area with a minimum of 5 feet of acid-neutralizing material with a permeability no greater than $1x10^{-4}$ centimeters per second to limit water percolation into the storage area
- Placement of acid-generating material at least 200 feet from the outer slope face of the final reclaimed storage area

The completed overburden and interburden storage area would be compacted, graded, and revegetated to promote evapotranspiration as proposed in SFPG's proposed reclamation plan for the Twin Creeks Mine.

A cross-section of an overburden and interburden storage area composed of selectively handled materials is provided in ***Figure 2-10***. The design of this alternative would decrease SFPG's flexibility to add additional material at the top or at the perimeters of the storage areas over time. SFPGwould need to carefully schedule the deposition of the different materials within the storage areas. There would be increased costs associated with this alternative due to the separate handling and storage of the acid-neutralizing and acid-generating materials.

2.5.1.3 Overburden and Interburden Storage Area Reclamation Alternatives

The BLM has proposed alternative reclamation configurations of the overburden and interburden storage areas based on potential visual impacts associated with the Proposed Action; the alternative configurations would involve additional rounding of the corners at the base of the storage areas.

The EIS examines two alternative postmining topography scenarios to address the visual impacts of the storage areas. Alternative 1 (***Figure 2-11***) would have the same general footprint as the Proposed Action. No additional land disturbance would occur. The corners of the storage areas would be more rounded, and more material would be stored at the ultimate elevation of the storage area to accommodate the required volume of overburden and interburden material. Alternative 2 (***Figure 2-12***) would also have more rounded corners than the Proposed Action. The height of storage area B would be similar to the Proposed Action. This alternative would disturb an additional 200 acres to the east in order to accommodate the required volume of material; the disturbance in Sections 22 and 27, Township 39 North, Range 43 East, would involve private lands not owned by SFPG. Subsequent reclamation of either alternative would follow the procedures described for the overburden and interburden storage areas under the Proposed Action. Under Alternative 2, rehabilitation of the Rabbit Creek drainage would conceptually follow the same approach as described for the Proposed Action. However, the alignment and location of controlled breach weirs, soil buffer dikes, and outlet spillways would be modified as appropriate to the Alternative 2 configuration.

2.5.2 Alternatives Considered but Eliminated from Detailed Analysis

2.5.2.1 Reclamation Alternatives

<u>Partial South Pit Backfill</u>

This alternative would involve the partial backfilling of the South Pit with oxide and sulfide material. The purposes of this alternative would be to:

- Eliminate the South Pit lake
- Reduce the surface area associated with overburden and interburden storage areas
- Reduce the visual impacts associated with overburden and interburden storage areas

The adverse impacts associated with this alternative include:

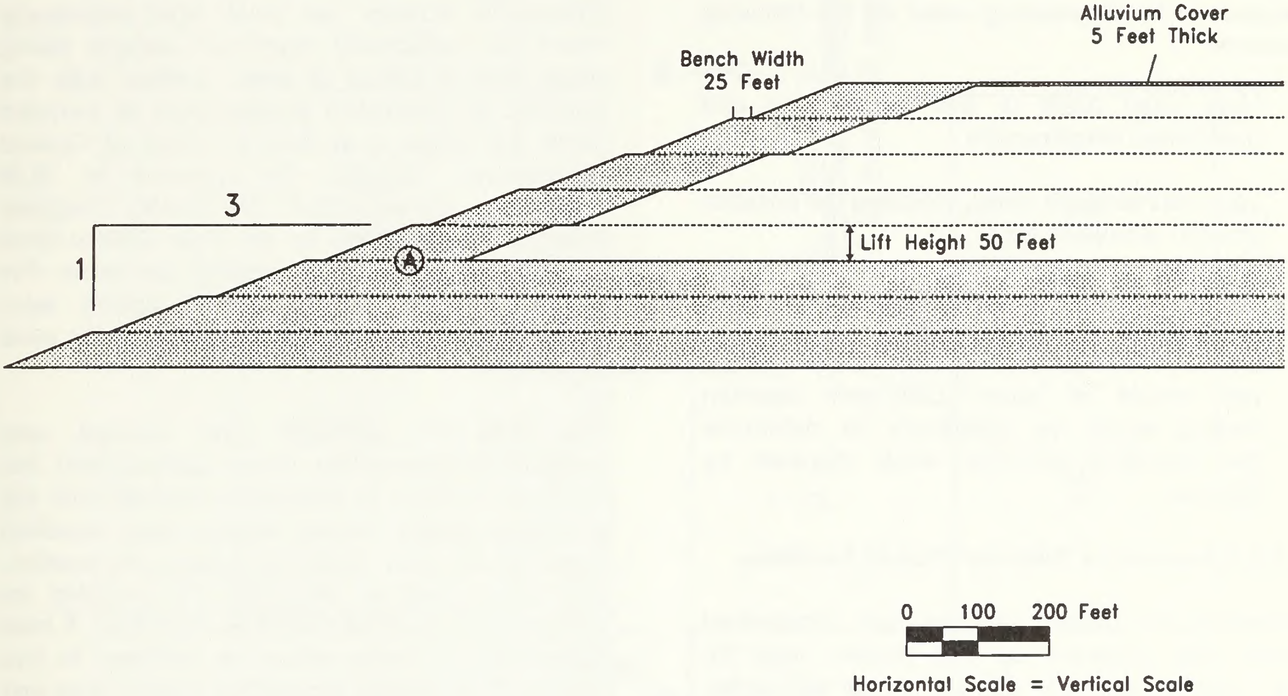
- Loss of potential mineral resources beneath the backfill material
- Costs associated with double handling of the overburden and interburden material, i.e., temporary stockpiling and subsequent backfilling
- Potential ground water outflow from the pit

<u>Restoration of Diversion Channels to Natural Channels</u>

The purpose of the diversion channels is to preclude the flow of surface water into open pits, overburden and interburden storage areas, or leach pads. Once the project facilities are constructed, it would not be technically or environmentally feasible to restore the diversions to the original channels.

2.5.2.2 Underground Injection of Dewatering Water

SFPG conducted field investigations (HCI 1994b) to evaluate the feasibility of the disposal of mine water by injection. To evaluate the use of injection wells, SFPG drilled, constructed, and hydraulically tested two pilot test wells completed into the rhyolite-derived alluvium to the east and southeast of the South Pit. The purpose



Legend

Acid-neutralizing material (alluvium)

Potentially acid-generating material

Ⓐ Mininum 200-foot (horizontal) set back from final reclaimed slope face

Note: The side-slope for each 50-foot lift would be graded to the final reclaimed slope configuration (2.5:1) and covered with acid-neutralizing material, as shown, prior to placement of subsequent lifts at the slope face.

Twin Creeks Mine

Figure 2-10

Selective Material Cell Cross Section

of the testing was to evaluate the potential for these materials to receive injected mine water. Transmissivities of 130 gallons per day per foot, and 40 to 50 gallons per day per foot were calculated for the two injection wells. Based on the results of the injection well testing, SFPG eliminated the use of injection wells for disposal of the dewatering water for the following reasons:

- High initial costs of well construction and associated infrastructure
- High maintenance costs, including the possible need to redevelop wells
- At the tested rates of 50 to 130 gallons per minute, 62 to 160 injection wells would be required to dispose of 8,000 gallons per minute of water. Long-term injection testing would be necessary to determine the feasibility of mine water disposal by injection.

2.5.2.3 Alternative Sites for Project Facilities

Locations for project facilities are constrained within and adjacent to the project area by the existing facilities, surface water drainages, and topography. SFPG has evaluated alternative sites for overburden and interburden storage areas, leach pads, and tailings impound ments. Some of these alternatives have been integrated into the Proposed Action as "optional use areas" and "multiple use areas." These optional and multiple uses were considered in the evaluation of the Proposed Action.

2.5.2.4 Pit Size Limit

A smaller South Pit is being evaluated in the No Action alternative. This pit size is currently permitted. It forms the basis for a comparison of the water quantity and water quality impacts associated with the South Pit expansion under the Proposed Action.

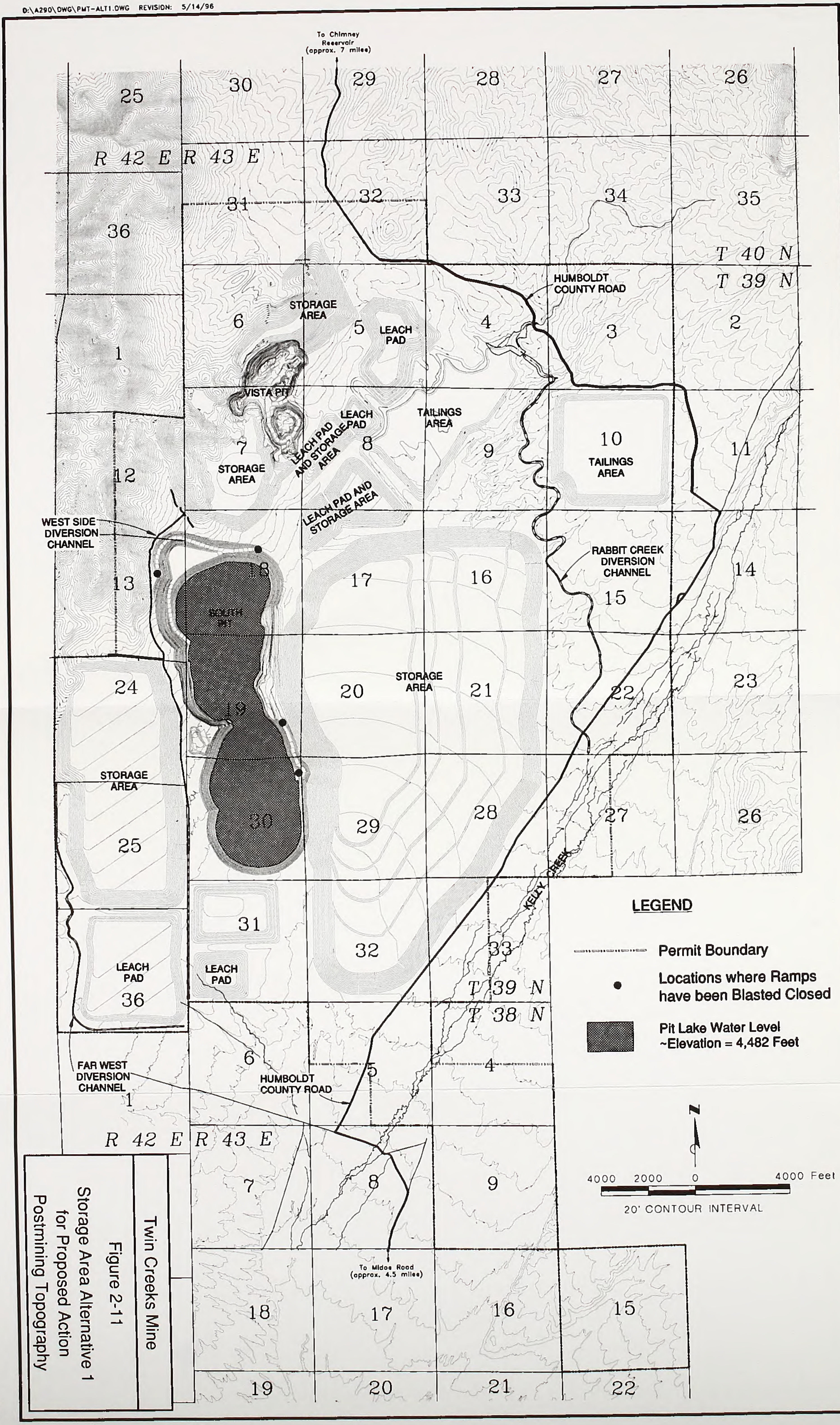
2.6 Past, Present, and Reasonably Foreseeable Future Actions

As defined in the Council on Environmental Quality regulations for implementing the National Environmental Policy Act (40 Code of Federal Regulations 1508.7), "Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions 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." Actions with the potential for cumulative impacts must be included within the scope of an EIS (40 Code of Federal Regulations 1508.25). As specified in BLM Instruction Memorandum NV-90-435, impacts must first be identified for the Twin Creeks Mine project before cumulative impacts can occur. For resources where project-specific impacts were identified in the EIS, cumulative impacts also were evaluated.

The BLM has identified past, present, and reasonably foreseeable future actions with the potential to result in cumulative impacts with the proposed project. These actions were identified based on the type of activity, geographic location, and time period to determine the potential for cumulative impacts to individual resources. A brief description of these actions is provided in this section. The specific cumulative impact area and the potential cumulative impacts for each resource are described in the respective cumulative impact sections of Chapter 3. The general area of cumulative impacts addressed in this EIS is the area on the east side of the Osgood Mountains and the west portion of the Kelly Creek Valley; this area is known as the Getchell trend.

2.6.1 Past and Present Actions

Livestock grazing and mining comprise the dominant activities in the general cumulative impact study area. Mining in the Osgood Mountains and the Kelly Creek Valley has historically included exploration (drilling, trenching, sampling, and road construction), underground mining, and open-pit mining. The surface disturbance associated with these mines includes mine workings (adits, shafts, prospect pits), open pits, waste rock piles, heapleach pads, tailing ponds, and ore milling and processing facilities. The Getchell trend contains a variety of mineral deposits, including bedded barite, skarn tungsten, tungsten-bearing manganese, silver, and disseminated gold (McCollum and McCollum 1991; Grauch and Bankey 1991). During the 1940s to



Twin Creeks Mine

Figure 2-11
Storage Area Alternative 1
for Proposed Action
Postmining Topography

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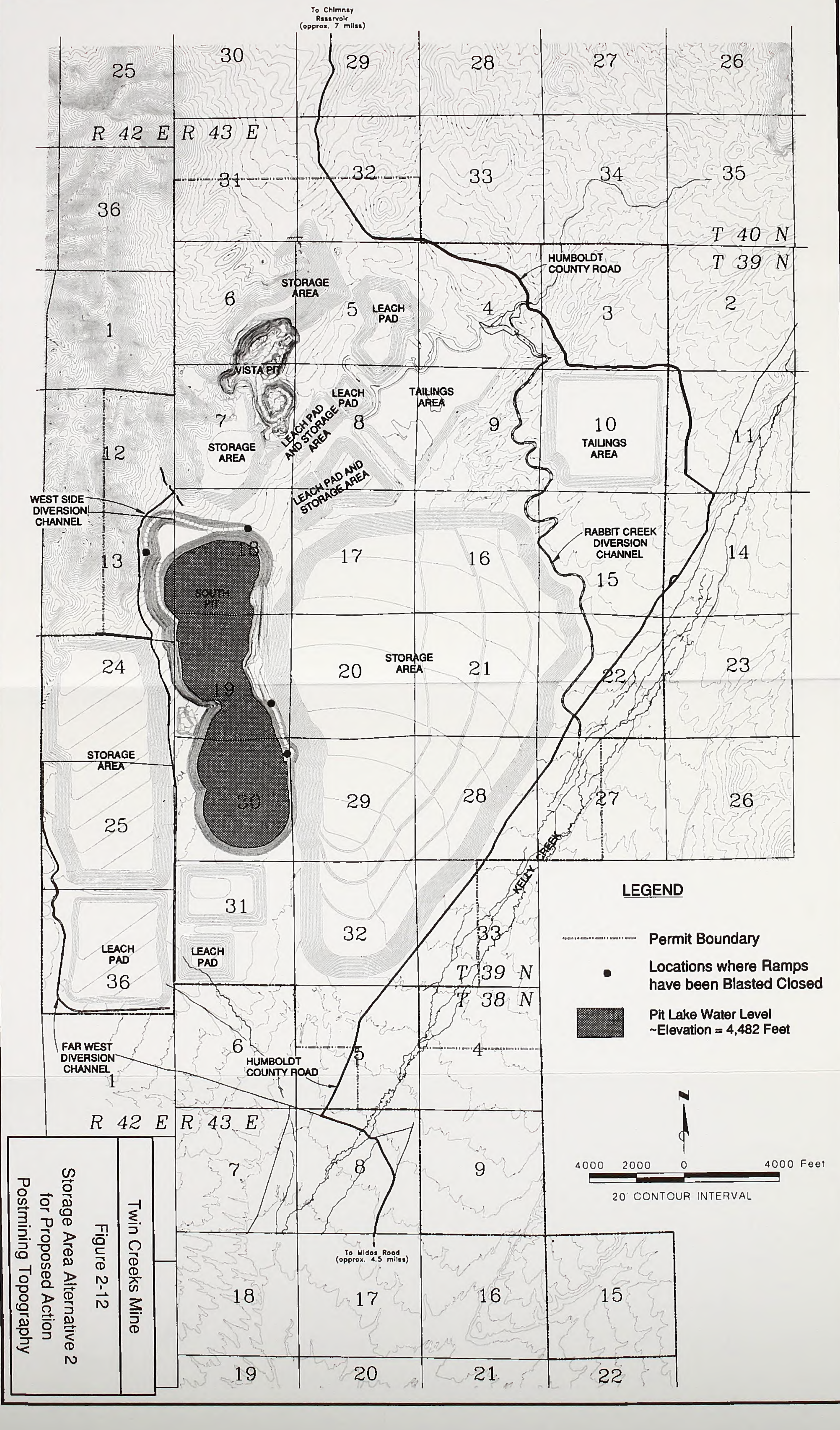

Twin Creeks Mine

Figure 2-12
Storage Area Alternative 2
for Proposed Action
Postmining Topography

1960s, many small open pit and underground workings concentrated on the tungsten and gold deposits, and a few workings on barite, copper, and manganese. Scheelite was mined from numerous skarn deposits from 1942 to 1962 (McCollum and McCollum 1991).

Mining activity prior to 1981 encompassed approximately 1,293 acres; Reclamation was not required under Nevada Division of Environmental Protection and BLM regulations prior to 1981. Within the region, present mining activity is centered around four primary mines: Twin Creeks, Getchell, Pinson-Mag, and Preble (Environmental Management Associates 1992). The location and approximate areal extent of these mining areas are shown in ***Figures 2-13*** and ***2-14***. ***Table 2-10*** presents the approximate acreages disturbed as determined from published sources. Small-scale mining and exploration operations (not shown on ***Figures 2-13*** and ***2-14***) creating isolated areas of land disturbance outside the named mining areas are scattered throughout the area.

2.6.1.1 The Twin Creeks Mine

Mining began in the Twin Creeks Mine area with the discovery in 1984 of the Chimney Creek deposit. The Chimney Creek Mine consisted of three separate pits: North, South, and Discovery Pits (Atkin 1989). The North and Discovery Pits were combined to create the Vista Pit, while the South Pit was combined with the Rabbit Creek Mine pit to create the existing South Pit. The Rabbit Creek deposit was discovered in January of 1987, and prestripping the mine of alluvium began in March 1989 (Bloomstein et al. 1991). The Twin Creeks Mine consists of a consolidation of the former Chimney Creek and Rabbit Creek Mines. The mine consists of three open pits: the Vista Pit, South Pit, and West Pit (the prestripping for the West Pit began in the fall of 1994).

2.6.1.2 The Getchell Mine

The Getchell Mine area has been the site of mineral exploration for more than 100 years. Mineralization in this area was first discovered in 1883 with sporadic mining for copper, lead, silver, and tungsten into the 1930s (BLM 1987b). The Getchell deposit was discovered in 1934 with the bulk of the mining for the first 5 years from oxidized ores, but as mining progressed, more and more arsenic sulfides ores were treated. From 1939 to 1942, the Getchell Mine was the leading gold producer in Nevada (Hotz and Willden 1964). The old Getchell Mine underwent modernization and now produces approximately 150,000 ounces of gold a year (Bloomstein et al. 1991). The Getchell Mine is currently operated by First Miss Gold and is located in Sections 22, 23, 26 through 35, Township 39 North, Range 42 East, and Sections 2, 3, and 4, Township 38 North, Range 42 East. Permitted disturbance is approximately 1,741 acres with pits covering 214 acres (BLM 1987b; Environmental Management Associates 1992). The open pit is expected to close in the near future, with a change to underground mining (Loda 1995).

2.6.1.3 The Pinson-Mag Mine

Originally, the Pinson-Mag Mine area was mined for tungsten with these operations being small; gold was discovered in 1945. The Pinson-Mag district currently is operated by the Pinson Mining Company and consists of eight open pits(Environmental Management Associates 1992), with five of the pits mined out. Pinson Mining Company is currently mining ore and waste rock from the Mag, C, and CX Pits (Loda 1995), with the mined ore being processed at the existing heap leach and milling facilities located to the east and south of the Mag Pit. In addition to the mining operation, Pinson is exploring for additional deposits in the surrounding areas (Environmental Management Associates 1992).

2.6.1.4 The Preble Mine

The Preble Mine is located in Section 18, Township 36 North, Range 41 East of Humboldt County (Environmental Management Associates 1992) and is operated by the Pinson Mining Company (Foster and Kretschmer 1991). The total acreage of disturbance is approximately 217 acres, with the single open pit covering 15 acres.

This small open pit operation removed approximately 350,000 tons of material and was a heap leach operation. Mining was completed in February 1991 (Environmental Management Associates 1992) and the mine is currently in reclamation (Loda 1995).

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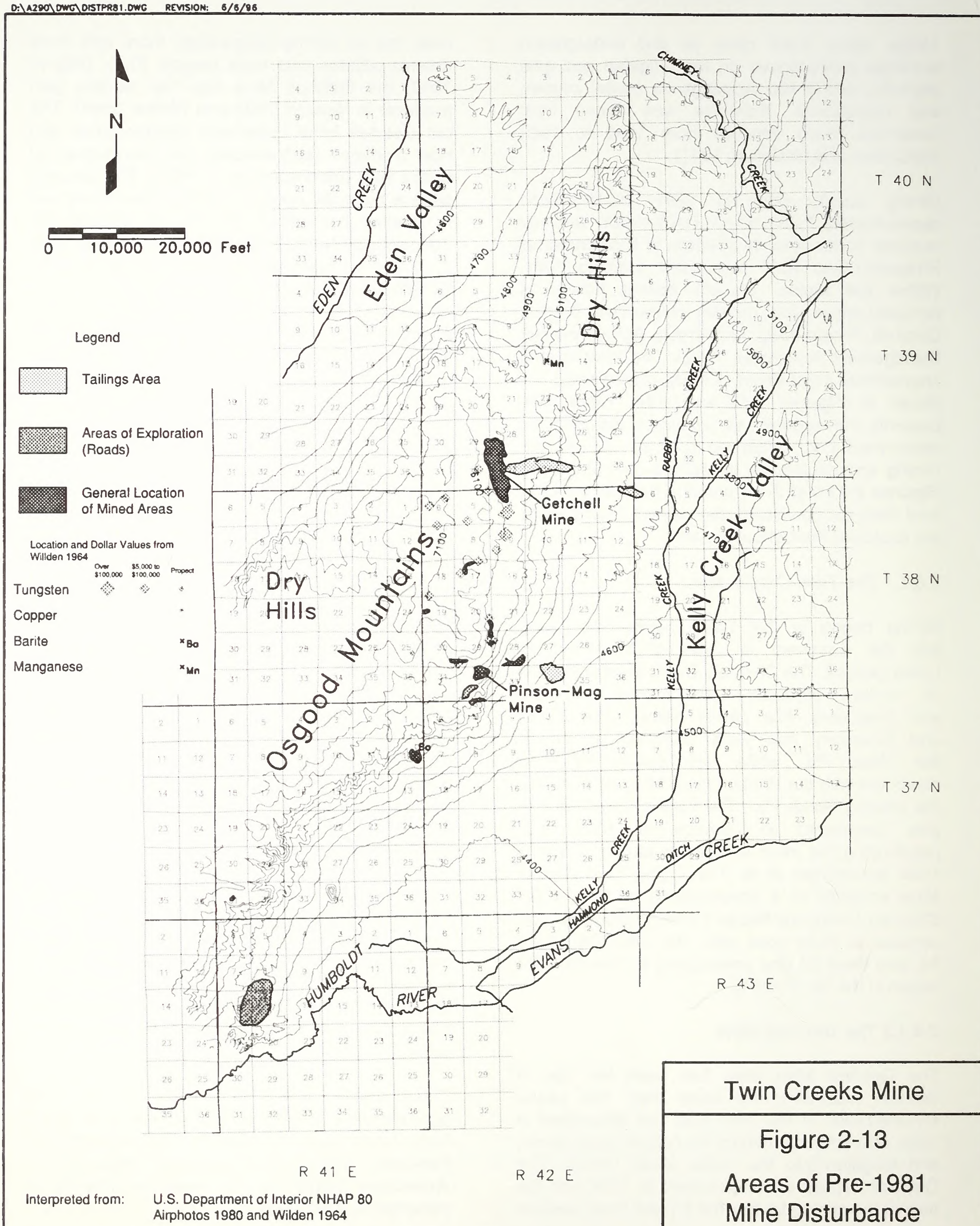

Twin Creeks Mine

Figure 2-13

Areas of Pre-1981 Mine Disturbance

Interpreted from: U.S. Department of Interior NHAP 80 Airphotos 1980 and Wilden 1964

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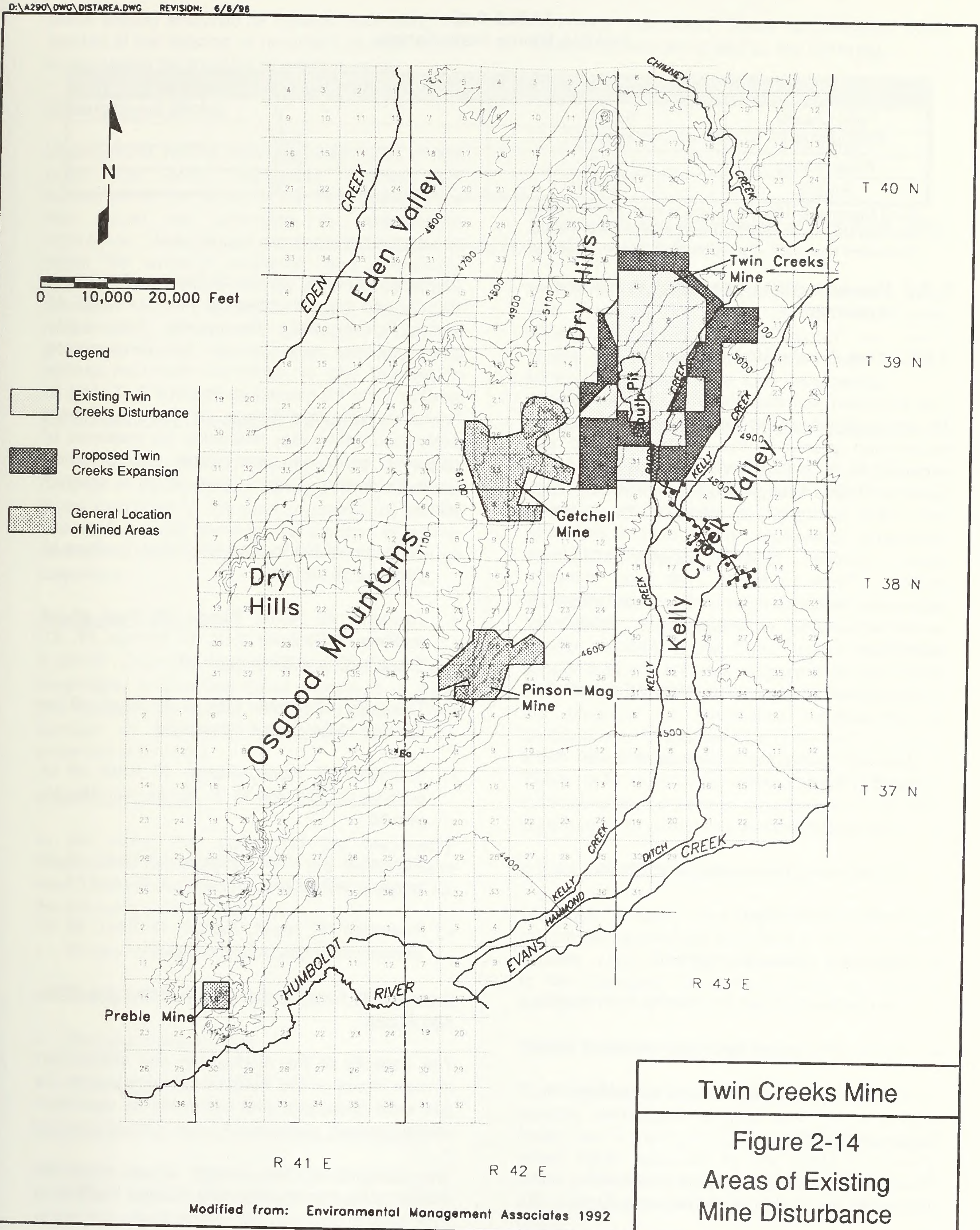


Twin Creeks Mine

Figure 2-14
Areas of Existing Mine Disturbance

TABLE 2-10
Existing Mining Disturbances

Mine	Disturbance (Acre)	Disturbed Acreage Prior to January 1, 1981
Twin Creeks	5,094[1]	0[3]
Getchell	1,741[2]	930[3]
Pinson-Mag	987[2]	363[3]
Preble	217[2]	0[3]

[1] As of December 1994; acreage is from SFPG 1995a.
[2] Nevada Division of Environmental Protection 1995b.
[3] Estimated from U.S. Department of Interior NHAP 80 air photos and excludes exploration disturbance.

2.6.2 Reasonably Foreseeable Future Actions

2.6.2.1 Twin Creeks Mine Actions

The proposed activities for SFPG's Twin Creeks Mine presented in the plan of operations and reclamation plan are those activities that are expected to be initiated within a 5-year planning window (1996 through 2000). However, long-term mine planning has identified the following reasonably foreseeable future actions that may occur outside of the 5-year planning window. These activities are not currently proposed because of the uncertainty of economics, ore reserves, and processing techniques.

- Expansion of open pits outside of the projected footprints
- Increase in number of overburden and inter-burden storage areas
- Underground mining
- Continuation of dewatering operations
- Addition of personnel
- Expansion of ancillary facilities
- Development of new processing technologies
- Import and processing of ore from other mines
- Off-site processing of Twin Creeks Mine ore

__Expansion of Pits__

The plan of operations projects that existing oxide pits would be further expanded into Section 30, Township 39 North, Range 43 East, and Sections 12, 13, and 24, Township 39 North, Range 42 East (***Figure 2-5***). Reasonably foreseeable future actions could include the development of planned pits or additional resources in the existing Vista Pit located in Sections 6, 7, and 8, Township 39 North, Range 43 East. Additional exploration drilling may determine the presence of economic gold resources within the Chimney North Exploration Project area, which is located within:

- Township 41 North, Range 42 East; portions of Sections 35 and 36
- Township 40 North, Range 42 East; all or portions of Sections 1, 2, 11 through 16, 21 through 28, and 33 through 36
- Township 40 North, Range 43 East; all or portions of Sections 1 through 36
- Township 39 North, Range 43 East; all or portions of Sections 2, 3, 10, 11, 15, 16, 21, and 28
- Township 39 North, Range 42 East; all or portions of Sections 1 through 4, 12, and 24
- Township 41 North, Range 43 East, all or portions of Sections 29 through 31

__Increase in Overburden and Interburden Storage Areas__.

The capacity of the overburden and interburden storage areas would have to be increased if the pits were developed and expanded as described above.

The capacity of the storage areas could be increased by constructing new storage facilities in areas already analyzed for impacts, increasing the heights of the existing or proposed storage areas, or increasing the footprint of existing areas.

Underground Mining

Underground mining may be undertaken in the event that deep, high-grade deposits are located within the vicinity of the Twin Creeks Mine that would be amenable to underground techniques. Underground mining could take place within the existing, proposed, and reasonably foreseeable pit footprints, as well as within the Chimney North Exploration Project Area. Ore mined using underground techniques would be processed using the existing and proposed facilities.

Continuation of Dewatering Operations

SFPG projects that dewatering of the pit would continue in the event that mining activities beyond those described in the plan of operations occur. Dewatering would occur for the duration of mining operations beyond those described in the plan of operations.

Additional Personnel

If SFPG undertook any of the above-described reasonably foreseeable future actions, it is likely that additional personnel would be employed. The number of additional employees cannot be projected at this time.

Ancillary Facilities

In the event that certain of the reasonably foreseeable future actions for the Twin Creeks Mine would occur, expansion may be required for the following ancillary facilities:

- Power lines and other utilities
- Haul roads and access roads
- Reagent storage areas
- Water treatment facilities

Development of New Processing Techniques

SFPG envisions that alternative processing techniques could be developed over the next 5 years that would enable the recovery of gold from non-oxide resources. These technologies could include, but are not limited to, the following:

- Bioleach technologies
- Hypochlorite leaching of refractory ores
- Roasting

Importation and Processing of Ore from Other Mines

SFPG may import and process ore from other gold mines in the vicinity of the Twin Creeks Mine. The receipt and milling of ore would enable SFPG to run the Twin Creeks Mine mills continuously at their full capacity.

Off-site Processing of Twin Creeks Mine Ore

SFPG may ship ore from the Twin Creeks Mine to other gold mines for off-site processing, depending on the capacity of the on-site mills.

2.6.2.2 Other Mining Actions

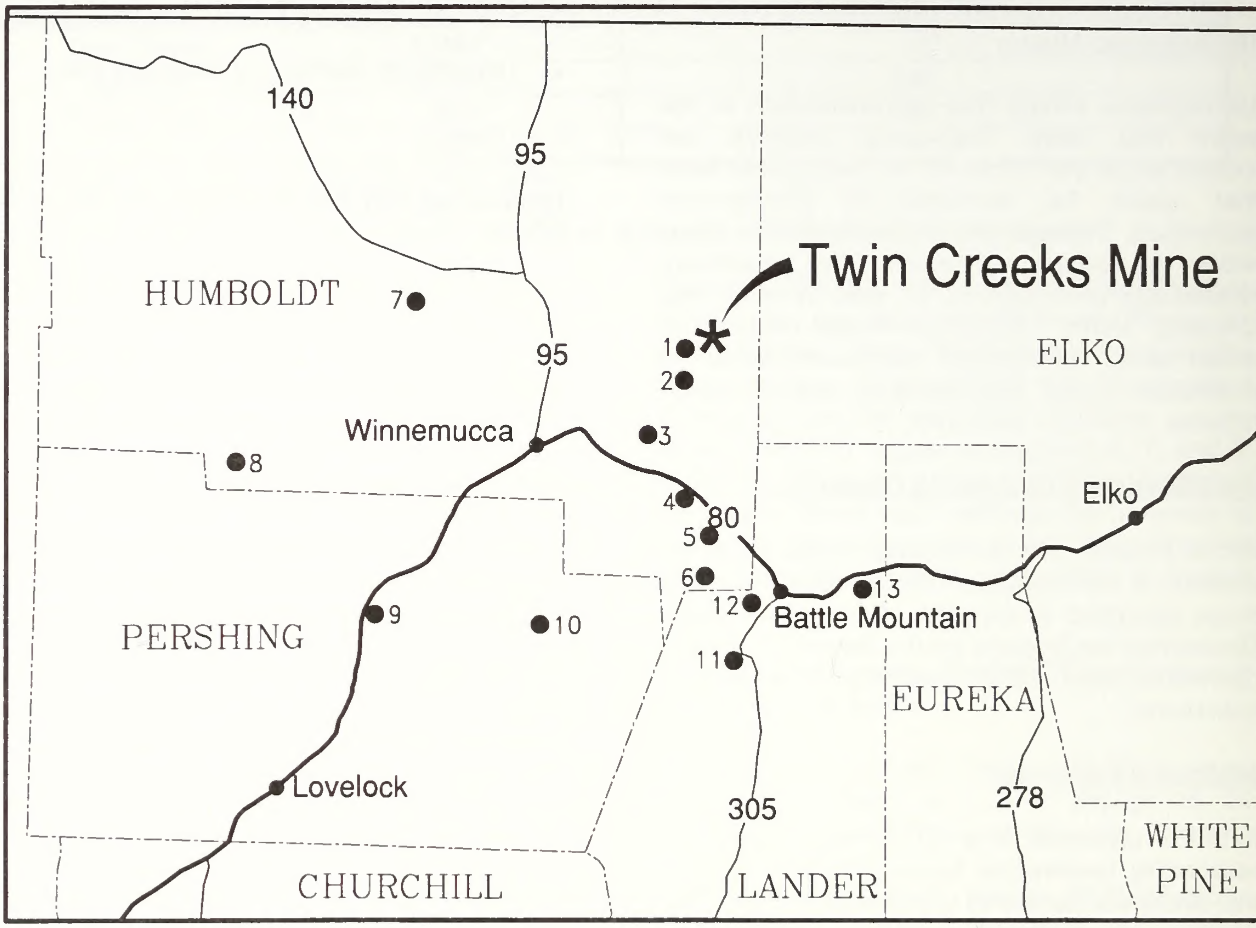
Locations, disturbed acreages, and project status for existing and reasonably foreseeable future mining activities in the Twin Creeks cumulative impact area are shown in ***Figure 2-15*** and ***Table 2-11.*** The Getchell, Pinson, and Preble Mines have the potential for cumulative impacts to all environmental resources based on their proximity to the Twin Creeks Mine. The remaining projects in ***Table 2-11*** have been evaluated for potential cumulative socioeconomic impacts associated with construction or operations employment.

2.6.2.3 Livestock Grazing and Agriculture

Livestock grazing and agriculture are likely to continue as principal land uses in the cumulative impacts area. Grazing allotments are expected to be managed at present levels of grazing activity.

2.6.2.4 Ground Water Use

The cumulative impact assessment for water quantity addressed existing and future ground water use in the hydrologic study area based on water rights recorded by the State Engineer's Office. The two major groups of ground water users include the mining industry and agricultural users.



Legend

1 Getchell Mine
2 Pinson Mine
3 Preble Mine
4 Lone Tree Mine
5 Marigold Mine
6 Trenton Canyon
7 Sleeper
8 Crowfoot/Lewis (Hycroft Mine)
9 Florida Canyon
10 Goldbanks
11 McCoy/Cove
12 Phoenix Project
13 Mule Canyon

N

0 10 20 30 40 Miles
0 10 20 30 40 Kilometers

Twin Creeks Mine

Figure 2-15

Other Mining Activities in the Twin Creeks Area

TABLE 2-11
Existing and Reasonably Foreseeable Mining Projects in the Twin Creeks Mine Cumulative Impacts Area

Facility Name and Company	Currently Permitted (acres)	Status
Getchell Mine First Miss Gold Inc.	1,741	Active; 140 employed; started 1989; mine life remaining: 7 years
Pinson Mine Pinson Mining Co.	987	Active; 130 employed; started 1981; mine life remaining: 5 years
Preble Mine Pinson Mining Co.	217	Inactive; 113 acres reclaimed
Lone Tree Mine[1] Santa Fe Pacific Gold Corp.	2,059	Expanding; 1,491 proposed acres; 350 employed; started operations in 1990
Marigold Mine[1] Marigold Mining Co.	1,187	Active; 132 employed; started in 1989; 65 acres reclaimed
Trenton Canyon[1] Santa Fe Pacific Gold Corp.	-----	Geologic resource; exploration disturbance; no mining disturbance to date; maximum employment estimated to be 130 employees
Sleeper Mine[1] Amax Gold, Inc.	-----	Active; 200 employed; started in January 1986
Crowfoot/Lewis[1] (Hycroft Mine) Granges, Inc.	-----	Active; 215 employed; started in 1987
Florida Canyon[1] Pegasus Gold, Inc.	-----	Active; 190 employed; started in 1987
Goldbanks Project[1] Kinross Goldbanks Mining Company	-----	Geologic resource; exploration disturbance; no mining disturbance to date; maximum operations employment estimated to be 200 to 350 new employees; construction employment unknown at this time.
McCoy/Cove[1] Echo Bay Mines	-----	Active; 500 employed; McCoy started in 1988, Cove started in 1990
Phoenix Project[1] Battle Mountain Gold Co.	3,832	Expanding; 1,969 proposed acres; 350 currently employed, 195 new employees
Mule Canyon[1] Santa Fe Pacific Gold Corp.	-----	New operation; 2,870 proposed acres; 100 construction workforce; 190 operations workforce; exploration disturbance; no mining disturbance to-date

[1] These projects would have potential cumulative socioeconomic impacts associated with construction and operations employment.

Sources: Barto 1996; Balfour Howell International, LLC 1995; BLM 1995a; Nevada Division of Environmental Protection 1995b.

2.7 Agency Preferred Alternative

In accordance with the National Environmental Policy Act, the lead agency is required by the Council on Environmental Quality (40 Code of Federal Regulations 1502.14) to identify its preferred project alternative in the EIS. The BLM's preferred alternative is the Proposed Action, with the Partial Vista Pit Backfill alternative (Section 2.5.1.1) and the Overburden and Interburden Storage Area Reclamation alternative 2 (Section 2.5.1.3), with mitigation. Potential monitoring and mitigation measures that may be required by the BLM are discussed in Chapter 3. Additionally, the Overburden and Interburden Storage Area Reclamation alternative 2 would involve private lands not owned by SFPG in Sections 22 and 27, Township 39 North, Range 43 East. If the use of these lands cannot be secured, Overburden and Interburden Storage Area Reclamation alternative 1 is the next preferred alternative (Section 2.5.1.3). These alternatives satisfy the BLM's responsibility to protect nonmineral resources (in this case, visual resources) to the extent possible, as directed by 43 Code of Federal Regulations 3809.0-2(a) and other guidance, while not placing an unreasonable burden on the project proponent. The preferred alternative provides the best balance between environmental protection and effective resource utilization.

2.8 Comparative Analysis of Alternatives

Table 2-12 identifies, summarizes, and compares the environmental impacts of the No Action alternative, Proposed Action, and the other project alternatives. The impacts associated with the other project alternatives are identified only as they differ from the same impact for the Proposed Action. Detailed descriptions of the impacts are presented in Chapter 3, Affected Environment and Environmental Consequences. The summarized impacts assume the absence of mitigation; implementing the monitoring and mitigation measures recommended in Chapter 3 would potentially reduce the impacts.

TABLE 2-12
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Summary of Disturbance						
New Surface Disturbance	3,136 acres	5,217 acres	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	5,417 acres
Acres Not Reclaimed (i.e., open pits)	528 acres	826 acres	800 acres	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Geology and Minerals						
Gold ore extraction	5.7 million ounces from the South Pit and 0.8 million ounces from the Vista Pit	15.8 million ounces from the South Pit	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Regional ground subsidence from mine dewatering	Area affected by subsidence of 1 foot or greater would extend up to 1 mile from the pit; maximum subsidence of 4 feet adjacent to the pit. Minor potential for facility damage	Area affected by subsidence of 1 foot or greater would increase to 1.4 miles from the pit, with maximum subsidence of 6 feet adjacent to the pit. Minor potential for facility damage	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Geotechnical issues and seismic stability	Minimal impacts anticipated with appropriate design and construction	Potential for settlement and deformation of tailings resulting from placement of storage area D and a portion of storage area B on top of the tailings. Minimal impacts anticipated to other facilities with appropriate design and construction	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Pit Slope Stability	Potential for future pit slope failure to damage portions of overburden and interburden storage areas located within close proximity to pit rim	Increased risk of damage to portions of overburden and interburden storage areas and leach pads located within close proximity to pit rim	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Future availability of mineral resources	No impacts expected	Placement of leach pad E and/or storage area K, and leach pad C and/or storage area G would inhibit recovery of identified economic gold mineralization	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Water Quantity and Quality						
Drawdown effects on wells	Water levels in several wells could potentially be impacted	Water levels in several wells could potentially be impacted; magnitude of impacts would increase over the No Action alternative	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Water Quantity and Quality (continued)						
Drawdown effects on perennial streams and springs	Reduction in flows to the Little Humboldt River, Hot Springs, and other streams and springs likely	Increased reduction in flows to the Little Humboldt River, Hot Springs, and other streams and springs likely	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Degradation of ground water and surface water quality	Not anticipated	Not anticipated	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Flooding, erosion, and sedimentation	Blockage of Rabbit Creek and pooling of runoff behind overburden and interburden storage area B	Blockage of Rabbit Creek and pooling of runoff upgradient of overburden and interburden storage area A. Additional erosion and sedimentation postclosure due to controlled breaching along the Rabbit Creek Diversion	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Waters of the United States	2.2 acres affected	3.3 acres affected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Soils						
Topsoil availability	Average depth of 16.6 inches; 6.4 million cubic yards	Average depth of 17.4 inches; 10.2 million cubic yards	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Vegetation						
Loss of unique vegetation resources	Potential impacts to riparian communities due to surface water flow reduction	Potential impacts to riparian, greasewood, and shadscale/saltbush communities	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Potential for noxious weed establishment	Low	Low	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Changes in vegetation community composition after reclamation	Vegetation communities would be comparable to or exceed average cover and productivity of existing communities	Vegetation communities would be comparable to or exceed average cover and productivity of existing communities	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Wildlife and Fisheries Resources						
Terrestrial Wildlife						
Habitat disturbed	3,136 acres	5,217 acres	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	An additional 200 acres would be disturbed; 5,417 total acres
Habitat lost	528 acres	826 acres	800 acres	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Wildlife and Fisheries Resources (continued)						
Animal displacement and habitat fragmentation	Increased displacement and fragmentation; potential impacts to big game summer, winter, and yearlong ranges due to decrease in water availability	Increased displacement and fragmentation; potential impacts to big game summer, winter, and yearlong ranges due to decrease in water availability	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Increased vehicle-related animal moralities	Construction traffic-related impacts; minimal increases expected	Construction traffic-related impacts; minimal increases expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Noise impacts	Minor increase	Minor increase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Regional biodiversity impacts	Potential decrease due to loss of available water and riparian habitat	Potential decrease due to loss of available water and riparian habitat	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Upland game bird impacts	Potential impacts to breeding sage grouse	Potential impacts to brooding habitat from decrease in water availability	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Raptor impacts	Potential impacts due to decrease in water availability; potential electrocution increase	Potential impacts due to decrease in water availability; potential electrocution increase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Impacts due to hazardous materials release	Low probability of impact	Slight increase in probability of impact	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Bat impacts	No expected direct impacts; potential indirect impacts due to decrease in water availability	No expected direct impacts; potential indirect impacts due to decrease in water availability	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Cyanide impacts	Low probability for impacts due to exclusion from facilities	Low probability for impacts due to exclusion from facilities	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Impacts to birds using reinfiltration basins	Potential long-term impacts from increased soil salinity, metals, and avian disease	Potential long-term impacts from increased soil salinity, metals, and avian disease	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Aquatic Biology						
Impacts due to hazardous materials release	Low probability of impact	Slight increase in probability of impacts	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Wildlife and Fisheries Resources (continued)						
Threatened , Endangered, and Sensitive Species						
Sensitive bat species	Potential impacts due to decreases in water availability and riparian habitat	Increased potential for impacts due to loss of surface water and riparian habitat	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Sensitive raptor species	No expected direct impacts; potential indirect impacts due to decrease in water availability and riparian habitat	Increased potential for impacts to northern goshawk due to loss of riparian habitat; slight increase in probability of indirect impacts to bald eagle prey from hazardous materials release	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Burrowing owl and loggerhead shrike	Potential direct impacts due to habitat loss and nest disturbance; indirect impacts to loggerhead shrike nesting habitat (greasewood)	Potential direct impacts due to habitat loss and nest disturbance; indirect impacts to loggerhead shrike nesting habitat (greasewood)	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Water birds - white-faced ibis, black tern, western least bittern	Potential indirect impacts due to decrease in water availability	Potential indirect impacts due to decrease in water availability	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Pygmy rabbit	Minor impacts expected	Minor impacts expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Spotted frog	Potential short-term beneficial impact due to dewatering discharge; potential long-term indirect impacts due to decrease in water availability	Potential short-term beneficial impact due to dewatering discharge; potential long-term indirect impacts due to decrease in water availability	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Range Resources						
Loss of key grazing areas	No significant impacts expected	Loss and exclusion of 1,603 acres in the Bullhead Seeding as a key holding pasture	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Increase in grazing pressure	Minimal grazing pressure increases in other areas, but irreparable degradation of grazing resources not expected	Minimal grazing pressure increases in other areas, but irreparable degradation of grazing resources not expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Loss of stock water resources	No changes expected during mining operations	Loss of the Rabbit Creek drainage and associated water flow within the Bullhead Seeding pasture	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Paleontological Resources						
Disturbance/loss of known resources	No impacts expected	No impacts expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Cultural Resources						
Impacts to historical/archaeological values	No direct impacts to National Register of Historic Places - eligible sites	No direct impacts to National Register of Historic Places - eligible sites	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Impacts to Native American traditional values	Potential impacts to Traditional Cultural Properties and Native American values include covering of burials, disturbance of medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be covered by an overburden and interburden storage area. Known burials may also be covered by an overburden and interburden storage area. The Native American consultation process is still underway to identify impact areas	Potential impacts to Traditional Cultural Properties and Native American values include disturbance of burials, disturbance of medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be either covered by an overburden and interburden storage area or disturbed during construction of a heap leach pad. Known burials may also be covered by an overburden and interburden storage area or disturbed by construction of a heap leach pad. The Native American consultation process is still underway to identify impact areas	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Air Quality						
Exceedance of federal or state standards	No impacts expected	No impacts expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Land Use and Access						
Changes to existing land use patterns	No permanent changes expected; reclamation would return lands to their premining land uses	No permanent changes expected; reclamation would return lands to their premining land uses	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Elimination of existing access	No changes expected	County road would be relocated prior to construction of project facilities; no impacts expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Land Use and Access (continued)						
Traffic increase	Short-term increase during construction; no changes expected during operations	Short-term increase during construction; traffic increase during operations due to transport of additional materials, Mule Canyon Mine ore, and Lone Tree Mine flotation concentrate	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Recreation and Wilderness						
Recreation availability and demand	No significant changes expected	No significant changes expected	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Social and Economic Values						
Population impact	Peak population increase of 410 people during construction phase	Peak population increase of 205 people during construction phase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Employment impact	Peak construction employment of 300 additional workers; 60 indirect jobs established	Peak construction employment of 150 additional workers; 30 indirect jobs established	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Housing impact	Demand would exceed existing supply during construction phase	Demand would exceed existing supply during construction phase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Community facilities and services impact	Potential short-term impacts to schools and law enforcement during construction phase	Potential short-term impacts to schools and law enforcement during construction phase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Public finances impact	Generation of sales and use tax revenue during 12-month construction phase; continuation of $55.9 million monthly payroll; contribution of approximately $6.3 million annual tax revenues to Humboldt County through the year 2000	Generation of $650,000 per month in sales and use tax revenue during 12-month construction phase; continuation of $55.9 million monthly payroll during operations (not including wage increases over life of project); continued contribution of approximately $6.3 million annual tax revenues (in 1994 dollars) to Humboldt County through the year 2011	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Visual Resources						
Compatibility with visual resource management objectives	Management guidelines for visual resource management class IV lands would not be exceeded	Management guidelines for visual resource management class IV lands would not be exceeded	Same as Proposed Action	Same as Proposed Action	Less visual contrast	Less visual contrast

TABLE 2-12 (continued)
Impact Summary and Alternatives Comparison

Resource Areas/Issues	No Action Alternative	Proposed Action	Partial Vista Pit Backfill Alternative	Selective Handling of Overburden and Interburden Alternative	Overburden and Interburden Storage Area Reclamation Alternatives	
					Alternative 1	Alternative 2
Noise						
Projected noise levels at sensitive receptors						
Construction	No permanent changes; noise levels would be short-term and within acceptable limits	No permanent changes; noise levels would be short-term and within acceptable limits	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Operations	No changes expected; noise levels within acceptable limits	No significant changes expected; noise levels within acceptable limits	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Blasting	Noise levels would exceed acceptable limits for the short duration of each blast; noise levels would decrease as the South Pit depth increases	Noise levels would continue to decrease as the South Pit depth increases slightly	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Hazardous Materials						
Potential impacts to environmental resources from accidental release of hazardous materials during transport to the project area or storage and use at the mine	No significant changes expected	Probability of an accidental release would increase	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action

3.0 Affected Environment and Environmental Consequences

CHAPTER 3.0 Affected Environment and Environmental Consequences

This chapter describes the environment that would be affected by the development of the Proposed Action, the No Action alternative, or the other project alternatives. The environmental baseline information summarized in this chapter was obtained from field and laboratory studies of the project area, published sources, unpublished materials, and communication with relevant government agencies and private individuals with knowledge of the area. The affected environment for individual resources was delineated based on the area of potential direct and indirect environmental impacts for the proposed project. For some resources, such as geology, soils, and vegetation, the affected area was determined to be the physical location and immediate vicinity of the areas to be disturbed by the project. For other resources, such as water quantity and quality, air quality, and social and economic values, the affected environment comprised a larger area, i.e., watershed, airshed, local counties, etc.

This chapter also describes the anticipated direct, indirect, and cumulative impacts of the Proposed Action and the project alternatives, including the No Action alternative. The criteria developed to determine impact significance were based on regulatory standards, regulatory agency guidance, or best professional judgment. Monitoring and mitigation measures developed in response to the impacts are recommended by the Bureau of Land Management (BLM) for individual resources. These measures are not part of Santa Fe Pacific Gold Corporation's (SFPG's) plan of operations and reclamation plan for the proposed project but could be required by the BLM or other regulatory agencies as conditions or stipulations of approval and authorization of the plan of operations and reclamation plan. This chapter also identifies residual adverse effects, i.e., the effects that would remain following the implementation of mitigation measures.

The proposed project may result in impacts interrelated with other past, present, and reasonably foreseeable future actions in the area. For resources where project-specific impacts are identified, the cumulative impacts associated with the proposed expansion together with other interrelated projects were evaluated. The period of potential cumulative impacts is defined as the life of the project, 1996 through 2011.

This chapter is organized by environmental resource. Sections 3.1 through 3.15 describe the existing conditions and potential environmental impacts associated with each resource. The short-term use of the environment relative to the long-term productivity of resources is discussed in Section 3.16. The irreversible or irretrievable commitment of resources is presented in Section 3.17.

Numerous technical reports were prepared as support documents to this environmental impact statement (EIS), including, but not limited to the following:

- Hydrogeologic Framework and Numerical Ground-Water Flow Modeling of the Region Surrounding the Twin Creeks Mine, Humboldt County, Nevada. Prepared by Hydrologic Consultants, Inc. (HCI 1996).
- Predicted Water Quality in the Twin Creeks Mine Pit Lakes. Prepared by PTI Environmental Services (PTI 1996).
- Final Twin Creeks Mine Materials Handling Plan. Prepared by PTI and Welsh Engineering and Science Technology (WESTEC 1996).
- Ecological and Human Health Risk Assessments of the Future Pit Lakes: Twin Creeks Mine, Golconda, Nevada. Prepared by Parametrix, Inc. (1996).

Copies of these technical reports are available for review at:

- BLM Winnemucca District Office
  5100 East Winnemucca Boulevard
  Winnemucca, Nevada 89445
- BLM Nevada State Office
  850 Harvard Way
  Reno, Nevada 89520

3.1 Geology and Minerals

3.1.1 Affected Environment

This section addresses the topography, regional geology, bedrock geology, surficial deposits, seismicity, geologic hazards, and mineral resources for the Twin Creeks Mine. The geologic conditions discussed below also provide the background information for the characterization of the hydrogeologic conditions and rock geochemistry discussed in Section 3.2, Water Quantity and Quality.

3.1.1.1 Physiographic and Topographic Setting

The topography and physiographic features of the regional study area for geology and minerals are shown in ***Figure 3-1***. This study area is coincident with the hydrologic study area for water quantity and quality and includes the western portion of Eden Valley, parts of the Osgood Mountains, the Snowstorm Mountains, and Kelly Creek basin. The regional study area is bounded by the Little Humboldt River on the north, the South Fork of the Little Humboldt on the east, Evans Creek and the Humboldt River on the south, and the crest of the Osgood Mountains and Eden Creek on the west. The elevations across this area range from 8,680 feet in the Osgood Mountains to 4,350 feet in the valley floor along the Humboldt River. The elevation across the Twin Creeks Mine ranges from approximately 5,300 to 4,700 feet. All tributaries within this area drain to either the Humboldt River or the Little Humboldt River, a tributary to the Humboldt River.

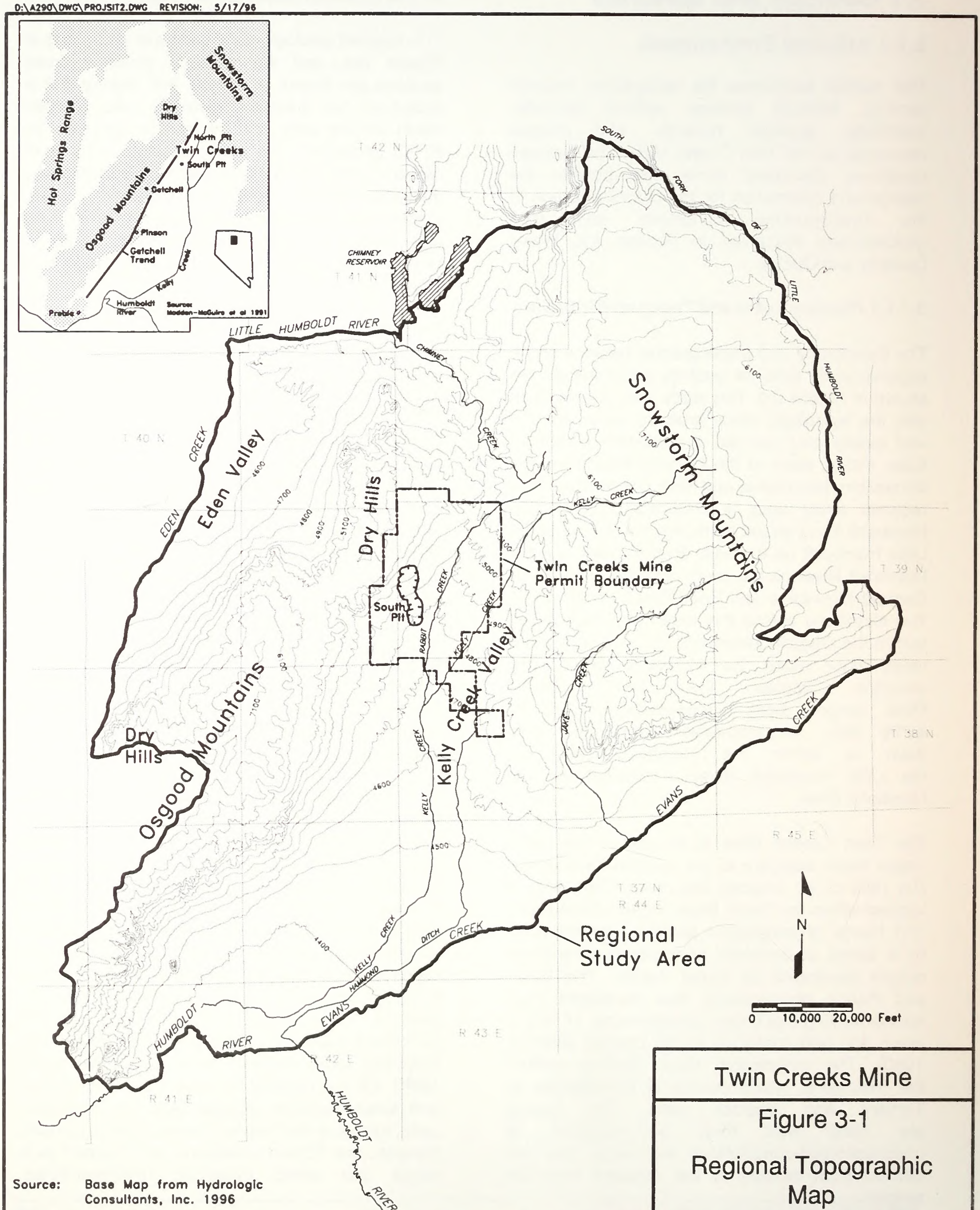
The Twin Creeks Mine is situated in the Kelly Creek basin adjacent to the eastern flank of the Dry Hills of the Osgood Mountains. This area is located within the Great Basin region of the Basin and Range physiographic province characterized by a series of generally north-trending mountain ranges separated 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-consolidated sediments that are derived from erosion of the adjacent mountain ranges.

3.1.1.2 Regional Geologic Setting

The regional geologic conditions are presented in ***Figure 3-2,*** and the regional geologic cross sections are shown in ***Figure 3-3***. ***Figure 3-2*** is based on the published geologic map (Willden 1964) for the area and information provided by SFPG geologists. The major geologic units, from oldest to youngest, include Paleozoic sedimentary, metasedimentary, and metavolcanic rocks; Cretaceous granodiorite; Tertiary volcanic tuffs and flows of various composition; Tertiary volcaniclastic sediments; and Tertiary-Quaternary alluvium.

Paleozoic sedimentary, metasedimentary, and metavolcanic rocks form the regional basement through the area. The oldest unit is the lower Cambrian Osgood Mountain quartzite, which grades upward into the Cambrian Preble Formation composed of shale, limestone, and sandstone. These Cambrian rocks are stratigraphically overlain by the Ordovician Comus Formation composed of dolomitic shale, mudstone, and basalt, and the Valmy Formation composed of siliceous shales, basalt, and calcareous dolomitic shale. The Valmy is unconformably overlain by the Mississippian Goughs Canyon Formation (also called the Leviathan Sequence), which predominantly consists of greenstone with inter-bedded sedimentary rocks. The Pennsylvanian-Permian Etchart Limestone stratigraphically overlies the older Paleozoic rocks and is composed of interbedded carbonate and clastic sequences.

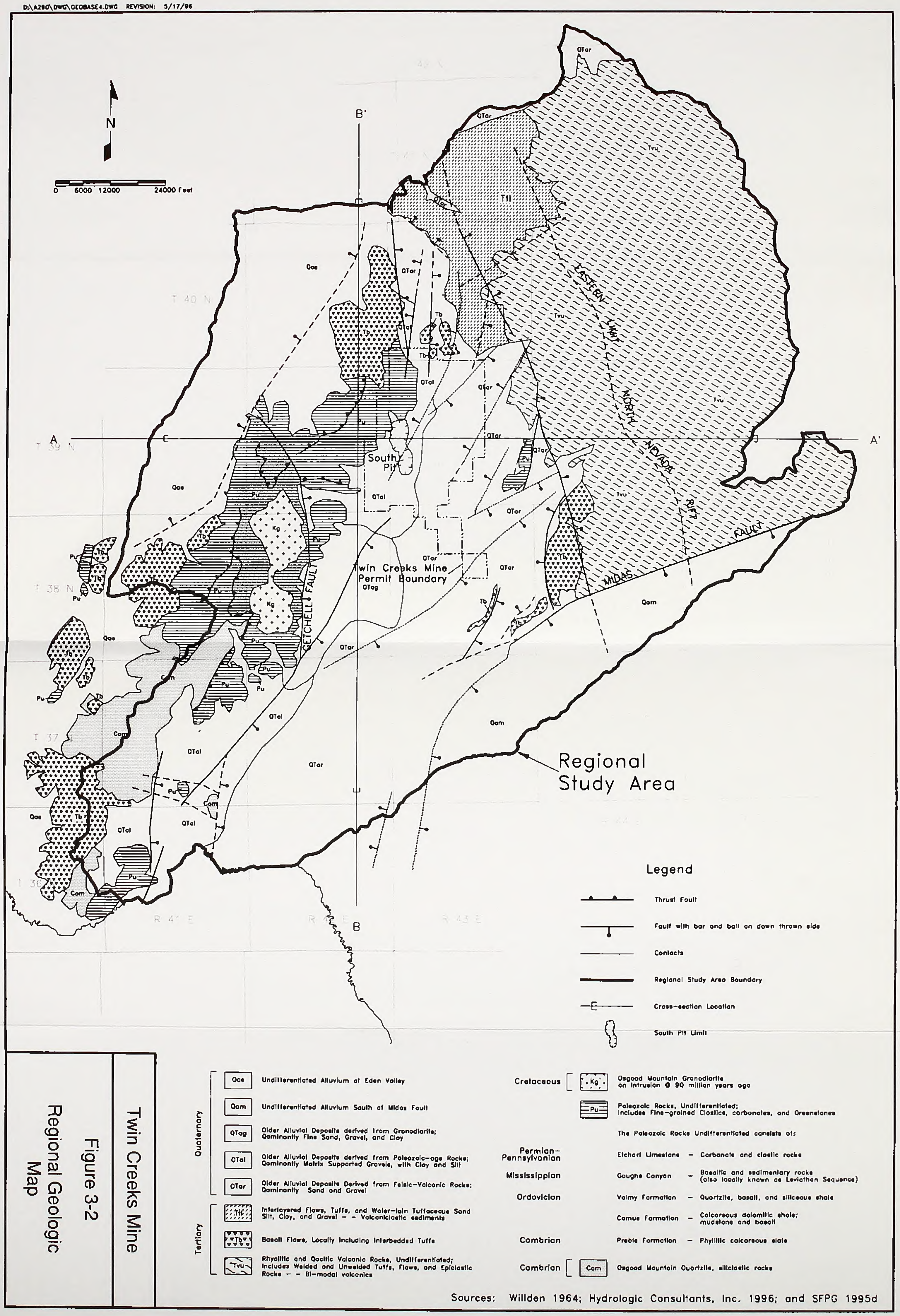
The Paleozoic rocks have undergone a complex history of intense deformation. During the Devonian and Mississippian periods, the lower Paleozoic sediments were folded and subjected to low-grade regional metamorphism (Foster and Kretshmer 1991). This event, called the Antler Orogeny, also resulted in the eastward movement of silicic and volcanic rocks over lithologically dissimilar shallow-water carbonate rocks along the Roberts Mountains thrust (Stewart 1980). In addition, the Goughs Canyon and Etchart Limestone have also been thrust over the lower Paleozoic rocks (Roberts 1966; Bloomstein et al. 1991). On the regional geologic map (***Figure 3-2***) and cross sections (***Figure 3-3***), the Paleozoic units, including the Preble, Comus, Valmy, Goughs Canyon, and Etchart Limestone, are mapped as a single unit called Paleozoic undifferentiated.



Twin Creeks Mine

Figure 3-1

Regional Topographic Map



Twin Creeks Mine

Figure 3-2
Regional Geologic Map

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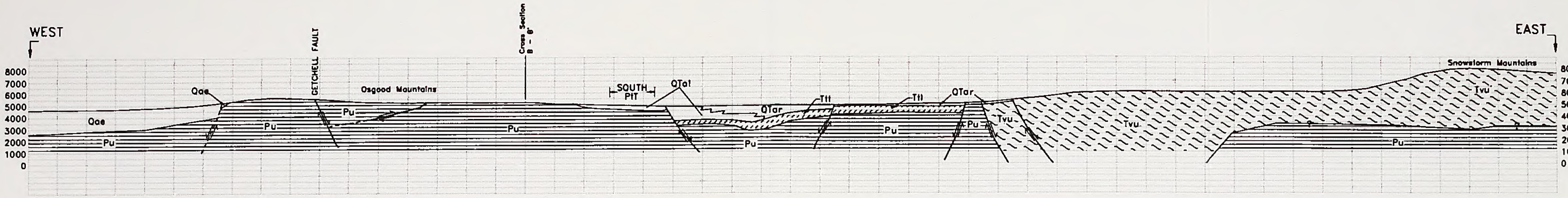
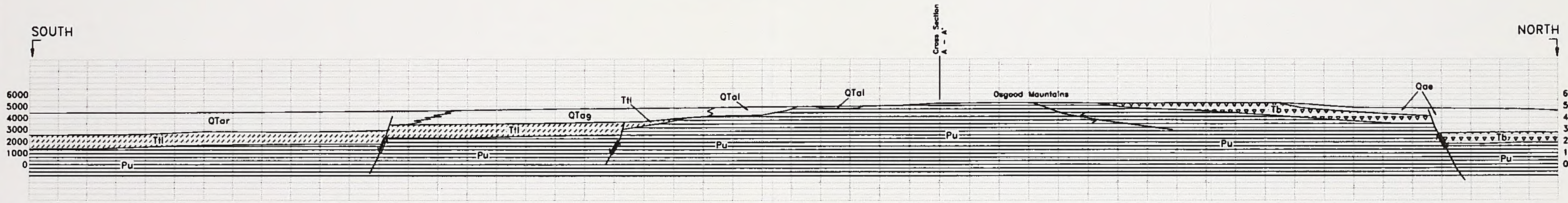
Cross Section A – A'



a.

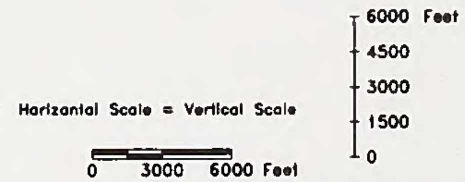
Cross Section B – B'



b.

Legend

- **Qae** — Undifferentiated Alluvium at Eden Valley
- **QTag** — Older Alluvial Deposits derived from Granodiorite; Dominantly Fine Sand, Gravel, and Clay
- **QTal** — Older Alluvial Deposits derived from Paleozoic-age Rocks; Dominantly Matrix Supported Gravels, with Clay and Silt
- **QTar** — Older Alluvial Deposits Derived from Felsic-Volcanic Rocks; Dominantly Sand and Gravel
- **Ttl** — Interlayered Flows, Tuffs, and Water-lain Tuffaceous Sand Silt, Clay, and Gravel
- **Tb** — Basalt Flows, Locally Including Interbedded Tuffs
- **Tvu** — Rhyolitic and Dacitic Volcanic Rocks, Undifferentiated; Includes Welded and Unwelded Tuffs, Flows, and Epiclastic Rocks
- **Pu** — Paleozoic Rocks, Undifferentiated; Includes Fine-grained Clastics, carbonates, and Greenstones



Source: modified from Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-3

Regional Geologic Cross Sections

The Paleozoic volcanic-sedimentary section was intruded by the Osgood Mountains Granodiorite approximately 90 million years ago (Silberman et al. 1974). At the surface, the stock has two lobes and is shaped like an hourglass. The emplacement of this stock resulted in the alteration, metamorphism, and mineralization of the surrounding country rocks. This metamorphosed and altered zone extends out approximately 10,000 feet into the adjacent sedimentary rocks, marble, and hornfels (Silberman et al. 1974).

As illustrated in the regional geologic cross sections (***Figure 3-3***), the Paleozoic rocks are locally capped by a sequence of Tertiary-age volcanic rocks that include basalts, andesite, and rhyolite lava flows and pyroclastics that erupted between 6 to 17 million years ago (Osterberg and Guilbert 1991). This period of volcanic eruptions and block faulting reflects the extensional tectonism that affected the Great Basin during the late Tertiary era. In the regional study area, the volcanics have been subdivided into undifferentiated volcanic rocks and basalt. The Snowstorm Mountains are composed of a thick sequence of predominantly silicic lavas, welded tuffs, and volcaniclastic sediments that are up to 3,000 feet thick. Most of the volcanic rocks apparently emanated from source vents situated along the Northern Nevada Rift, a major volcano-tectonic structure trending north-northwest through the Snowstorm Mountains (Zoback and Thompson 1978; Zoback et al. 1994). Volcanism ended approximately 6 million years ago with the eruption of basalt lava flows.

Beginning in the late Cenozoic era, the area was block-faulted by a series of normal faults that created the basin and range topography that characterizes the region. Broad valleys in the regional study area such as the Kelly Creek basin and Evans Valley were formed as down-dropped blocks between uplifted mountain ranges. As shown on the regional geologic map, ***Figure 3-2***, major normal fault zones that control block fault movement bound both the east and west flanks of the Osgood Mountains and the west flank of the Snowstorm Mountains.

Uplift and subsequent erosion of the mountains during the late Cenozoic era have partially filled the basin with poorly consolidated to unconsolidated silt, sand, gravel, and boulders deposited primarily as a series of coalescing alluvial fans during the late Tertiary and Quaternary time. As illustrated in ***Figure 3-3***, drilling and geophysical information indicates that the thickness of these deposits ranges from a thin veneer on pediment slopes to a thousand feet or more near the central portions of the basins.

The Quaternary alluvium can be subdivided into five different deposits based on the predominant clast lithology or distribution (HCI 1995): (1) Volcanic-derived alluvium (QTar); (2) Paleozoic-rock-derived alluvium (QTal); (3) Granodiorite-derived alluvium (QTag); (4) Eden Valley alluvium (Qae); and (5) alluvium located south of the Midas fault (Qam).

The volcanic-derived alluvium occurs in the eastern portion of the Kelly Creek basin and consists primarily of sand, gravel, and pebbles of rhyolite accumulated by erosion of the volcanics from the Snowstorm Mountains. The Paleozoic-rock-derived alluvium is deposited along the western portion of the Kelly Creek basin and consists of chert, shale, siltstone, sandstone, conglomerate, limestone, and granodiorite fragments eroded from the Osgood Mountains. Alluvium derived from the granodiorite intrusive consists of fine sand, gravel, and clay deposited along the western margin of the Kelly Creek basin. The Eden Valley alluvium is composed of undifferentiated detritus from both basaltic and Paleozoic sedimentary rocks deposited in Eden Valley. The alluvium south of the Midas Fault consists predominantly of coarse-grained volcanically-derived material deposited in the valley drained by Evans Creek. These sediments are generally more coarsely grained than alluvium in the Kelly Creek basin (HCI 1996). Near the mine, the QTar and QTag map units are cemented with calcium carbonate and clay minerals (Madden-McGuire et al. 1991).

3.1.1.3 Mineralization and Pit Geology

The Twin Creeks Mine lies within a north to northeast trending mineralized zone known as the Getchell Trend or Potosi (Getchell) Mining District. The mining district extends in a northeast direction along the eastern flank of the Osgood Mountains. As shown in ***Figure 2-13***, major gold producing mines within the district include, from southwest to northeast, the Preble, Pinson, Getchell, and Twin Creeks Mine (formerly the Chimney Creek and Rabbit Creek Mines). Combined annual gold production for active mines within this District currently exceeds 650,000 ounces of gold per year. The mineral deposits within the Getchell Trend are primarily hosted in Paleozoic sedimentary rocks.

At the Twin Creeks Mine, gold occurs in a north-south trending mineralized zone that is several miles long and up to 5,000 feet wide. This zone consists of gold-arsenic-mercury mineralization controlled by an apparent major north-south trending structural zone referred to as the Rabbit Suture (Bloomstein et al. 1991; Thomas 1992). Mineralization at the Twin Creeks Mine occurs in two geologically distinct deposits: the South Pit and the Vista Pit. Overall, the bulk of the known gold mineralization occurs in the South Pit deposit. Both the South Pit and Vista Pit deposits contain oxidized ore; however, sulfide ore is primarily restricted to the South Pit deposit. Sulfide minerals associated with gold include pyrite, stibnite, realgar, and orpiment. The general stratigraphic column and major mineralized zones associated with each pit are summarized in ***Figure 3-4***.

<u>South Pit</u>

The existing South Pit area includes the main South Pit and the much smaller West Pit, located northwest of the South Pit (***Figure 2-2***), which would eventually be incorporated within the boundaries of the South Pit. The generalized geology of the South Pit is illustrated in ***Figures 3-5*** and ***3-6***. Mineralization in the South Pit is hosted primarily in the Valmy Formation and, to a much lesser extent, the Leviathan greenstone. As shown in the stratigraphic column (***Figure 3-4***), the Valmy formation can be subdivided into a lower member dominated by shales and an upper member dominated by basaltic flows, sills, and basaltic tuffs. These rocks have been tightly folded, and mineralization occurs in favorable beds along the hinge and limbs of the fold. The Mississippian Leviathan greenstone consists of altered basalts and basaltic tuffs with cherty interbeds. The Leviathan greenstone occurs primarily in the northwestern portion of the pit and hosts some oxide mineralization. As shown in ***Figure 3-6***, the host rocks for mineralization are segmented by a series of northeast trending faults. These faults display right-lateral displacement of up to 2,000 feet and apparently control the localization of mineralization. The entire South Pit deposit is veneered by up to 600 feet of alluvial material. A total of 1,742 million ounces of gold were mined from the South Pit through 1995.

<u>Vista Pit</u>

In the Vista Pit area, the Etchart limestone is the primary host rock for oxide mineralization, with lesser mineralization in the Leviathan greenstone (part of the Goughs Canyon Formation). The Etchart limestone consists of interbedded limestone, dolomite, and sandy limestones and dolomites, which overly the Leviathan greenstone. By the end of 1995, 2.174 million ounces of gold were mined from the Vista Pit.

3.1.1.4 Faulting and Seismicity

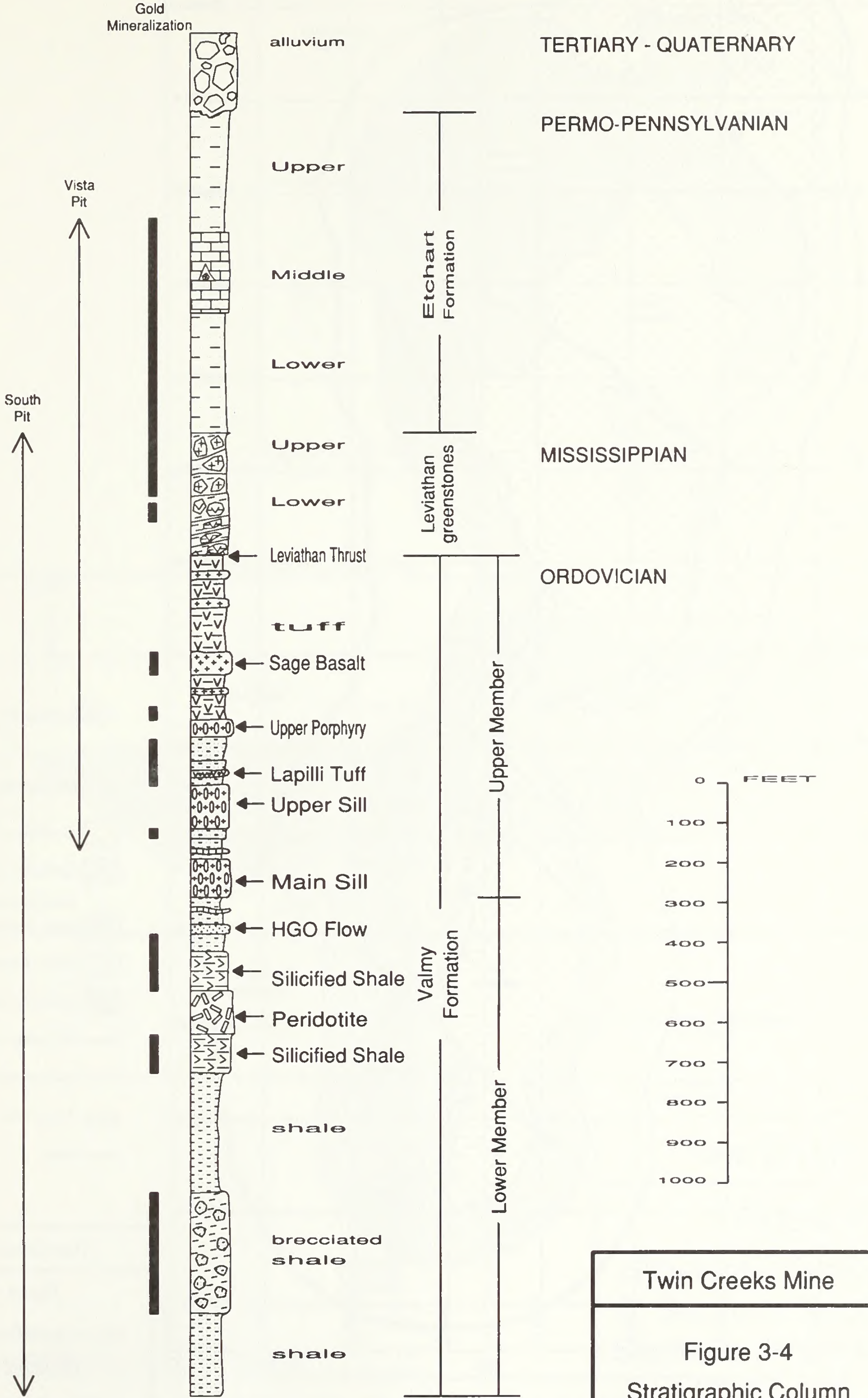
<u>Faulting</u>

The project site is located in a region that is characterized by active and potentially active faults and a relatively high level of historic seismicity. An active fault is one that shows evidence of displacement during the Holocene period (last 10,000 years), and a potentially active fault is a fault that shows evidence of surface displacement during the late Quaternary period (last 150,000 years). 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 southwest of the project site (***Figure 3-7***). The closest historic surface displacement to the Twin Creeks Mine was in 1915, approximately 50 miles to the southwest. Surface fault rupture typically occurs along active fault traces. Review of maps of potentially active faults (Dohrenwend and Moring 1991) indicate that there are no known active faults in the immediate vicinity of the project site. The nearest mapped potentially active faults are located several miles south of the project site in the Kelly Creek basin (***Figure 3-8***).

<u>Seismicity</u>

The project site is located in a region that has experienced considerable seismic activity in historic time. Earthquake records indicate that 62 earthquake events greater than 4.0 Richter Magnitude have been recorded (U.S. Geological Survey Earthquake Database) within a 100-mile radius of the Twin Creeks Mine between 1872 and October 5, 1995. ***Figure 3-8*** shows the approximate location and estimated magnitude of the recorded seismic events relative to the Twin Creeks Mine. As shown in ***Table 3-1***, the largest

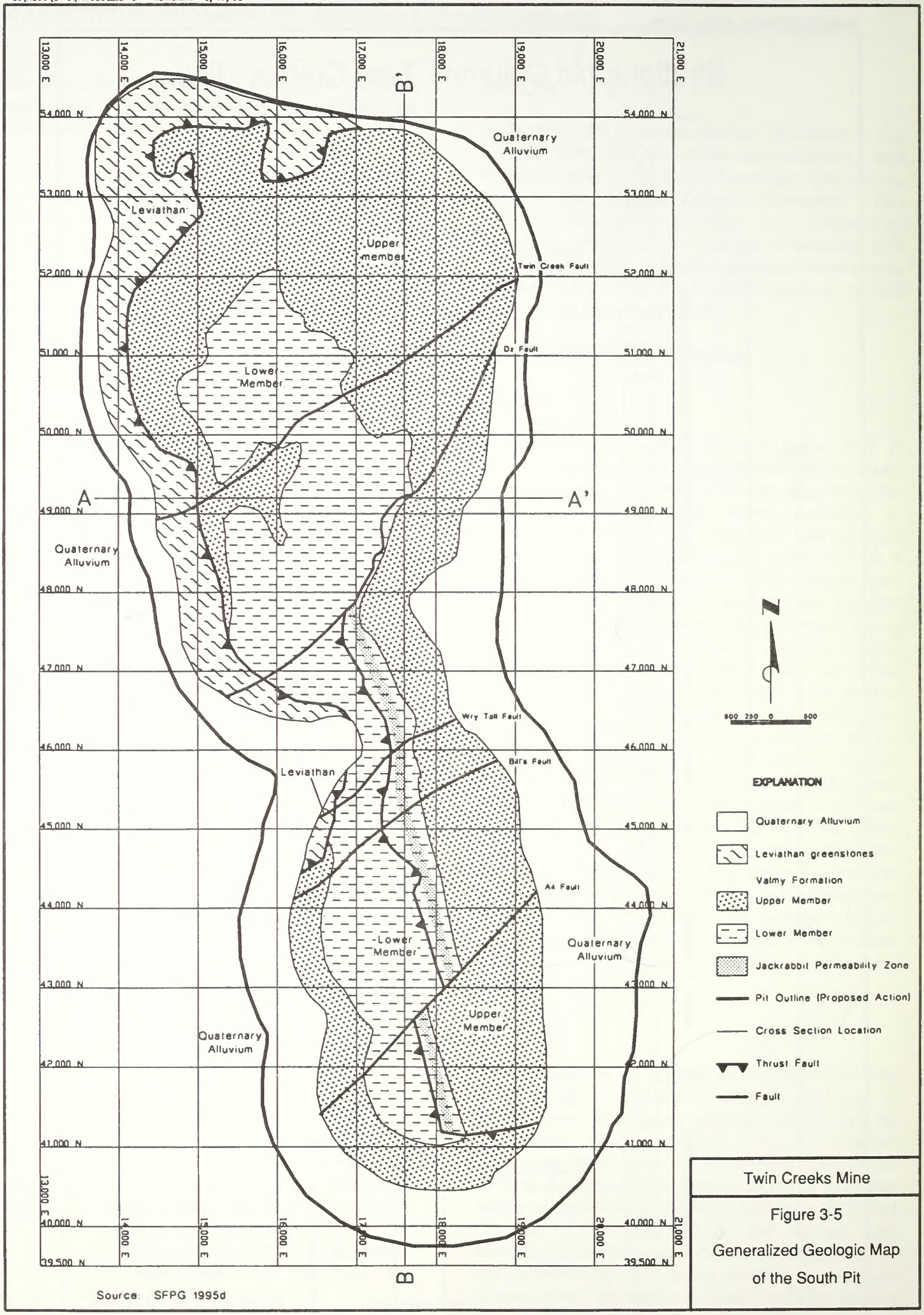
Stratigraphic Column - Twin Creeks Mine



Source: SFPG 1995d

Twin Creeks Mine

Figure 3-4
Stratigraphic Column



Twin Creeks Mine

Figure 3-5

Generalized Geologic Map of the South Pit

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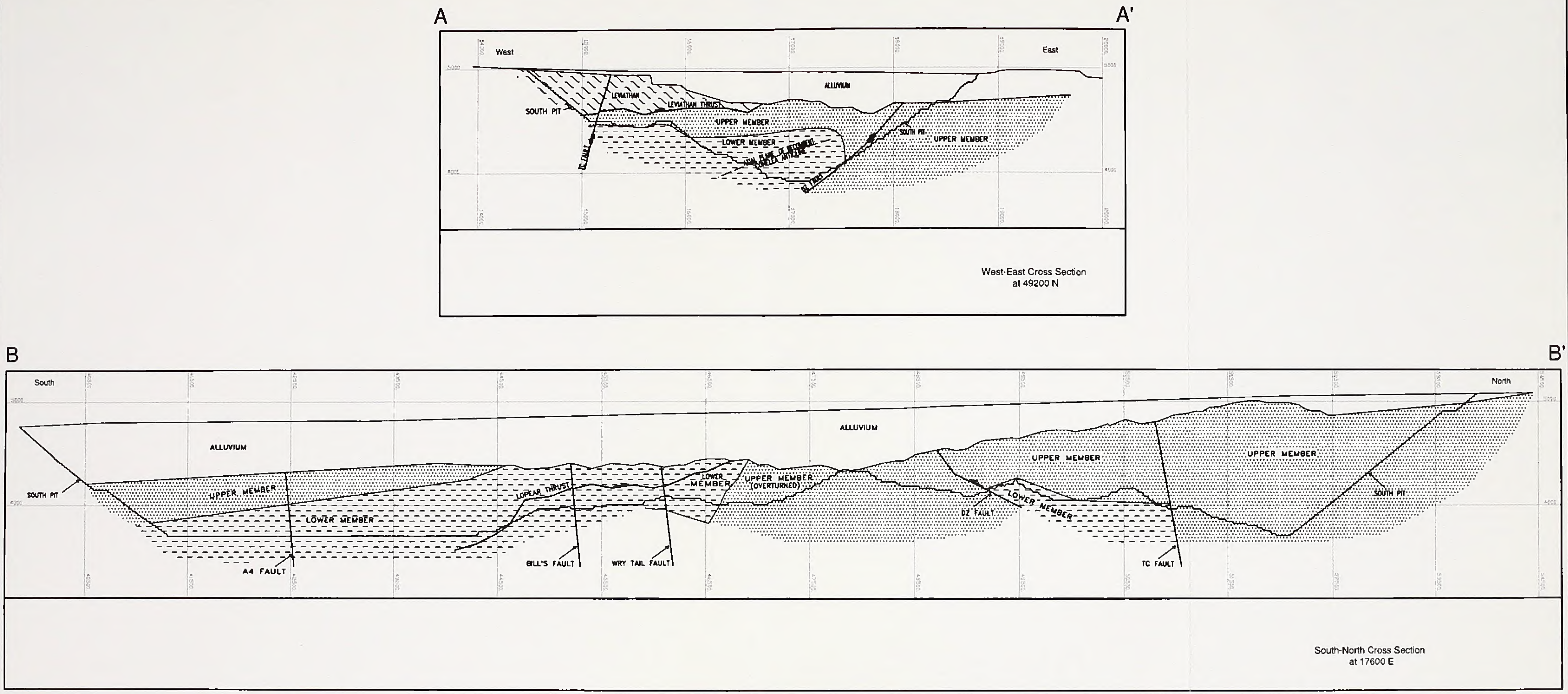


Legend

Quaternary Alluvium	Valmy Formation
Leviathan	Upper Member
	Lower Member

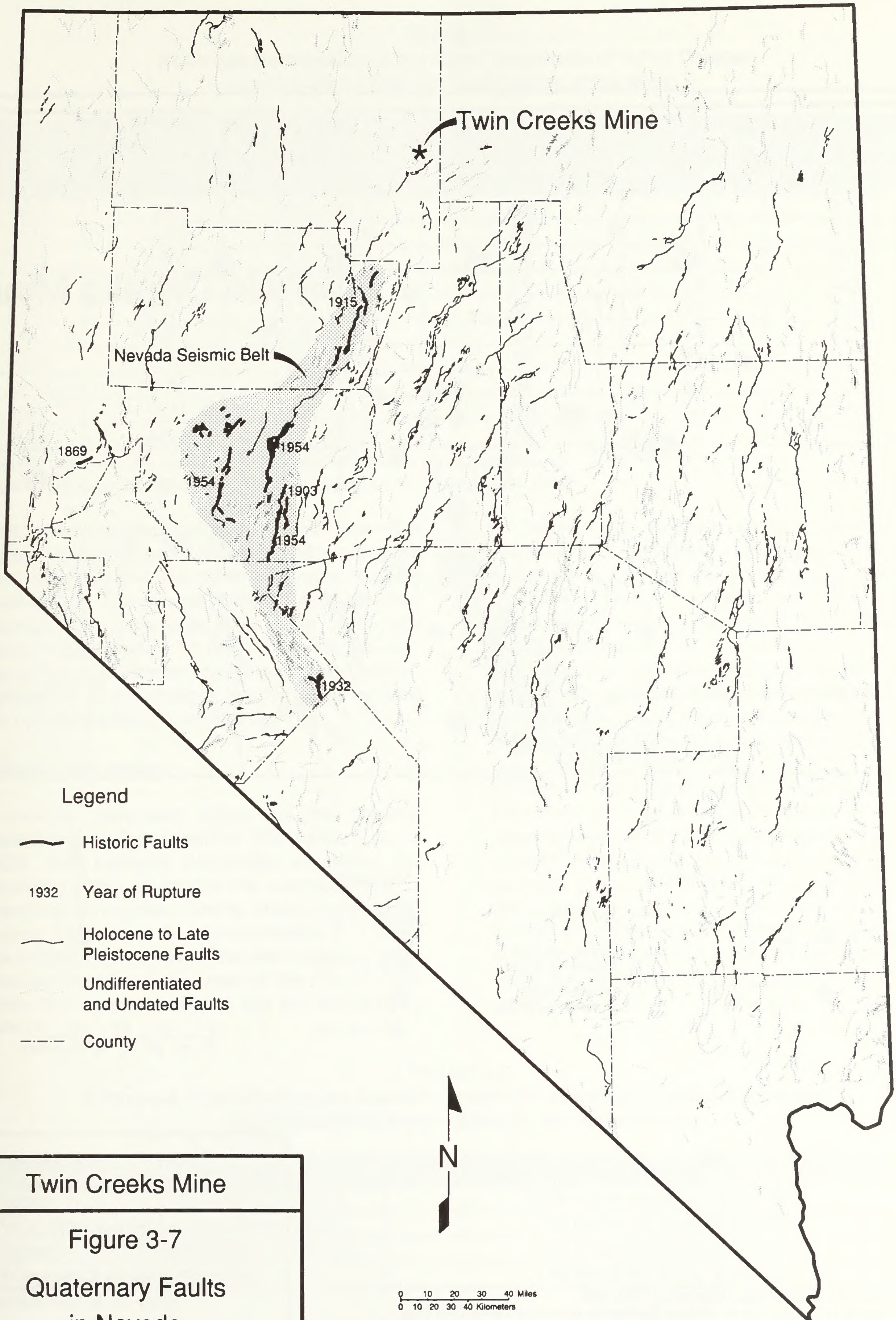
0 500 1000 1500

Horizontal Scale = Vertical Scale

Source: modified from SFPG 1995d

Twin Creeks Mine

Figure 3-6
Schematic Geologic Cross Sections Through the South Pit (Proposed Action)

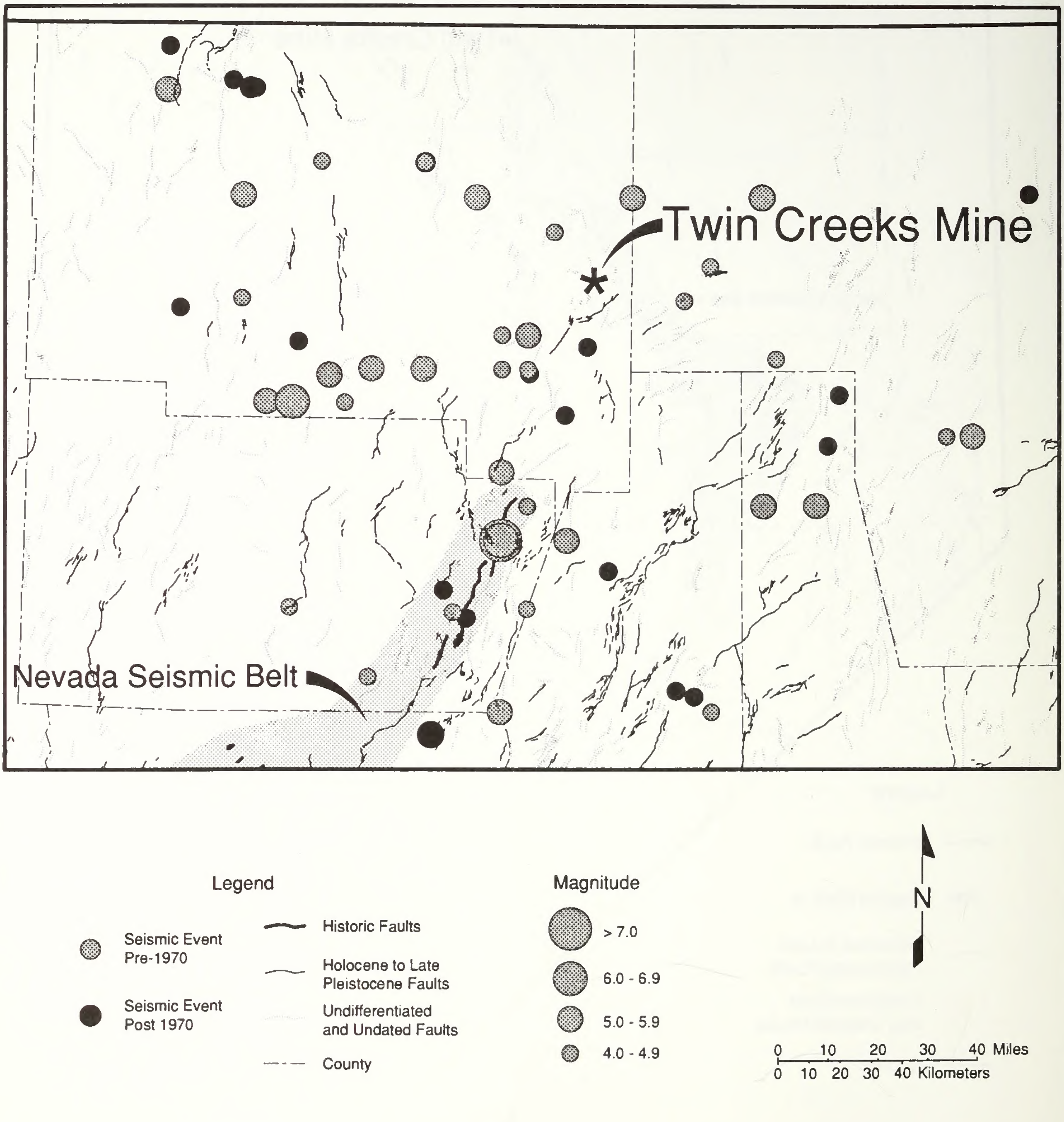


Source: Dohrenwend et al. 1995

Twin Creeks Mine

Figure 3-7

Quaternary Faults in Nevada



Source for Fault Traces: Dohrenwend et al. 1995
Source for Seismic Events: National Earthquake Information Center Data Base

Twin Creeks Mine

Figure 3-8

Seismic Events

TABLE 3-1
Recorded Earthquakes with Richter Magnitude of 5.0 or Greater and Located Within 60 Radial Miles of the Mine

Year	Month/Day	Location (latitude, longitude)	Approximate Distance from the Site (Miles)	Estimated Magnitude	Estimated Peak Bedrock Acceleration[1]
1916	10/3	40.5 -117.5	58	7.8	0.09
1916	2/3	41.5,-117.6	40	5.9	0.03
1916	8/3	41.5,-116.5	36	5.9	0.03
1916	8/4	41.5,-117.0	40	5.0	0.09
1916	10/11	41.5,-116.5	36	5.0	0.01
1941	8/29	41.0,-118.0	50	5.9	0.01
1916	9/18	40.6,-116.5	58	5.1	0.01
1946	1/15	40.5,-117.3	55	5.1	0.01
1961	7/4	40.9,-118.4	57	5.4	0.01
1968	7/6	41.1 - 117.4	19	5.5	0.07

[1]Seismic Data from the National Earthquake Information Center Database.
Peak bedrock acceleration was estimated based on the plot by Idriss 1985.

recorded earthquake to affect the region was a 7.8 Richter Magnitude event located approximately 57 miles southwest of the mine within the Nevada Seismic Belt. The closest recorded earthquake of magnitude 5.0 or greater occurred in 1916, was located approximately 16 miles from the site, and measured 5.0 Richter Magnitude. No historic earthquake of 6.0 Richter Magnitude or greater has occurred within 30 miles of the site.

__Design Earthquakes__

A recently completed study for the Nevada Department of Transportation (Siddharthan et. al. 1993) used available information on active and potentially active faults and the seismic record to determine appropriate seismic design parameters. Factors that control the ground motion at a given site include (1) the size of the earthquake, (2) the distance from the earthquake to the site, (3) and subsurface conditions at the site that can amplify or dampen the bedrock motion. Based on a probabilistic approach, horizontal bedrock accelerations for the 10, 50, and 100 years of exposure period were determined. The acceleration values presented in ***Table 3-2*** represent values that have a 10 percent probability of exceedance (90 percent probability that these acceleration values would not be exceeded) within the exposure period. Over the 50- and 100-year periods, the maximum probable earthquake would result in estimated peak horizontal bedrock accelerations of 0.16 times the force of gravity and 0.22 times the force of gravity, respectively. Critical mine facilities, such as tailings embankments, are commonly designed to withstand the largest probable earthquake that may affect the site during mine operation and the reclamation period. For design of critical facilities, the operational basis event is considered to be the maximum probable event that would occur within a 50- or 100-year period.

TABLE 3-2
Estimated Peak Acceleration Associated with the Maximum Credible Earthquake and Probabilistic Earthquakes for the Project Area

Design Earthquakes	Estimated Peak Horizontal Ground Acceleration[1]
Probability of 10% Exceedance in 10 yrs.	0.06 times the force of gravity
Probability of 10% Exceedance in 50 yrs.	0.16 times the force of gravity
Probability of 10% Exceedance in 100 yrs.	0.22 times the force of gravity
Maximum Credible Earthquake	0.48 times the force of gravity

[1]Siddharthan et. al. 1993.

The maximum credible earthquake is defined as the largest event considered possible under the current tectonic setting that would produce the highest horizontal acceleration. The maximum credible earthquake for the project site (***Table 3-2***) would produce an estimated maximum acceleration of 0.48 times the force of gravity at the site. Critical facilities, such as tailings embankments, should be designed to prevent excessive deformation or collapse under this estimated maximum seismic loading.

3.1.2 Environmental Consequences

Major issues related to geology and minerals include (1) geologic hazards created or exacerbated by project development, (2) failure of or damage to critical facilities caused by seismically-induced ground shaking, and (3) exclusion of future mineral resource availability caused by the placement of facilities (tailings, heap leach piles, overburden and interburden storage areas). Potential impacts associated with acid generation from sulfide-bearing rock are addressed separately in Section 3.2, Water Quantity and Quality.

Environmental impacts to geology and minerals would be significant if the Proposed Action, No Action alternative, or other project alternatives result in any of the following:

- Impacts to the facility site or design caused by geologic hazards, including landslides, debris flows, ground subsidence, and active fault rupture
- Structural damage or failure of a facility caused by seismic loading from design earthquakes
- Restriction of future extraction of other known mineral resources because of facility location
- Alteration of the geologic terrain

3.1.2.1 No Action Alternative

Direct impacts of the No Action alternative on geologic and mineral resources would include (1) the generation and permanent disposal of approximately 44.5 million tons of tailings material, 691.7 million tons of overburden and interburden material, and 72.2 million tons of spent heap leach material; (2) the permanent alteration of the geologic terrain and disturbance of an additional 3,136 acres on both private and public lands; and (3) the mining of approximately 5.7 million ounces of gold reserves from the South Pit and 0.8 million ounces of gold from the Vista Pit.

<u>Geologic Hazards</u>

There are no known active or potentially active faults or landslides in the vicinity of the No Action alternative facilities. Therefore, the risk of facility damage from fault rupture or landslide is not anticipated. The risk associated with possible erosion or damage to project facilities during flooding events is addressed in Section 3.2, Water Quantity and Quality. Given the depth of ground water throughout the project site, liquefaction of the foundation substrate beneath the facilities is not anticipated during seismic events.

Dewatering-Induced Surface Subsidence. The mine would pump from a series of dewatering wells to progressively lower the elevation of the ground water table to below the bottom of the pit as mining advances. The predicted magnitude and extent of ground water drawdown in the region surrounding the mine are addressed in Section 3.2. Dewatering would lower water levels in both fractured bedrock and the basin sediments. As mine dewatering lowers the ground water levels and water is expelled from the basin fill sediment, the load born by the sediment (known as the effective stress) would increase and tend to compact the sediment, causing subsidence of the ground surface.

Subsidence induced by ground water withdrawal is common in valleys in the western United States where ground water levels are lowered by ground water extraction and the valleys are filled with unconsolidated to poorly consolidated alluvial and lacustrine sediments (Poland 1984). The sedimentary sequence in these basins typically consists of aquifers (sand or sand and gravel beds) separated by aquitards (fine-grained compressible interbeds). Since the aquitards are highly compressible compared to the coarser-grained beds, they determine (by their number and thickness in the sequence) the susceptibility and magnitude of subsidence that could occur in response to lowering ground water levels (Poland 1984).

Potential subsidence induced by dewatering resulting from the No Action alternative was estimated using a finite difference subsidence model. The general approach, methodology, geomechanical unit description, and model results are described in a report by Itasca (1996). In summary, the method of analysis included (1) defining the physical characteristics and distribution of potentially compressible geologic materials, (2) defining the initial water pressures and ground water levels and the stress on the various materials, (3) estimating the change in water pressure and water levels resulting from mine dewatering, and (4) estimating compaction and resultant surface subsidence resulting from dewatering using a finite-difference model (Itasca 1996).

The predicted subsidence resulting from dewatering under the No Action alternative is presented in ***Figure 3-9.*** The subsidence analysis indicates that the maximum subsidence would be less than 4 feet and would occur on the east and southwest sides of the South Pit. The area affected by 1 foot or greater subsidence is predicted to extend up to 1 mile (5,000 feet) from the pit perimeter.The subsidence is predicted to cause the surface around the pit to lower gradually. However, based on the available information, it is not possible to determine if ground water withdrawal could result in discontinuous subsidence (i.e., abrupt changes in the surface) (Itasca 1996). Discontinuous subsidence could break the ground surface and potentially damage solution-bearing facilities, such as leach pads, process ponds, and tailings facilities. Other potential problems associated with dewatering-induced subsidence include:

- Changes in elevation and gradient of channels, drains, pipes, and other water- or solution-transporting structures

- Development of high shear strains in a soil or synthetic liner or an earthen embankment resulting in seepage or breach of containment

- Reduction in pond freeboard and storage allocations

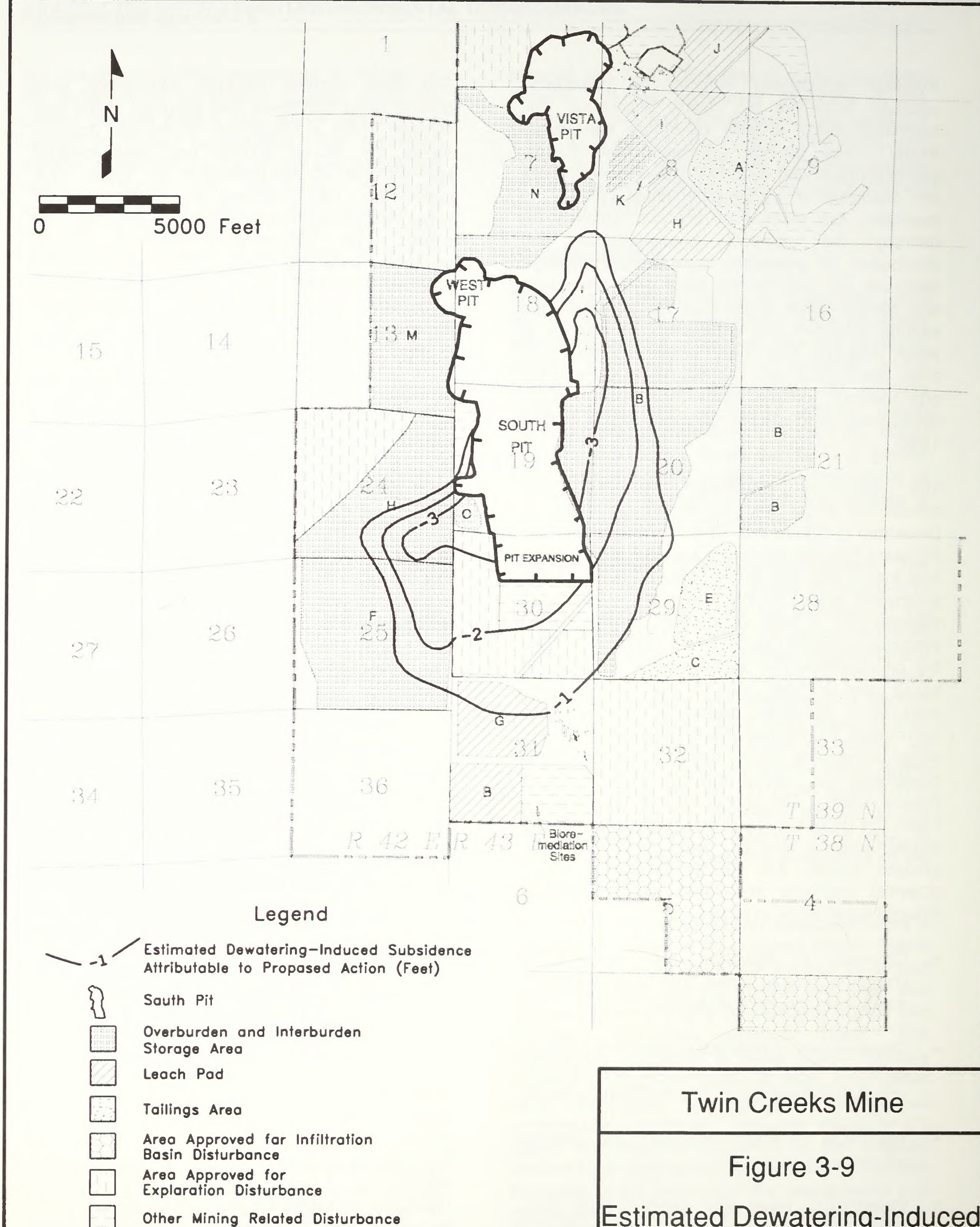
- Damage to water well casings from compressive stresses generated by compaction of the alluvial sequence

The most extreme reported subsidence from ground water withdrawal has occurred in the San Joaquin Valley in California. In the San Joaquin Valley, the ground surface has been lowered approximately 30 feet (Ireland et. al., 1984). This subsidence has resulted in problems with water transporting characteristics of channels and altered levee requirements and has caused irrigation wells to fail. However, ground breakage caused by localized discontinous settlement or damage to other engineering structures or facilities has not been reported (Poland 1984).

As shown in ***Figure 3-9*** for the No Action alternative, the area enclosed by the 1-foot ground subsidence contour would encompass the northern portion of leach pad G and several overburden and interburden storage areas. WESTEC (1996b) performed an evaluation of the potential effects of dewatering-induced subsidence to leach pad G and solution ponds associated with this facility. The results of WESTEC's analysis indicate that the amount of settlement predicted would not adversely affect liner integrity, the drainage system, or freeboard design criteria for the ponds (WESTEC 1996b). However, the overburden and interburden storage facilities would experience up to approximately 4 feet of ground water-induced subsidence. This subsidence is predicted to increase the gradient of the surface locally up to approximately 0.17 percent. This minor increase in gradient should have negligible impacts on the short- and long-term stability of project facilities.

The predicted dewatering-induced subsidence for the No Action alternative could potentially affect other planned facilities. However, assuming that all future process facilities are designed to accommodate the predicted dewatering-induced subsidence, the subsidence is not anticipated to result in significant impacts.

It is possible that subsidence could damage water diversion structures and water supply wells. However, the diversion structures and all non-SFPG water supply wells are located a considerable distance from the area that would be affected by 1 foot or more of subsidence. Therefore, no significant damage to surface water diversion structures or to non-SFPG water supply wells is anticipated.



Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-9

Estimated Dewatering-Induced Subsidence at End of Mining (No Action Alternative)

Geotechnical Considerations

The primary geotechnical issues considered in this evaluation are the potential for slope instability, liquefaction, or settlement to damage the primary process and storage facilities during both operational and postclosure periods. Depending on the timing, geotechnical problems could release chemicals into the environment, injure or cause loss of life to workers, or inhibit the success of reclamation efforts.

The geotechnical stability of these facilities is a function of the facility design and construction quality control. As part of the engineering design, the probability of failure of a project component is expressed as the calculated factor of safety. Factors of safety greater than 1 imply that the facility is strong enough to support the designed loads, while factors of safety less than 1 imply that the facility could experience some failure. A factor of safety of exactly 1 implies that the facility is exactly strong enough to support the intended loads without failure. The higher the calculated factors of safety, the more certain the stability of the design. To account for uncertainties regarding the soil parameters, fluid pressures, and seismic loads, these facilities are commonly designed with factors of safety that are greater than 1.

Tailings and Tailings Embankment Stability. A description of the tailings facilities expansion under the No Action alternative is provided in Section 2.3.6. Under the No Action alternative, tailings area A would be expanded, tailings area C would be constructed, and additional tailings would be placed within the boundaries of the existing tailings area E. At the time of this impact evaluation, geotechnical design information was available for the tailings area A expansion (Knight Piesold, Inc. 1992) but not for tailings areas C or E.

The general design components within the tailings area A expansion include a low-permeability soil underliner, an earthen dam to retain tailings, an underseepage collection system over the liner to minimize hydrostatic buildup, and a decant system to collect and transport ponded fluids. Results of the stability analysis indicated that at completion the facility would have factors of safety above 1 for the considered failure scenarios. The analysis also indicated that during seismic loading (from a moderate earthquake that could likely occur in the region) the factor of safety would range from 1.1 to 1.3. Therefore, the embankment should withstand a moderate earthquake that could occur during operations or the postclosure/reclamation period. In addition, the analysis indicated that because of the underdrain system, liquefaction of the tailings material was unlikely. Even if the tailings were saturated and experienced liquefaction, the slope stability analysis indicated that the embankment would remain stable (Knight Piesold, Inc. 1992).

Overburden and Interburden Storage Area Stability. Knight Piesold and Company (1993) conducted analyses of various overburden and interburden storage area configurations at the Twin Creeks Mine. In these analyses, representative storage area sections were analyzed for both static and pseudostatic (seismic loading) conditions. The stability analysis indicated that the overall operational and postreclamation slope configuration for the overburden and interburden storage areas should be stable even during anticipated seismic events. During operation, localized surface sloughing of the angle of repose slopes could occur from seismic events or periods of unusually high precipitation. However, because of the localized and surficial nature of this type of sloughing, the structural integrity of the storage facilities should not be affected.

Heap Leach Pads. The additional heap leach facilities would be operated similarly to existing leaching facilities at the Twin Creeks Mine. Slope stability determinations and the degree of settlement for the additional heaps were based on an analysis performed by WESTEC (WESTEC 1994n; SFPG 1995a). The results of the stability analysis indicated that the configuration of the heaps should be stable during both static and pseudo-static (seismic loading) conditions. Settlement would occur beneath the heap leach facility; however, it would not be great enough to impair the integrity of the high-density polyethylene liner (WESTEC 1994n).

Pit Slopes. Open pit mines commonly experience periodic slope instability problems because of weak geologic materials; adversely oriented geologic structures, such as bedding, faults, and jointing; and the presence of groundwater. It is assumed that the potential for these types of slope stability conditions would continue to exist with the expansion of the South Pit under the No Action alternative. However, ongoing data collection and analysis, including detailed pit mapping, slope monitoring, and ground water monitoring, as well as the use of controlled blasting techniques, should minimize the potential risk to mine workers during operation.

Stabilization of the pit walls is not proposed as part of reclamation or closure. After some period of weathering, it is likely that portions of the pit walls would eventually experience some degree of slope failure. Typical slope failures that occur in steep rock cuts of this nature include rock falls, toppling, and localized block slides. Progressive slope failure through time would tend to expand the perimeter of the pit and reduce the overall angle of the pit slopes. There is the potential for damage to portions of overburden and interburden storage areas situated within close proximity to the final pit rim (such as storage areas B, O, H, M, and N) associated with future slope instability of the pit walls. Damage or failure of a portion of these storage areas would be considered a significant impact.

Mineral Resources

Existing geologic information and condemnation drilling results for each facility were reviewed to evaluate if placement of the No Action alternative facilities could potentially conceal known or inferred mineral resources. The existing information indicates that with respect to public lands, continued mine expansion would not inhibit future attempts to recover minerals.

3.1.2.2 Proposed Action

Direct impacts of the Proposed Action on geologic and mineral resources would include (1) the generation and permanent disposal of approximately 131.5 million tons of tailings material, 1,731.8 million tons of overburden and interburden material, and 135.0 million tons of spent heap leach material, (2) the permanent alteration of the landscape and disturbance of an additional 5,217 acres of alluvial fan on both private and public lands, and (3) the mining of proven and probable ore reserves of approximately 11.7 million ounces of gold and a possible additional 4.1 million ounces of gold.

Geologic Hazards

There are no known active or potentially active faults or landslides in the vicinity of the Proposed Action facilities. Therefore, as with the No Action alternative, the risk of facility damage caused by fault rupture or landsliding would not be anticipated under the Proposed Action. The risks associated with possible erosion or damage to project facilities during flooding events are addressed in Section 3.2, Water Quantity and Quality.

Dewatering-Induced Surface Subsidence. The magnitude of dewatering-induced subsidence resulting from the Proposed Action was estimated using a finite difference subsidence model. The general approach, methodology, geomechanical unit description, and model results are described in a report by Itasca (1996) and summarized previously for the No Action alternative.

The predicted subsidence resulting from dewatering under the Proposed Action is presented in ***Figure 3-10***. The subsidence analysis indicates that 4 to 6 feet of subsidence could occur around the perimeter of the pit by the end of mining. The maximum subsidence is predicted to occur on the east and southwest sides of the South Pit. The area affected by 1 foot or greater subsidence is predicted to extend approximately 1.4 miles (7,100 feet) from the pit perimeter.

The subsidence is predicted to lower the surface around the pit gradually. However, based on the available information, it is not possible to determine if ground water withdrawal could result in discontinuous subsidence (Itasca 1996). Discontinuous subsidence could break the ground surface and potentially damage solution bearing facilities. Any substantial discontinuous subsidence and ground breakage beneath process or solution facilities that could potentially damage the fluid containment would be considered a significant impact.

For the Proposed Action, the area enclosed by the 1-foot ground subsidence contour would encompasses the existing leach pad G and tailings area E facilities, and several overburden and interburden storage facilities. Other proposed solution-bearing facilities would also be within the 1-foot ground subsidence contour.

WESTEC (1996b) performed an evaluation of the potential effects of the predicted dewatering-induced subsidence on leach pad G and tailings area E. For leach pad G, the predicted dewatering-induced subsidence would range from less than 1 foot (along the southern margin) to over 5 feet (along the northern margin). The north half of the pad drains to the north, and the south half of the

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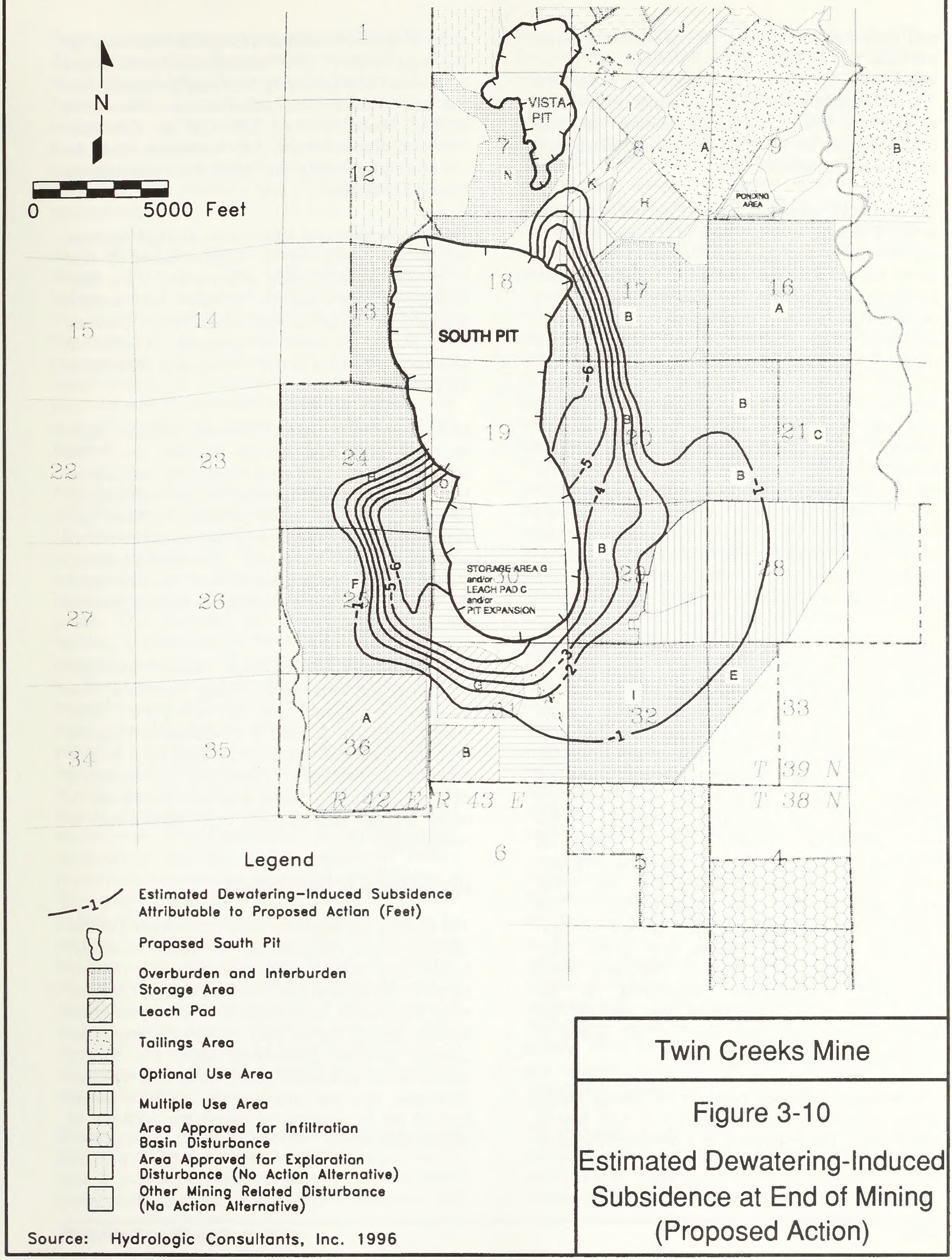


Twin Creeks Mine

Figure 3-10

Estimated Dewatering-Induced Subsidence at End of Mining (Proposed Action) pad drains to the south. This subsidence would increase the gradient along the north half of the leach pad up to approximately 0.25 percent. Therefore, for the north half of the pad, this change in gradient would favorably increase the flow characteristics for both the solution collection and leak detection systems.

The predicted subsidence would decrease the flow gradient along the south side of the pad by up to approximately 0.17 percent; the drainage system along the south side of the pad was designed assuming a minimum 0.5 percent grade. The dewatering-induced subsidence, along with settlement from loading of the facility, would reduce the drainage gradient to approximately 0.6_ percent. However, this gradient would be greater than the 0.5 percent design criteria and should not adversely affect the drainage design (WESTEC 1996b). The predicted subsidence would not affect the stability of the liner or drainage system of the solution ponds associated with the leach pad. The subsidence would diminish the allotted freeboard of the ponds from approximately 2 feet to 1 foot. However, the remaining 1 foot of freeboard would still be sufficient to prevent the ponds from overtopping (WESTEC 1996b).

Existing tailings facility E is predicted to experience dewatering-induced subsidence of approximately 1.5 feet along the east side and 2 feet along the west side. This subsidence would result in a slight increase in the surface gradient of up to 0.02 percent toward the pit. This subsidence should not affect the liner system, gravity drainage system, pipeline leading to and from the impoundment, or structural integrity of the dam (WESTEC 1996b). As a result of total settlement, the crest of the west embankment would be approximately 0.5 foot lower than that of the east embankment. The current dam permit from the Nevada Division of Water Resources requires that SFPG main tain a minimum of 3 feet of freeboard along the west embankment. Depending on the actual amount of subsidence that occurs, the west embankment may need to be raised to meet the permit stipulations.

The seepage collection pond for the tailings facility would experience approximately 2 to 2.25 feet of settlement. The estimated 0.1 percent change in surface gradient should not affect the liner or drainage system. The west embank-ment would be lowered approximately 0.25 foot compared with the east embankment, which would diminish the allotted freeboard from 2.25 feet to 1.75 feet. However, the remaining 1.75 freeboard would be sufficient to prevent the pond from overtopping (WESTEC 1996b).

The overburden and interburden storage facilities would experience up to approximately 6 feet of ground water-induced subsidence. The subsidence is predicted to increase the surface gradient locally up to approximately 0.4 percent. This minor increase in gradient should not adversely affect the short- or long-term stability of these facilities.

In addition, other solution-bearing facilities, such as leach pads and tailings facilities, would be constructed within the area affected by subsidence resulting from the Proposed Action dewatering. Assuming that all future process facilities are designed to accommodate the combined effects of settlement and predicted dewatering-induced subsidence, the total subsidence is not anticipated to result in significant impacts to other proposed process facilities.

Subsidence could damage water diversion structures and water supply wells. However, the diversion structures and all non-SFPG water supply wells are located a considerable distance from the area that would be affected by 1 foot or more of subsidence. Therefore, no significant damage to surface water diversion structures or water supply well casings from subsidence is anticipated.

Geotechnical Considerations

The primary geotechnical issues considered in this evaluation are the potential for slope instability, liquefaction, or settlement to damage the primary process and storage facilities (i.e., tailings facilities, heap leach pads, and overburden and interburden storage areas) during both operations and post-closure periods. Depending upon the timing, geotechnical problems could potentially release chemicals into the environment, injure or cause loss of life to workers, or inhibit the success of reclamation efforts.

Tailings and Tailings Embankment Stability. A description of the tailings facilities expansion under the Proposed Action is provided in Section 2.4.4.3. Tailings area A would be expanded toward the northeast to accommodate an additional 25 million tons, and tailings areas B and D would be constructed, as needed, to provide storage for an additional 50 million and 56 million tons, respectively.

At the time of this impact evaluation, geotechnical design information was only available for the tailings area A expansion (Knight Piesold 1994a). The general design components included within the tailings area A expansion include a low permeability soil underliner, an earthen dam to retain tailings, an underseepage collection system over the liner to minimize hydrostatic buildup, and a decant system to collect and transport ponded fluids.

Key factors to consider with respect to the safety of tailings embankment dams are (1) the potential for overtopping caused by infrequent floods, and (2) the stability of the embankments during earthquake events. Any failure of the embankment could potentially release tailings to downstream areas. The potential risk of dam failure from flooding is addressed in Section 3.2.2. The risk of embankment failure caused by earthquake loading is generally evaluated by considering slope instability and deformation that could potentially occur from the design earthquake. Because of the potential for the release of contaminates, tailings facilities should be designed to remain functional during an Operational Basis Earthquake and should resist failure during the Maximum Credible Earthquake. The Operational Basis Earthquake depends on the life of the project; for mining projects, it is commonly an earthquake that has a 10 percent probability of exceedance in a 50-year period. The risk of embankment failure caused by seismic loading was not determined for the tailings facilities under the Proposed Action. In addition, the static design and potential for failure caused by liquefaction were not evaluated for tailings areas B and D, since these facilities have not been designed. Failure of any of these facilities because of an inadequate design would be a significant geologic impact.

Overburden and Interburden Storage Area Stability. With the exception of storage area D, and a portion of storage area B as discussed below, the proposed design of the overburden and interburden storage areas are the same as for the No Action alternative. Therefore, the impacts associated with the design of these storage areas would be the same as for the No Action alternative discussed in Section 3.1.2.1. The stability analysis indicated that for these facilities, operations and postreclamation slope configuration should be stable even during anticipated seismic events. During operation, localized surface sloughing of the angle of repose slopes could occur; however, sloughing should not affect the structural integrity of the storage facilities.

As shown on ***Figure 2-4***, storage area D and a portion of storage area B would be constructed over tailings facilities in Section 28 and the east half of Section 29 (Township 39 North, Range 43 East). Since the tailings would be placed as a hydraulic fill, this material would be weaker than the partly consolidated alluvium that provides the foundation for the other storage areas. In addition, even with the tailings underdrain system, it is conceivable that some of the tailings could be saturated and, therefore, might be susceptible to liquefaction during an earthquake. Also, it would probably not be feasible to construct the overburden and interburden storage facility until the tailings facility, underdrain, and solution ponds were successfully closed and decommissioned. Therefore, the design, including geotechnical stability, seismic design, liquefaction of the substrate, settlement and deformation issues, and decommissioning of the tailings prior to construction, has not been evaluated. Improper design, construction, and facility closure could result in slope failure and damage to the underlying tailings containment structure and could cause significant geologic impacts.

Heap Leach Pads. The impacts associated with the design of the leach pad areas are the same as for the No Action alternative discussed in Section 3.1.2.1. The results of the stability analysis indicated that the configuration of the heaps should be stable during both static and pseudo-static (seismic loading) conditions. Settlement would occur beneath the heap leach facility, but it would not be great enough to impair the integrity of the high-density polyethylene liner (WESTEC 1994n).

Pit Slopes. Most open pit mines experience periodic slope instability ranging from bench sloughing to large-scale slope movement. Slope instability is caused by weak geologic materials;

adversely orientated geologic structures, such as bedding, faults, and jointing; and the presence of groundwater. The overall slope heights would range from approximately 1,200 to 1,400 feet in the northern lobe to 1,000 feet in the southern lobe. Compared with the No Action alternative, the overall slope height would increase by approximately 200 to 400 feet in the north lobe and 300 feet in the south lobe. In addition, the expansion of the South Pit under the Proposed Action would significantly increase the amount of slope area compared to the No Action alternative.

The performance of the slopes during operation and postclosure would depend on the geologic conditions encountered and the pit slope design. Assuming that similar geologic materials are encountered as the pit expands and that the pit slope angles are consistent, the risk of slope instability would tend to increase as the overall slope height and amount of slope area increases between the No Action alternative and the Proposed Action pits. Thus, it is likely that expanding the South Pit under the Proposed Action could potentially increase slope instability problems compared to the No Action alternative pit. However, ongoing data collection and analysis, including detailed pit mapping, slope monitoring, ground water monitoring, as well as controlled blasting techniques should minimize the potential risk to mine workers during operation.

As with the No Action alternative, stabilization of the pit walls is not proposed as part of reclamation or closure. After some period of weathering, it is likely that portions of the pit walls would eventually experience some degree of slope failure. Typical slope failures that occur in steep rock cuts of this nature include rock falls, toppling, and localized block slides. Progressive slope failure through time would tend to expand the perimeter of the pit and reduce the overall angle of the pit slopes.

Several existing and proposed facilities are situated within close proximity to the final pit rim, including overburden and interburden storage areas B, F, G, H, L, N, and M, and leach pads C, F and G. Depending on the location and extent of slope failure and the actual location of the final pit rim, there is a potential for future slope instability of the pit walls to damage facilities during both the operation and postclosure periods. Damage or failure of a portion of the overburden and interburden facilities or leach pads resulting from failure of the pit slopes would be considered a significant impact.

Mineral Resources

Existing geologic information and condemnation drilling results were reviewed to evaluate if placement of the Proposed Action facilities could potentially conceal known or inferred mineral resources. The existing condemnation results indicate that the placement of leach pad E and/or storage area K (Section 8, Township 39 North, Range 43 East) and storage area G and/or leach pad C (Section 30, Township 39 North, Range 43 East) would cover identified economic gold mineralization amenable to open-pit extraction. Therefore, construction of these facilities as planned would potentially inhibit future attempts to recover these mineral resources on public lands, resulting in a significant impact to mineral resources. Other proposed facilities on public lands are located in areas where there is no known mineralization or where the mineralization is sufficiently deep and low-grade as to be non-economic.

3.1.2.3 Partial Vista Pit Backfill Alternative

This alternative would modify the Proposed Action to include the placement of approximately 3.7 million tons of overburden and interburden as partial backfill of the west-central portion of the Vista Pit. This would represent approximately 0.2 percent of the total overburden and interburden material generated by mining under the Proposed Action, and would not reduce the total area of disturbance needed for overburden and interburden storage areas. Placement of the fill would reduce the overall height of the high wall from approximately 250 feet to 230 feet. This slight reduction in slope height and placement of fill at the toe of the slope could potentially increase the long-term stability of the pit slopes adjacent to the backfill. All other geology and mineral impacts would be the same as for the Proposed Action.

3.1.2.4 Selective Handling of Overburden and Interburden Alternative

Potential impacts associated with the selective handling of overburden and interburden alternative would be the same as those described for the Proposed Action.

3.1.2.5 Overburden and Interburden Storage Area Reclamation Alternatives

This alternative consists of two similar optional configurations that would involve rounding the corners of the storage area to reduce visual impacts following reclamation. Alternative 1 would have the same footprint as the Proposed Action; hence, the geology and minerals impacts would be the same as with the Proposed Action. Alternative 2 would involve more rounding of the corners and would require an additional 200 acres of disturbance. This increase represents an approximately 7.3 percent increase in the area required for the storage facilities, and a 3.7 percent increase in the total area of disturbance of alluvial fan areas as compared to the Proposed Action.

3.1.3 Cumulative Impacts

Surface mining activity affects geology and mineral resources by excavating, modifying, or covering natural topographic and geomorphic features and by removing mineral deposits. The study area for the cumulative impact analysis for geology and mineral resources includes the four identified mines within the Getchell Mineral Trend: the Twin Creeks, Getchell, Pinson, and Preble Mines. This mining district is described in Section 2.6.1, Past, Present, and Reasonably Foreseeable Future Actions; their locations and approximate aerial extents are shown in ***Figure 2-13***.

Mining disturbance in the area has included exploration (drilling, trenching, sampling, and road construction), open pit and underground mining, overburden and interburden storage, heap leaching, ore milling and processing, and tailings disposal. Production in these areas has included gold, tungsten, and a few workings in barite, copper, and manganese.

Prior to 1981, mine reclamation was not required. Historic aerial photographs indicate that the Getchell and Pinson Mines constituted the bulk of the pre-1981 mine disturbance, while the Preble and Twin Creeks Mines were not affected by mining or mineral processing activities. The total area affected by mining prior to 1981 is estimated at 1,293 acres (excluding exploration disturbance). By December 1994, the area affected by mining activity increased to an estimated 8,039 total acres. This represents an increase of 6,746 acres between 1981 and December 31, 1994. The No Action alternative would create approximately 3,136 acres of new disturbance, increasing the total geologic and surface disturbance by 39 percent to 11,175 acres. The Proposed Action would create an additional 5,217 acres of additional disturbance, increasing the total geologic and surface disturbance another 47 percent to approximately 16,392 acres.

Because gold mining is a major activity in this area, it is reasonable to assume that large-scale mining would continue and would result in the creation or expansion of open pits, overburden and interburden storage areas, heap leach pads, and tailings facilities. The amount of additional disturbance that may occur at other mines or by further expansion of the Twin Creeks Mine is unknown at this time. However, considering the current level of activity in the district, it is reasonably foreseeable that in addition to the Proposed Action, the mining in this area could expand the acreage of disturbance by another 25 to 50 percent within the next decade.

3.1.4 Monitoring and Mitigation Measures

Potential impacts to geology and minerals would be minimized by the following proposed mitigation measures.

GM-1: All tailings facilities, heap leach pads, and overburden and interburden storage areas would be designed, constructed, and maintained in a stable manner during both the operation and postmining periods. Stability analyses would be performed to demonstrate that all proposed tailings facilities would remain functional after the passage of an Operational Basis Earthquake, and would not fail catastrophically or release tailings or fluids during a Maximum Credible Earthquake. The minimum factors of safety for all slope designs would be determined as part of the permits and approvals granted by the Nevada Division of Environmental Protection, Nevada Department of Water Resources, Dam Safety Division, and the BLM.

GM-2: A monitoring program would be established to continually monitor land subsidence and identify discontinuous subsidence features in the vicinity of solution-bearing facilities. The number and location of monitoring devices (such as periodic leveling surveys and remote-reading horizontal extensometers) should be determine based on site conditions as determined by the design geotechnical engineer. Periodic monitoring of total settlement and local discontinuous subsidence should continue until all facilities containing process solution are decommissioned. In the unlikely event that significant discontinuous settlement is identified that could potentially cause damage to the liner or the drainage and containment system, a remedial design would be developed and the facility would be repaired or modified as necessary to reduce the potential for solution release. All facilities containing process solutions, such as tailings facilities, heap leach pads, and solution containment ponds, would be designed to prevent failure of the liner or drainage system from the combined effects of settlement and dewatering-induced subsidence. The freeboard for all existing and future ponds and containment structures would be designed to maintain adequate capacity to prevent overtopping should the maximum potential subsidence occur. In addition, the west embankment for tailings area E would be raised with additional lifts as necessary to maintain a minimum 3-foot freeboard on the west embankment as required under the current dam permit from the Nevada Division of Water Resources.

GM-3: Geotechnical evaluations would be performed for overburden and interburden storage area D and a portion of storage area B that would be constructed over tailings facilities in Section 28 and the eastern half of Section 29 (Township 39 North, Range 43 East). The purpose of the geotechnical evaluation would be to demonstrate that the facilities would be stable during normal conditions and design earthquake events, and that deformation from consolidation and liquefaction would not compromise the integrity of the facilities during the operations and postclosure periods. In addition, overburden and interburden material would not be placed on the tailings until seepage from the tailings underdrain ceases and the tailings facility, underdrain, and collection ponds are properly decommissioned as approved by the Nevada Division of Environmental Protection and Nevada Department of Water Resources, Dam Safety Division.

GM-4: The potential for damage to existing and proposed facilities from pit slope failures would be minimized by conducting geotechnical investigations and slope stability analyses to determine an appropriate setback distance for each existing or proposed facility. In determining the design setback distance for these facilities, potential failures that could occur during both the operational and postclosure periods should be considered. Options to preclude impacts to existing or proposed facilities from future pit slope failures include modifying the final pit rim location or adjusting the facility location to provide an adequate setback distance. If potentially unforeseen adverse geologic conditions are exposed in the pit wall as mining progresses, the final setback distance of any potentially affected facility would be modified as necessary to reduce the potential for damage during the operation and postclosure periods.

GM-5: The existing condemnation results indicate that the placement of leach pad E and/or storage area K (Section 8, Township 39 North, Range 43 East) and storage area G and/or leach pad C (Section 30, Township 39 North, Range 43 East) would cover identified gold mineralization that could probably be mined at a profit. Therefore, the footprint for these facilities would be modified or the facility would be moved to avoid covering or otherwise precluding future surface attempts to recover known or suspected economic mineral resources on public lands.

3.1.5 Residual Adverse Effects

Residual adverse effects associated with the Proposed Action would include the mining and processing of approximately 11.7 million ounces of gold; generation and permanent disposal of approximately 2 billion tons of alluvium and bedrock as tailings, overburden and interburden, and heap leach material; and the disturbance of approximately 5,217 acres of alluvial fan. Under the Proposed Action, these direct impacts would not be mitigated.

3.2 Water Resources

3.2.1 Affected Environment

3.2.1.1 Hydrologic Setting

The Twin Creeks Mine is located within the Humboldt River Basin in north-central Nevada. The hydrologic study area (***Figure 3-11***) covers approximately 645 square miles and includes portions of Eden Valley, the Osgood Mountains, Kelly Creek Basin, and the Snowstorm Mountains. The hydrologic study area is bounded by the Little Humboldt River on the north, the South Fork of the Little Humboldt River on the east, Evans Creek and the Humboldt River on the south, and the crest of the Osgood Mountains and Eden Creek on the west. The elevation ranges from approximately 8,680 feet above mean sea level (in the Osgood Mountains to 4,350 feet above mean sea level along the Humboldt River. All tributaries in the hydrologic study area drain into three subbasins designated as the Little Humboldt Basin, Kelly Creek Basin, and Clovers Basin (***Figure 3-11***). Streams in the Little Humboldt Basin drain to the Little Humboldt River, a tributary to the Humboldt River; whereas streams in the Kelly Creek Basin and Clovers Basin drain to the Humboldt River mainstem.

Precipitation in the form of rain and snow is the source of water for stream flow and provides recharge for the ground water flow system. The average annual precipitation varies widely but generally increases with altitude from the valley floor to the mountain crests. Precipitation data from seven stations were analyzed by HCI (1996) to develop a relationship between precipitation and altitude for north-central Nevada. Based on this relationship, the mean annual precipitation is estimated to range from approximately 7 inches in the lowest elevation areas to 25 inches in the highest elevation areas. Discontinuous precipitation data for the Twin Creeks Mine for 1987 through 1995 indicate the annual precipitation ranged from approximately 9 to 12 inches per year (WESTEC 1993a; SFPG 1995a).

Flooding may occur from rapid snowmelt in the spring or from intense summer thunderstorms. Snowmelt can result in sizable volumes of runoff and high flood stages over large areas. In contrast, flash floods from thunderstorms are generally confined to smaller areas.

Evaporation from a free water surface (such as a shallow lake) is estimated at 40 to 45 inches per year, with 30 to 35 inches evaporating between May and October (National Oceanic and Atmospheric Administration 1982; Houghton et. al. 1975).

3.2.1.2 Surface Water

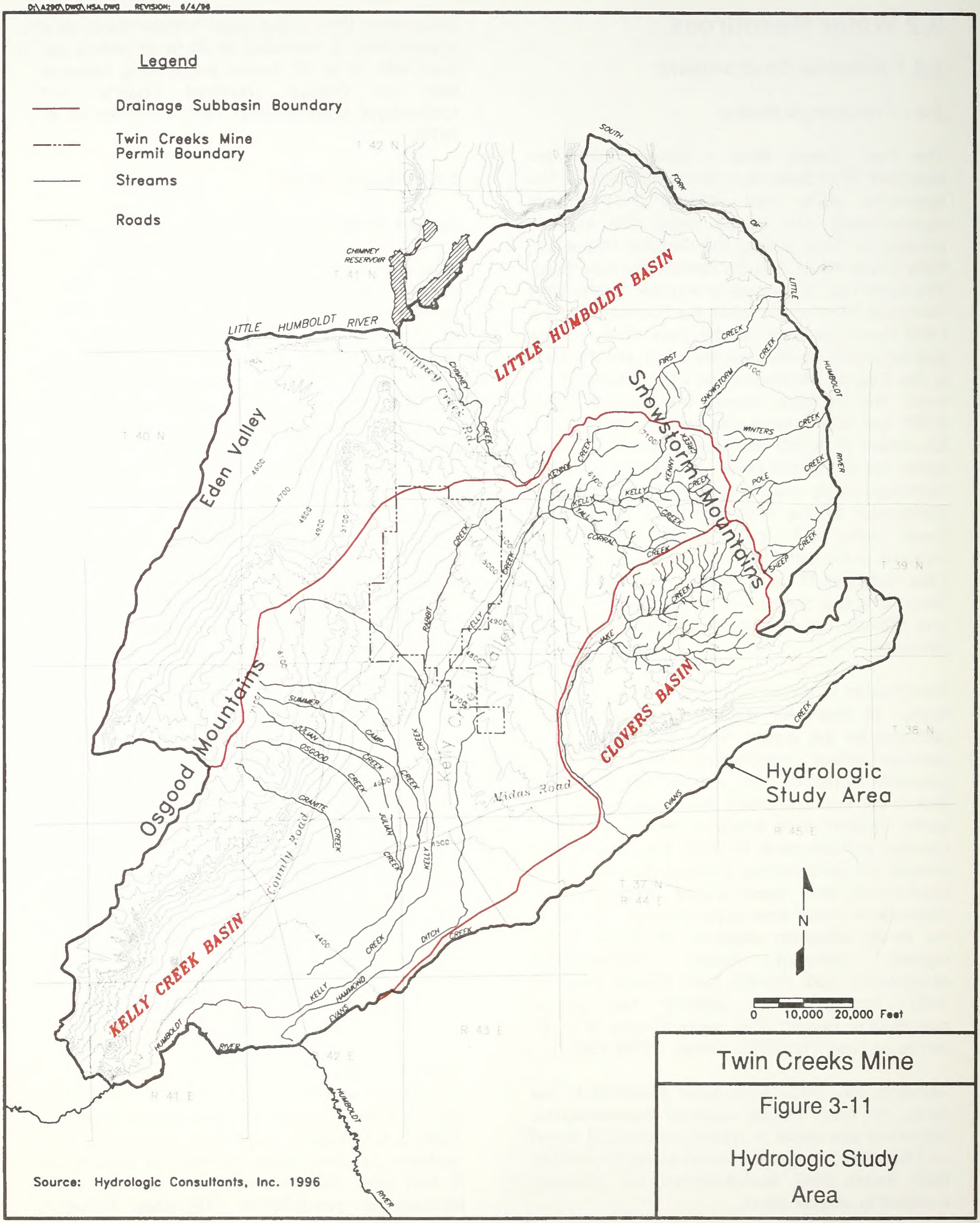
<u>Surface Water Flows</u>

Tributaries originating in the hydrologic study area join the mainstem of the Humboldt River along the reach between the U.S. Geological Survey stream gage at Comus on the east and the town of Winnemucca on the west (***Figure 3-12***). The river is perennial throughout the reach within the hydrologic study area, but flows are highly variable and nearly cease during some low flow periods. Low flow or baseflow conditions typically occur in October and November, apparently in response to seasonal precipitation minimums near the end of summer and early fall (HCI 1996).

Major regional tributaries to the Humboldt River mainstem include Kelly Creek and the Little Humboldt River (Nevada Department of Conservation and Natural Resources and U. S. Department of Agriculture 1962 and 1964). Almost all surface runoff from the project area originates within the Kelly Creek watershed, which occupies approximately 501 square miles at its outlet to the Humboldt River. Ground water inflows contribute to spring and channel flows in both the Kelly Creek and Little Humboldt River drainages during part of the year. Typically, almost no surface flow from these subwatersheds reaches the main course of the Humboldt River because of infiltration and recharge of regional ground water systems and high evapotranspiration losses.

Hydrologic baseline information has been collected in the study area since March 1994 by WESTEC (WESTEC 1995b, 1995c). Water quality samples were collected and analyzed at both channel sites and springs.

Surface water monitoring stations (including springs) are shown in ***Figure 3-13***. Results of the surface water measurement program are shown in ***Table 3-3***. The table is organized by channel, from upstream to downstream. Substantial differences in flow rates can be seen from 1994 to 1995 because of precipitation differences between

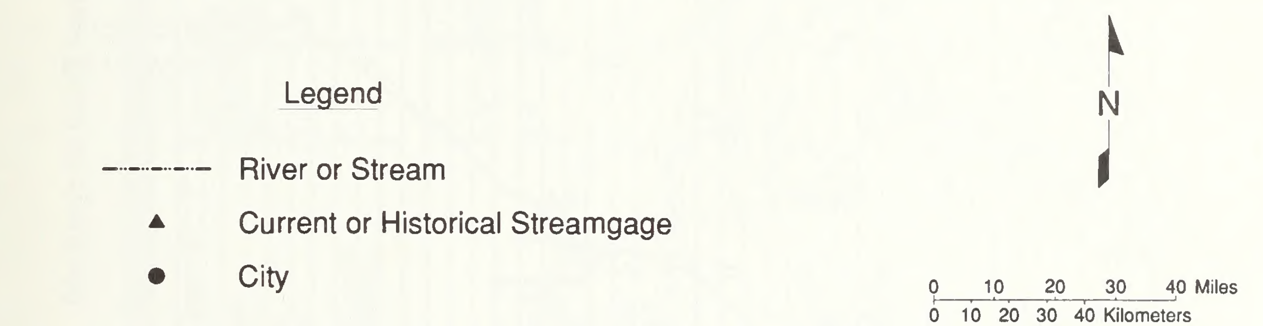


Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-11

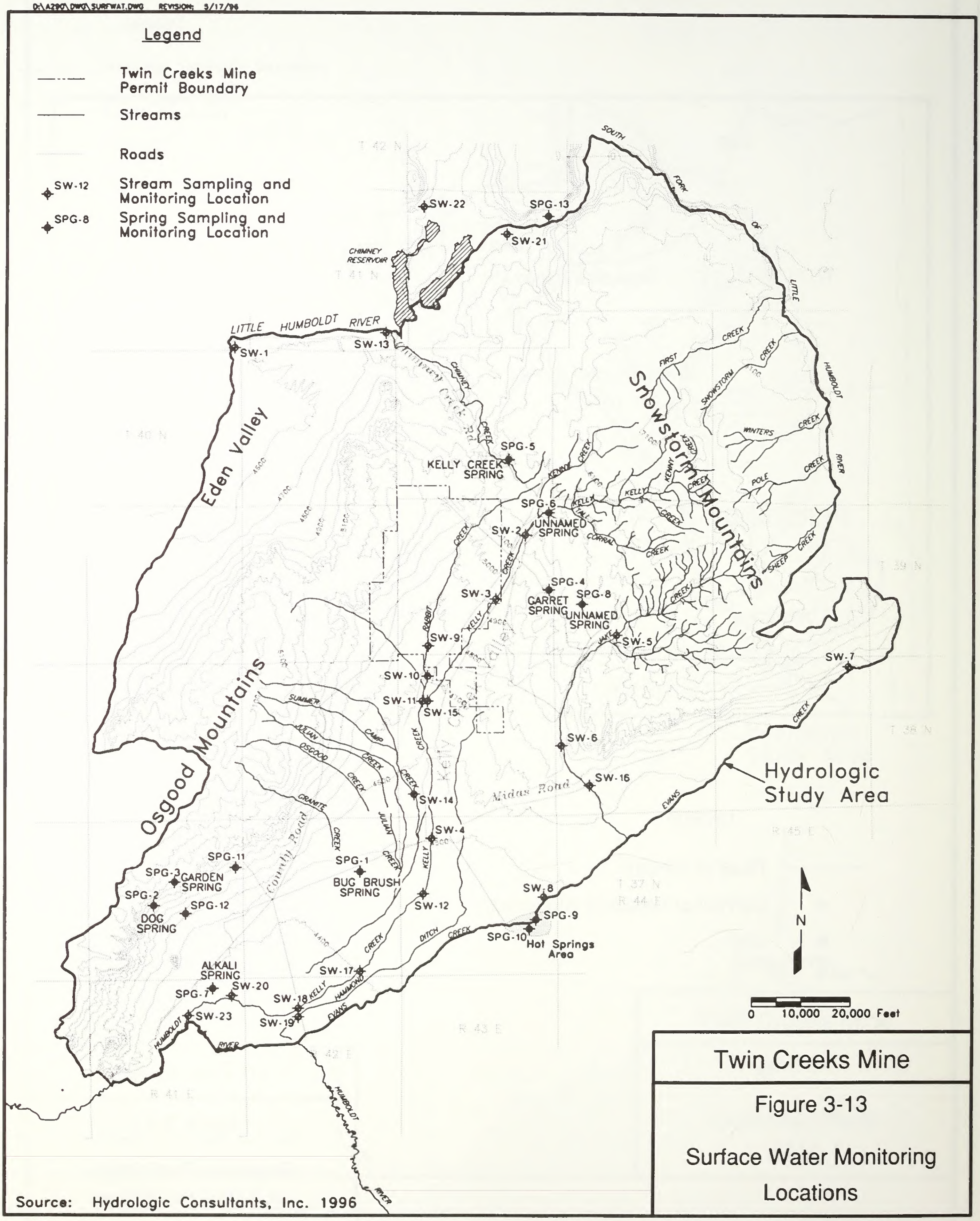
Hydrologic Study Area



Twin Creeks Mine

Figure 3-12

Regional Drainages and Stream Gages



Twin Creeks Mine

Figure 3-13

Surface Water Monitoring Locations

TABLE 3-3
Twin Creeks Flow Monitoring
Discharge (in Cubic Feet Per Second) Upstream to Downstream on Each Sub-Drainage

Sample #	Sample Site	~3/8/94	~3/24/94	~4/1/94	~4/14/94	~4/27/94	~5/9/94	~5/23/94	~6/6/94	~6/20/94	~9/20/94	~11/28/94	~2/15/95	~2/24/95
KELLY CREEK														
SW-24	Above Kelly Cr. Ranch													
SW-2	Kelly Creek Ranch	0.31	0.29	[2]	0.275	0.275	0.263	0.335	0.275	0.240	DRY	[2]	[2]	3.413
SW-3	Corral S. of Kelly Cr. Ranch	<0.08	<0.08	[2]	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	DRY	[2]	FROZEN	0.167
SW-15	Kelly Cr. above Rabbit Cr.	DRY	DRY	[2]	DRY	DRY	DRY	DRY	DRY	DRY	DRY	[2]	DRY	DRY
SW-4	Kelly Creek at Midas Rd.	[1,2]	[2]	[2]	[2]	0.791	1.032	0.967	0.414	DRY	DRY	FROZEN	0.948	2.868
SW-12	Kelly Cr. at Dudley Ranch	0.15	0.14	[2]	0.15	0.087	0.132	0.190	0.102	<0.08	DRY	FROZEN	1.753	2.377
SW-17	Kelly Cr. at Tank Rd.	[2]	[2]	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
SW-18	Kelly Cr. div. ditch-Red House Rd.	[2]	[2]	NO FLOW	NO FLOW	NO FLOW	NO FLOW	DRY	DRY	DRY	NO FLOW	[2]	NO FLOW	NO FLOW
SW-20	Evans/Kelly above Humboldt Riv.	[2]	[2]	[2]	[2]	[2]	DRY	DRY	DRY	DRY	DRY	NO FLOW	DRY	DRY
SW-23	Kelly Cr. AB Humboldt													
RABBIT CREEK														
SW-9	Rabbit Creek Culvert	[1,2]	[2]	[2]	[2]	[2]	0.164	1.063	0.097	0.099	7.229	[1,2]	4.034	11.342
SW-10	Rabbit Creek Culvert	[1,2]	[2]	[2]	[2]	[2]	0.280	0.319	2.474	0.177	2.755	6.460	3.541	8.528
SW-11	Rabbit Creek Flume	3.16	3.19	[2]	3.46	2.540	2.085	2.850	2.330	1.987	1.750	[2]	1.840	6.724
JAKE CREEK														
SW-5	Jake Cr.-Hammond Ranch	0.29	0.33	[2]	0.33	0.336	0.387	0.568	0.374	0.311	<0.08	[2]	[2]	3.589
SW-6	Jake Cr.-S. of Desmond Ranch	[1,2]	[2]	[2]	[2]	0.287	0.263	0.240	<0.240	<0.240	DRY	[2]	4.789	5.572
SW-16	Jake Creek at Midas Rd.	[1,2]	[2]	[2]	[2]	3.19	4.384	5.105	1.821	0.179	DRY	FROZEN	4.122	5.598
EVANS CREEK														
SW-7	Evans Creek Above Jake Cr.	[1,2]	[2]	[2]	[2]	0.988	2.309	1.101	0.973	0.299	0.210	[2]	3.418	1.908
SW-8	Evans Cr. at Hot Spr. Rnch	[2]	[2]	[2]	[2]	[2]	DRY	DRY	DRY	DRY	DRY	[2]	FROZEN	DRY
SW-19	Hammond Ditch-Evans Cr. at Red House Rd.	[2]	[2]	[2]	[2]	0.447	NO FLOW	FLOW	FLOW	DRY	NO FLOW[1]	[2]	0.377	1.738
OTHER CREEKS														
SW-1	Eden Creek	DRY	[2]	[2]	[2]	[2]	DRY	DRY	DRY	DRY	DRY	[2]	FROZEN	NO FLOW
SW-13	Chimney Cr. Reservoir	[1,2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[1,2]	[1,2]	[1,2]	[2]	[2]
SW-14	Summer Camp Creek	DRY	DRY	[2]	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
SW-21	Spring Creek													
SW-22	N. Fk Little Humboldt													
SPRINGS														
SPG-1	Bug Brush Spring	DRY	[2]	[2]	[2]	[2]	[2]	[2]	[2]	DRY	DRY	[2]		
SPG-2	Dog Spring	0.003	[2]	[2]	[2]	[2]	[2]	[2]	[2]	0.003	0.003	[2]		
SPG-3	Garden Spring	[2]	[2]	0.009	[2]	[2]	[2]	[2]	[2]	0.010	0.009	[2]		
SPG-4	Garret Spring	<0.08	[2]	[2]	[2]	[2]	[2]	[2]	[2]	<0.08	<0.08	[1,2]		
SPG-5	Kelly Creek Spring	0.001	[2]	[2]	[2]	[2]	[2]	[2]	[2]	~0[1]	~0	~0[1]		
SPG-6	North of Kelly Cr. Ranch	DRY	[2]	[2]	[2]	[2]	[2]	[2]	[2]	DRY	DRY	[2]		
SPG-7	Allsell Spring	<0.08	[2]	[2]	[2]	[2]	[2]	[2]	[2]	<0.08	<0.08	0.060		
SPG-8	NW of Hammond Ranch	0.001	[2]	[2]	[2]	[2]	[2]	[2]	[2]	~0[1]	~0	~0[1]		
SPG-9	East of Hot Springs Ranch	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	4.267	4.054	[2]		
SPG-10	East of Hot Springs Ranch	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]		
SPG-11	Pinson Spring (Christison)	[2]	[2]	0.005	[2]	[2]	[2]	[2]	[2]	0.006	0.004	[2]		
SPG-12	Corral Spring (Christison)	[2]	[2]	0.001	[2]	[2]	[2]	[2]	[2]	0.001	0.004	[2]		
SPG-13	Layton Spring													

TABLE 3-3 (continued)
Twin Creeks Flow Monitoring
Discharge (in Cubic Feet Per Second) Upstream to Downstream on Each Sub-Drainage

Sample #	Sample Site	~3/3/95	~3/20/95	~4/4/95	~4/21/95	~5/5/95	~5/20/95	~6/2/95	~6/20/95	~7/1/95	~7/18/95	~7/29/95	~8/18/95	~11/15/95
KELLY CREEK														
SW-21	Above Kelly Cr. Ranch													0.734
SW-2	Kelly Creek Ranch	3.757	11.796	6.425	7.217	36.085	16.711	31.194	12.489	5.864	2.855	2.392	1.958	0.856
SW-9	Corral S. of Kelly Cr. Ranch	0.314	4.664	1.958	1.225	14.672	10.216	4.057	4.805	0.295	V.LOW	0.178	0.034	DRY
SW-16	Kelly Cr. above Rabbit Cr.	NO FLOW	10.030	5.436	6.587	24.426	44.588	26.413	11.309	2.449	0.470	DRY	DRY	DRY
SW-4	Kelly Creek at Midas Rd.	3.390	16.651	6.720	10.084	33.422	35.651	32.308	14.670	6.060	0.140	1.910	DRY	DRY
SW-12	Kelly Cr. at Dudley Ranch	2.688	13.203	5.577	9.553	30.080	31.194	33.422	13.447	5.839	DRY	DRY	DRY	DRY
SW-17	Kelly Cr. at Tank Rd.	NO FLOW	6.623	2.342	4.981	8.946	14.197	8.621	7.551	2.959	V. LOW	DRY	DRY	DRY
SW-18	Kelly Cr. div. ditch-Red House Rd.	[2]	[1,2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
SW-20	Evans/Kelly above Humboldt Riv.	NO FLOW	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
SW-23	Kelly Cr. AB Humboldt		4.078	0.295	[2]	[2]	0.333	3.342	[2]	[2]	[2]	[2]	0.041	DRY
RABBIT CREEK														
SW-9	Rabbit Creek Culvert	12.224	9.101	2.873	9.904	10.378	7.851	4.425	2.772	3.220	1.472	1.015	V. LOW	2.144
SW-10	Rabbit Creek Culvert	8.864	5.382	2.369	6.859	5.436	6.350	2.191	2.543	2.015	1.707	0.972	V.LOW	6.312
SW-18	Rabbit Creek Flume	6.992	7.484	1.840	5.573	1.950	5.233	2.438	2.330	0.990	1.635	0.661	0.815	0.036
JAKE CREEK														
SW-5	Jake Cr.-Hammond Ranch	3.976	12.848	6.518	8.016	[2]	41.757	33.074	20.398	14.212	8.592	5.783	2.858	1.077
SW-9	Jake Cr.-S. of Desmond Ranch	5.583	13.087	5.978	7.276	26.151	43.606	31.753	21.176	13.963	8.295	3.248	1.839	0.981
SW-16	Jake Creek at Midas Rd.	5.805	13.577	5.877	6.736	26.908	47.305	29.332	20.909	13.797	8.123	2.782	1.958	0.813
EVANS CREEK														
SW-7	Evans Creek Above Jake Cr.	2.303	4.763	4.078	5.627	6.977	14.203	13.667	5.938	11.581	8.633	7.022	4.337	0.677
SW-4	Evans Cr. at Hot Spr. Rnch	DRY	0.053	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	DRY	DRY	DRY	DRY
SW-19	Hammond Ditch-Evans Cr. at Red House Rd	2.199	4.573	2.811	3.577	5.133	2.669	4.981	FLOOD	DRY	DRY	DRY	DRY	DRY
OTHER CREEKS														
SW-4	Eden Creek	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	DRY	DRY	DRY	DRY
SW-13	Chimney Cr. Reservoir	[2]	[1,2]	[2]	[2]	[2]	[1,2]	[2]	[2]	[2]	[2]	[2]	[2]	[2]
SW-18	Summer Camp Creek	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	NO FLOW	DRY	DRY	DRY	DRY
SW-21	Spring Creek	1.240	0.080	0.023	[2]	[2]	[1,2]	NO FLOW	[2]	0.370	DRY	DRY	0.048	0.026
SW-22	N. Fk Little Humboldt	2.591	3.156	2.726	3.503	>16.71	44 (EST.)	44 (EST.)	[2]	[2]	[2]	[2]	[2]	[2]
SPRINGS														
SPG-1	Bug Brush Spring		DRY					DRY					DRY	DRY
SPG-2	Dog Spring		0.0029					0.0045					0.0026	0.003
SPG-3	Garden Spring		0.0078					0.0084					0.0109	0.0085
SPG-4	Garret Spring		<0.079					V. LOW					0.0240	0.0010
SPG-8	Kelly Creek Spring		0.0011					0.0013					V. LOW	0.0025
SPG-6	North of Kelly Cr. Ranch		DRY					DRY					DRY	DRY
SPG-7	Allsell Spring		0.056					V. LOW					0.0035	0.26
SPG-8	NW of Hammond Ranch		<0.0022					0.0017					0.0002	0.0007
SPG-9	East of Hot Springs Ranch		[1,2]					[1,2]					3.2200	?
SPG-10	East of Hot Springs Ranch		[2]					[2]						
SPG-11	Pinson Spring (Christison)		0.0049					0.0084					0.0050	0.005
SPG-12	Corral Spring (Christison)		0.0007					0.0026					0.0007	0.007
SPG-13	Layton Spring		0.0007					0.0014					0.0049	0.0071

[1]No flow records, but water quality sample taken.
[2]No flow data reported.
Sources: WESTEC 1995b, 1995c

the years. Most climatological stations in north-central Nevada reported below average precipitation for 1994 and above average precipitation for 1995 (NOAA 1994, 1995).

The general location of perennial stream reaches is shown in ***Figure 3-14A***. The location and extent of perennial stream reaches has been estimated based on measured flow data, vegetation data, fisheries studies, aerial photography and field observations (Drake, 1996). ***Figure 3-14A*** also shows the locations of spring discharge areas included in SFPG's surface water monitoring program. The locations of other possible perennial springs in the hydrologic study area are shown in ***Figure 3-14B***. The spring locations are based on information from USGS 7.5-minute quadrangle maps and available BLM spring inventory maps. The actual location and baseflow discharge of perennial springs that are not included in SFPG's surface water monitoring program have not been field verified. In addition, water quality data are not available for springs that are not included in SFPG's surface water monitoring program. As shown in ***Figure 3-14B***, the majority of the springs are located in higher elevation areas in the Snowstorm and Osgood Mountains.

Perennial reaches on Kelly Creek are believed to occur upstream of the SE1/4 Section 22, Township 39 North, Range 43 East, based on the occurrence of willows (HCI 1996). This is near surface water monitoring station SW-3 (***Figure 3-13***). Kelly Creek is intermittent downstream of this point.

Springs were also monitored in the Kelly Creek drainage. The most upstream spring monitoring station along the creek was SPG-6 (***Figure 3-13***); it was dry throughout the monitoring period. Bug Brush Spring was also dry throughout the monitoring period. Flow data recorded at other monitored springs in the Kelly Creek drainage are shown in ***Table 3-3***.

Jake Creek is identified as perennial above a point located in the SW1/4 Section 18, Township 38 North, Range 44 East, approximately 0.5 mile south of the Desmond Ranch (HCI 1996). The perennial reach may extend farther downstream, but Jake Creek becomes intermittent in this general locale. The monitoring program indicated that above station SW-6, Jake Creek is a losing stream (***Figure 3-13***). Based on 1994 data, Jake Creek is a gaining reach in the spring and early summer between SW-6 and SW-16 at Midas Road, but typically is a losing reach the rest of the year. There is only approximately 1 square mile of additional watershed between the latter two stations, and local runoff from this low-elevation area is not likely to contribute to significant flow differences between stations over an extended period.

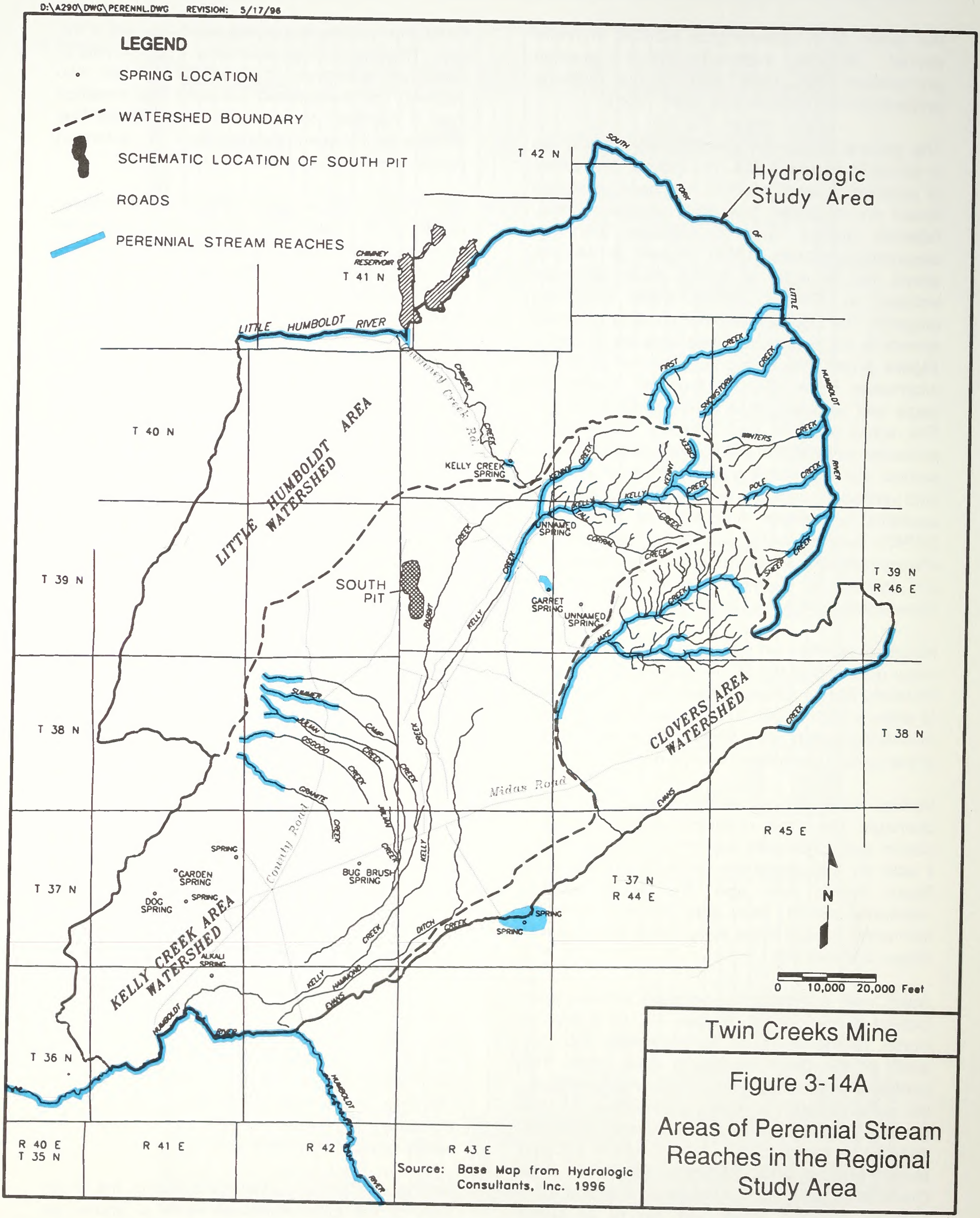
On U.S. Geological Survey topographic quadrangles, Evans Creek is perennial above the confluence with Jake Creek. This is corroborated by field data at monitoring station SW-7 (***Figure 3-13***). Data from monitoring station SW-8 imply that Evans Creek may be a losing reach nearer the Hot Springs Ranch, but surface flow losses from irrigation diversions below the confluence with Jake Creek are unknown. Evans Creek is shown on U.S. Geological Survey topographic quadrangles as a perennial stream above Hot Springs Ranch, with intermittent flows downstream of the ranch. However, 1994 monitoring data indicate that Evans Creek may become intermittent somewhere between Jake Creek and the monitoring station near the ranch (SW-8). Flow data collected at station SW-19 at the Hammond Ditch indicate that the ditch flows intermittently.

A spring (SPG-9) along Evans Creek in the Hot Springs area was included in the baseline monitoring program (***Figure 3-13, Table 3-3***). Flow was continuous at this station, although rates were low during most of the monitoring period. It is possible that springs in this area originate from deep-seated fracture systems or permeable faults (HCI 1996).

Flow data are not available for Eden Creek in the Little Humboldt watershed. Field observations indicate that the creek is typically dry immediately upstream of the confluence with the Little Humboldt River (HCI 1996). The occurrence of perennial reaches in the headwaters of Eden Creek is unknown.

Flow data are not available for Chimney Creek in the Little Humboldt watershed. The stream is shown as intermittent or ephemeral on U.S. Geological Survey mapping. Near the head of Chimney Creek, Kelly Creek Spring (SPG-5) was monitored; it flowed at low rates during the sampling program (***Table 3-3***).

Northeast of the Snowstorm Mountains, the South Fork of the Little Humboldt River is shown as



Twin Creeks Mine

Figure 3-14A

Areas of Perennial Stream Reaches in the Regional Study Area

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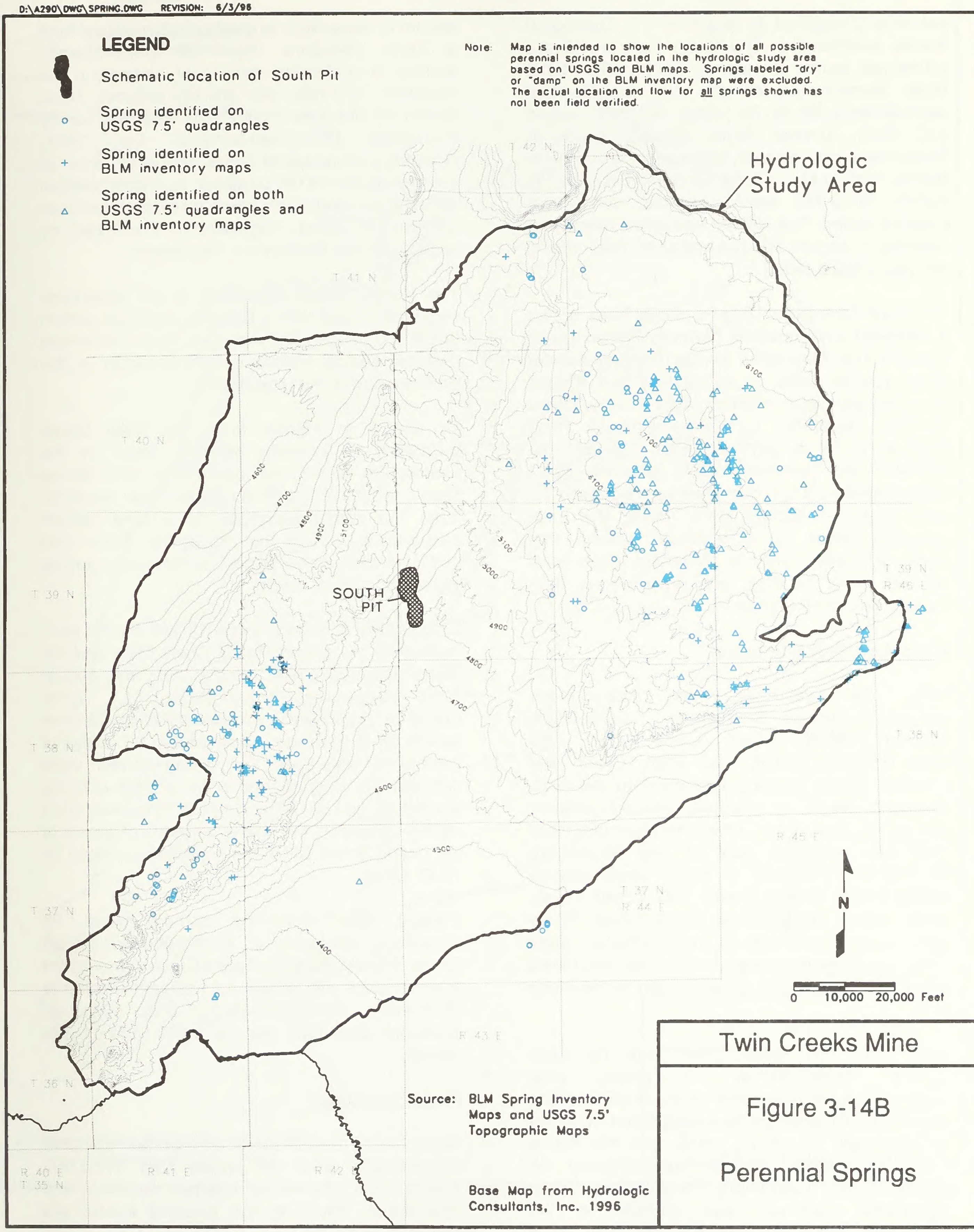


Twin Creeks Mine

Figure 3-14B

Perennial Springs

perennial throughout its length on U.S. Geological Survey quadrangles. The South Fork provides a substantial source of water for the Little Humboldt River. Recent data indicate flows ranging from approximately 62 to 0.0 cubic feet per second (HCI 1996). Lowest flows typically occur in September, and highest flows typically occur in March, April, or May. Along the South Fork, Layton Spring (SPG-13) was monitored during the baseline period. The highest springflow rates were reported in August and November of 1995 after a wet year (***Table 3-3***).

The North Fork of the Little Humboldt River is also a perennial stream above Chimney Reservoir, as shown in U.S. Geological Survey mapping. Lowest flows typically occur in September, and highest flows typically occur in March, April, or May. Below Chimney Reservoir, the Little Humboldt River appears to be a gaining stream between the reservoir and Paradise Valley. Historical flows have ranged from 170 cubic feet per second to 0.0 cubic feet per second (HCI 1996). The Little Humboldt River is a perennial stream that discharges from Chimney Reservoir. High flows typically occur in May, with lowest flows from August through November.

<u>**Watershed Characteristics**</u>

Within the hydrologic study area, major watersheds include Kelly Creek, Evans Creek draining south and west to the main Humboldt River, and Eden Creek and Chimney Creek draining northward to the Little Humboldt River. In addition, several streams drain to the South Fork of the Little Humboldt River from the northeast side of the Snowstorm Mountains. Tributaries of Kelly Creek include Rabbit Creek, Kenny Creek, Tall Corral Creek, Julian Creek, and Summer Camp Creek. Flows from Evans Creek and its major tributary, Jake Creek, are largely dispersed or diverted and mixed with Kelly Creek in the southern part of the study area.

Kelly Creek and Rabbit Creek form the major surface drainages in the project area (***Figure 3-15***). At their confluence just south of the project area, the Kelly Creek watershed occupies approximately 35 square miles, and the Rabbit Creek watershed occupies approximately 43 square miles. Topography ranges from steep mountains, canyons, and foothills in the Snowstorm Mountains and the Dry Hills, to a system of moderately to gently sloping alluvial fans at lower elevations. Soils are predominantly shallow to moderately deep over bedrock in the mountains and hills, with gravelly textures. Deep loamy and silty soils occur on the fans. Soil survey information (Stoneman-Landers, Inc. 1994) indicated that indurated layers frequently occur at shallow depths on fan positions, restricting vertical drainage and enhancing storm runoff potential (see Section 3.3, Soils). Vegetation is dominated by sagebrush (see Section 3.4, Vegetation).

The Rabbit Creek watershed is an ephemeral convergent basin with a dendritic drainage pattern (WESTEC 1995e). The mainstem is an entrenched channel. Deeply incised conditions occur in the southern part of the project area.

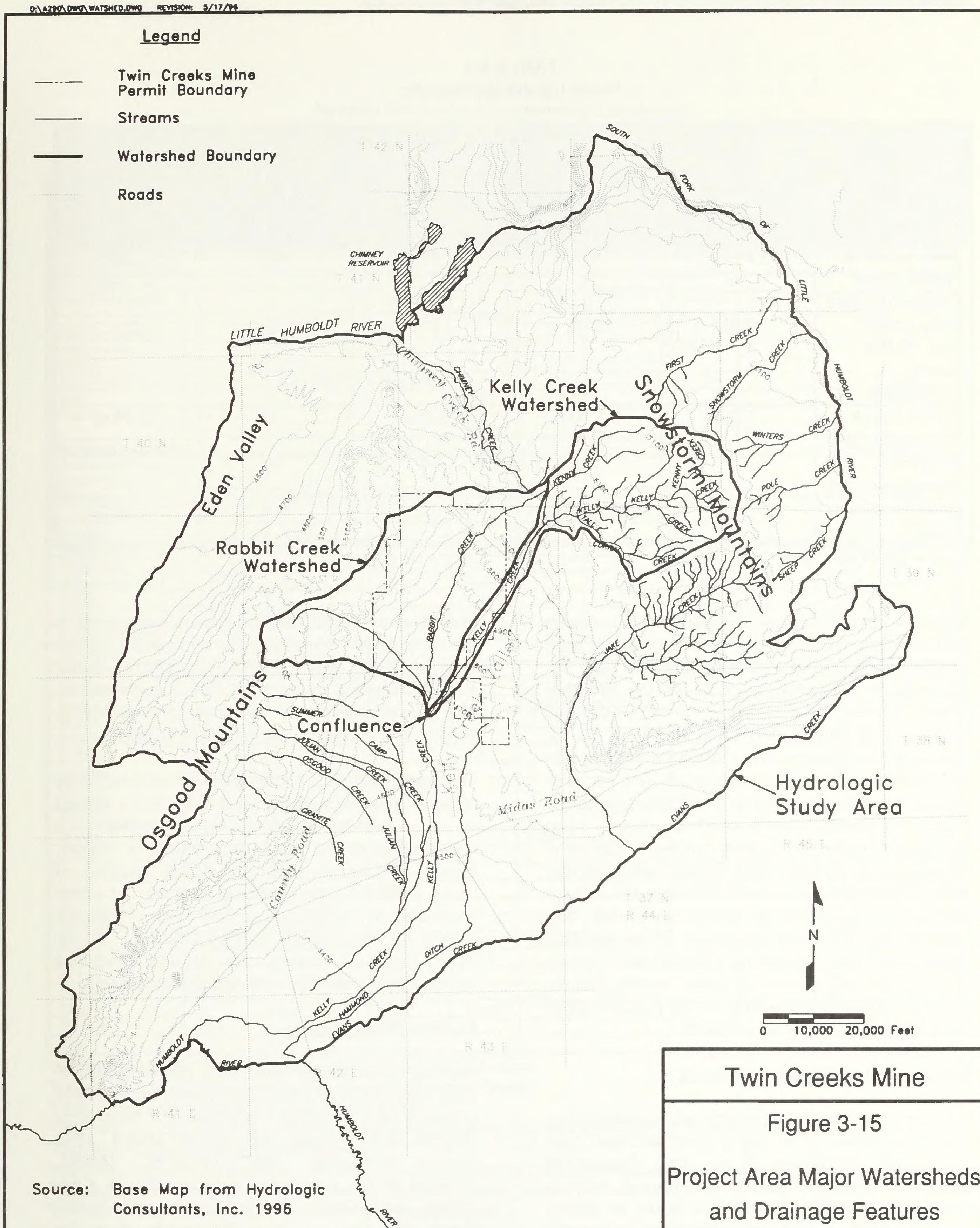
As shown in ***Figure 3-15***, the Kelly Creek watershed is a steep dendritic basin in the headwaters above the confluence with Kenny Creek (WESTEC 1995e). Below the mountain front, the basin converges to a long narrow conveyance section that transports water and sediment discharges without substantially adding watershed area or runoff.

Delineations of waters of the United States were verified for the former Rabbit Creek Mine and the former Chimney Creek Mine in July and August 1993, respectively. Subsequently, U.S. Army Corps of Engineers Nationwide Permit 26 was issued for both mines. An additional 8.7 acres of ephemeral waters of the United States were delineated in 1995 and are in the process of being verified by the U.S. Army Corps of Engineers (RCI 1995b). If verified, the total occurrence of waters of the United States within the project area would be 15.57 acres.

Treated water from the current South Pit dewatering operation is discharged to Rabbit Creek. The discharge to Rabbit Creek is monitored in accordance with a National Pollutant Discharge Elimination System permit. The maximum allowable discharge rate is 5,000 gallons per minute.

<u>**Flood Hydrology**</u>

Storm events were modeled at important points of concentration within the project area (WESTEC 1995e). The recurrence interval, duration, and precipitation inputs for the modeled events are shown in ***Table 3-4***.



Twin Creeks Mine

Figure 3-15

Project Area Major Watersheds and Drainage Features

Source: Base Map from Hydrologic Consultants, Inc. 1996

TABLE 3-4
Flood Hydrology Results

Summary of Peak Flows (cubic feet per second)					
Point of Concentration	**100-Yr 24-Hr (2.4 inches precipitation)**	**100-Yr 6-Hr (1.4 inches precipitation)**	**100-Yr 1-Hr (1.0 inch precipitation)**	**10-Yr 24-Hr (1.6 inches precipitation)**	**2-Yr 24-Hr (1.0 inch precipitation)**
Kelly Creek at Rabbit Creek Diversion outfall	1,644	411	70	406	36
Kelly Creek near Rabbit Creek confluence	1,280	270	27	294	25
Rabbit Creek Diversion outfall	173	10	No Flow	16	No Flow
Far West Diversion outfall	878	189	56	25	30
West Diversion outfall	590	155	102	205	32

Source: WESTEC 1995e.

Standard rainfall versus time distribution curves were used as inputs to the various events. Precipitation inputs (***Table 3-4***) were identified from the Precipitation - Frequency Atlas of the Western United States, Volume VII - Nevada (National Oceanic and Atmospheric Administration 1973). Runoff curve numbers, times of concentration, and flow routing parameters were developed for site-specific conditions according to industry standards. These parameters were used as inputs to a curvilinear unit hydrograph model, Technical Reference 20 (TR-20) (Soil Conservation Service 1982) to estimate peak flow rates from the various events. The results, as shown in ***Table 3-4,*** indicate that the peak discharge at all modeled points would be caused by the 100-year (return period), 24-hour (storm duration) event. Shorter duration thunderstorm events would produce lower peak flows than the 24-hour events.

Surface Water Quality Standards

Surface water quality standards are established by the State of Nevada for designated beneficial uses associated with waters of the state. Designated beneficial uses are defined in Nevada Administrative Code 445A.122, and are listed, as appropriate, in ***Table 3-5***. Waters of the State of Nevada are defined in the Nevada Revised Statutes, Chapter 445, Section 445.191, "Waters of the State Defined," and include, but are not limited to (1) all streams, lakes, ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation systems, and drainage systems; and (2) all bodies of accumulations of water, surface and underground, natural or artificial.

The water quality of all designated beneficial uses of water must be suitable for a use without relying on a treatment mechanism, except for municipal/domestic supply and industrial supply. Municipal/domestic supply must be capable of being treated by conventional methods of water treatment in order to comply with Nevada's maximum contaminant levels. Industrial supply water must be treatable to provide a quality suitable for the specific intended industrial use.

Surface Water Quality

Surface water quality data in the hydrologic study area have been characterized based on samples collected from 20 stream locations and 10 springs (***Figure 3-13***) during the period March 1994 through November 1995 (WESTEC 1995b). Streams in the monitoring network include Kelly Creek, Jake Creek, Evans Creek, and Rabbit Creek. Selected water quality results from the sampling events are presented in ***Table A-1*** (see Appendix A).

TABLE 3-5
Nevada Maximum Contaminant Levels and Water Quality Criteria for Designated Beneficial Uses

Constituent (mg/L[8])	Nevada Drinking Water Standards MCL		Municipal or Domestic Supply	Aquatic Life			Propagation of Wildlife	Water Contact Recreation	Irrigation	Watering of Livestock
	Primary	Secondary		Single Sample Limit	1-hour Average	96-hour Average				
Physical Properties										
Temperature (°C)										
Dissolved Oxygen			Aerobic	(5.0-6.0)(a)			Aerobic	Aerobic		Aerobic
Color (color units)		15[1]	75							
Alkalinity (as $CaCO_3$)				(b)			30-130			
TDS (@180°C)		500[1]; 1000[2]	500; 1000							3000
TSS				25-80						
Turbidity (NTU)	0.5			50(w) 10(c)						
Inorganic Nonmetals										
Ammonia unionized (Total NH_3 as N)			0.5	0.02(c)						
Chloride		250[1]; 400[2]	250; 400				1500			1500
Cyanide (as CN)	0.2		0.2		0.022	0.0052				
Fluoride	4.0	2.0[3]							1.0	
Nitrate (as N)	10		10	90(w)			100			100
Nitrite (as N)	1.0		1.0	0.06			10			10
pH (standard units)		(6.5-8.5)[1]	5.0-9.0	6.5-9.0			7.0-9.2	6.5-8.3	4.5-9.0	5.0-9.0
Sulfide				0.002						
Sulfate		250[1]; 500[2]								
Metals[7]/Elements										
Aluminum		(0.05-0.2)[3]								
Antimony	0.006		0.146							
Arsenic (total)	0.05		0.05						0.10	0.20
Arsenic (III)					0.342[5]	0.180[5]				
Barium	2.0		1.0							
Beryllium	0.004								0.10	
Boron				0.55			5.0		0.75	5.0
Cadmium	0.005		0.01		[6]	[6]			0.01	0.05
Chromium (total)	0.1		0.05						0.10	1.0
Chromium (III)					[6]	[6]				
Chromium (VI)					0.015[5]	0.010[5]				
Copper	1.3		11.0		[6]	[6]			0.20	0.50
Iron		0.3[1]		1.0					5.0	
Lead	0.015		0.05		[6]	[6]			5.0	0.10
Magnesium		125[1], 150[2]								
Manganese		0.05[1]; 0.1[2]							0.20	
Mercury	0.002		0.002		0.0020[5]	0.000012[5]				0.01
Molybdenum				0.019						
Nickel	0.1		0.0134		[6]	[6]			0.20	
Selenium	0.05		0.01		0.02	0.005			0.02	0.05
Silver		0.1[3]	0.05	0.0035[5,6]						
Thallium	0.002		0.13							
Zinc		5.0[3]			[6]	[6]			2.0	25

[1]Nevada Secondary recommended maximum contaminant levels.
[2]Nevada Secondary (Enforceable) maximum contaminant levels.
[3]Federal Secondary maximum contaminant levels.
[4]One-hour average and 96-hour average concentration limits may be exceeded only once every 3 years.
[5]Standard applies to the dissolved fraction.
[6]Hardness dependent parameter, site specific determination, see Nevada Administrative Code 445A.144.
[7]The standards for metals are expressed as total recoverable, unless otherwise noted.
[8]Units are milligrams per liter (mg/L) unless otherwise noted.
a = Site specific; b = Less than 25 percent change from natural conditions; w = propagation of warm water aquatic life only; c = propagation of cold water aquatic life only; TDS = total dissolved solids; TSS = total suspended solids.
Source: Nevada Administrative Code 445A.119 and 445A.144.

Stream and spring waters in the project area are primarily calcium/sodium bicarbonate type waters (***Figure 3-16***), with some exceptions. Rabbit Creek, near the Twin Creeks Mine, consists of treated mine water discharge and contains higher proportions of magnesium and sulfate than the other surface waters. Kelly Creek and Evans Creek are calcium/sodium bicarbonate type waters in the upgradient reaches but change to sodium/calcium bicarbonate type waters in the downgradient reaches. The change in water type in the downstream reaches is caused in part by the addition of flow from Alkali Spring to Kelly Creek and the Hot Springs discharge to Evans Creek. which consists of sodium bicarbonate type water. Samples taken from downgradient reaches of Kelly Creek and from Evans Creek contain higher total dissolved solids and sodium concentrations than samples collected farther upstream.

The total dissolved solids concentration of stream waters ranges from approximately 50 to 470 milligrams per liter, and shows a general increase with distance downstream. The total dissolved solids concentrations of all streams and springs, with the exception of SPG-7, are below the secondary standard of 500 milligrams per liter (***Table 3-5***). Spring SPG-7 contains a total dissolved solids concentration of approximately 1,500 milligrams per liter.

During the sampling period, the concentrations of constituents in the stream and surface waters in the study area did not exceed water quality standards, with the exception of pH, alkalinity, arsenic, fluoride, iron, phosphorous and manganese (***Table A-1***; Appendix A).

Elevated concentrations of antimony, arsenic, fluoride, iron, and manganese are not unusual for waters in mineralized or geothermal areas. For example, geothermal waters can contain arsenic concentrations of approximately 4 to 15 milligrams per liter (Hem 1985; Welsh et al. 1988). Arsenic concentrations in ground water in mineralized areas have been shown to reach 32 milligrams per liter (Welsh et al. 1988), and natural concentrations of fluoride up to 32 milligrams per liter are reported by Hem (1985) for ground waters from Arizona, Nevada, and Florida. The elevated arsenic and fluoride concentrations detected in the study area are generally associated with natural springs and can be assumed to be naturally occurring.

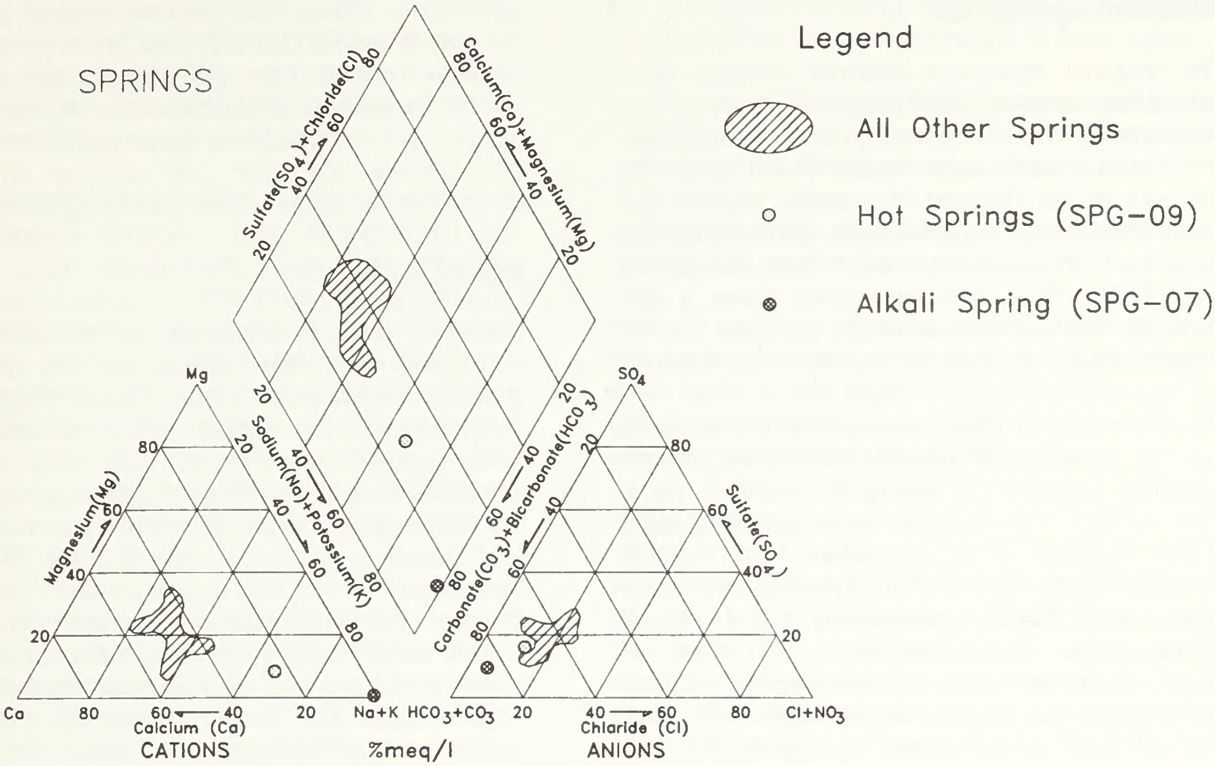
Analytical results for treated discharge to Rabbit Creek and the reinfiltration basins are summarized in ***Tables A-3*** and ***A-4*** (Appendix A). Constituent concentrations in treated discharge do not exceed permit limitations with the exception of isolated exceedances of arsenic, iron, total dissolved solids, and turbidity (***Tables A-3*** and ***A-4***; Appendix A). These exceedances resulted primarily from upset conditions in the operation of the water treatment plant.

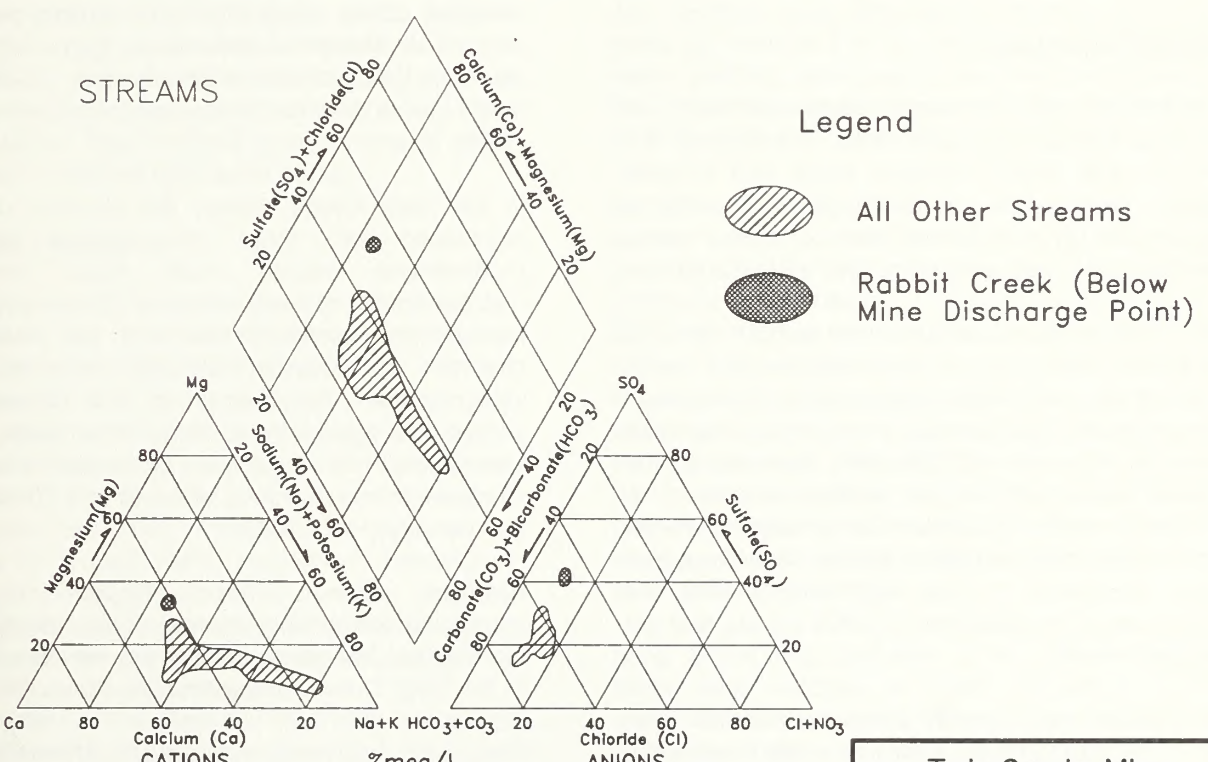
3.2.1.3 Ground Water

A series of hydrogeologic and hydrochemical investigations have been performed to provide information on the existing ground water conditions in the project area. These studies included hydrogeologic investigations to support ground water flow modeling to simulate mine dewatering and pit lake development (HCI 1996); quarterly sampling of monitoring wells to establish baseline ground water quality in the mine vicinity and reinfiltration basin area (WESTEC 1995a, 1995c); and geochemical investigations to support geochemical modeling to predict pit lake water quality (PTI 1996). These investigations provide the baseline information on the hydrogeologic and geochemical conditions in the hydrologic study area and beneath the project site.

Hydrogeologic Setting

Recharge, storage, and movement of ground water is dependent in part on the geologic conditions. The general stratigraphic and structural framework throughout the hydrologic study area and at the project site is described in Section 3.1, Geology and Minerals. Principal hydrostratigraphic units in the regional study area include (from oldest to youngest): (1) regional basement assemblage composed of Paleozoic to Cretaceous age bedrock, (2) Tertiary to Quarternary volcanic rocks and volcaniclastic basin sediments, and (3) Pliocene to Pleistocene alluvial basin fill. The general distribution of these units is presented in ***Figures 3-2*** and ***3-3***. In bedrock, the recharge, storage, flow, and discharge of ground water are generally controlled by porosity, permeability, and structure (i.e., fault and fracture zones) of the geologic materials. In the basin fill sediments, the ground water is stored and transmitted through interconnected pores within the consolidated to unconsolidated sediments.





Note:
The major ion chemistry of ground water in the area was compared by plotting the data on a trilinear diagram (Piper 1944), in which anion and cation concentrations are represented as percentages on ternary diagrams, and the points are projected onto the diamond-shaped area. The trilinear diagram permits the cation and anion composition of many samples to be represented on a single graph, in which major groupings or trends in the data can be visually discerned (Freeze and Cherry 1979).

Twin Creeks Mine

Figure 3-16

Surface Water Piper Trilinear Diagram

Basement Assemblage

The regional basement bedrock consists of a structurally complex assemblage of Paleozoic-age sedimentary, metasedimentary, and metavolcanic and Cretaceous intrusive rocks. These rocks are exposed in the Osgood Mountains, underlie the basin fill sediments in the valleys, and underlie the volcanics in the Snowstorm Mountains. Aquifer test data (HCI 1996) from two wells show a low transmissivity (a measure of the ability of rock to transmit water) of 0.5 to 160 square feet per day.

The Twin Creeks Mine is centered over an area that has experienced intense deformation through repeated episodes of folding and faulting. As a result, rocks in the mine vicinity are generally more highly fractured than equivalent age regional basement rocks (HCI 1996). Available hydrologic data indicate that the permeability of the bedrock at the mine is approximately one order of magnitude higher than the surrounding regional basement rocks. In addition, the Jackrabbit zone and DZ fault zone, shown in ***Figure 3-5***, are localized high permeability zones that behave as local conduits for flow in and near the South Pit.

Tertiary Volcanics

The Tertiary volcanics can be separated into three principal hydrostratigraphic units, including (1) the rhyolitic and dacitic volcanic rocks and volcaniclastic rocks that comprise the Snowstorm Mountains, (2) local basalt flows, and (3) Tertiary volcaniclastic sediments deposited as basin fill.

The Snowstorm Mountains are composed of a northeast dipping sequence of rhyolite and dacite lava flows, ash-flow tuffs, and interlayered volcaniclastic material that presumably originated from the Northern Nevada Rift. Because of the layered nature and variation in lithology in this unit, the unit is anisotropic with much greater horizontal than vertical permeabilities. Aquifer tests from four wells completed in this unit indicate that the transmissivity ranges from 2 to 390 square feet per day (HCI 1996).

Basalt flows occur locally along the northern margin of the Dry Hills, the east and south flank of the Osgood Mountains, and in the Kelly Creek Valley. Aquifer test data are not available for this unit.

The Tertiary volcaniclastic sediments occur on the northwest margin of the Snowstorm Mountains and underlie the alluvium in Kelly Creek Basin. Locally, this unit is over 2,000 feet thick (HCI 1996). This material is generally granular in nature and exhibits alluvial hydrologic characteristics. Aquifer tests within this unit indicate a transmissivity of 30 to 200 square feet per day and a hydraulic conductivity of 0.3 to 1.8 feet per day (HCI 1996).

Basin Fill Alluvium

Saturated alluvial sediments, which partially fill structurally controlled basins, are the principal ground water reservoirs within the hydrologic study area. As shown in ***Figure 3-2***, these sediments cover extensive areas in the Kelly Creek Valley, Eden Valley, and the Midas trough area located in the southeastern portion of the study area. Drilling and geophysical survey data indicate that the thickness of the alluvium is variable and dependent on the underlying buried topography of these basins. In the vicinity of the Twin Creeks Mine, the alluvium thickens from approximately 50 feet in the northwest (at the margin of the Dry Hills), to approximately 700 feet south of the South Pit. Near Rabbit Creek, the alluvium dramatically thickens from approximately 600 feet to 1,200 feet because of the offset of the underlying bedrock along the Rabbit Creek fault. Regionally, the alluvium locally thickens to between 2,000 and 3,000 feet in the lower portions of the basins (HCI 1996).

In the Kelly Creek Valley, the alluvium can be subdivided into three units based on the predominant source rock type: volcanic, metasediment/metavolcanic, and granodiorite. The eastern and central portions of the basin are covered by alluvium derived primarily from volcanic rock originating in the Snowstorm Mountains. Aquifer test data from three wells indicate that this volcanically derived alluvium has a moderate transmissivity of 2,940 to 5,750 square feet per day (HCI 1996).

Alluvium derived from erosion of the metasedimentary/metavolcanic rocks exposed in the Osgood Mountains covers the western portion of the Kelly Creek Valley (and the South Pit area). Aquifer test data from two wells in this unit indicate that this alluvium has a moderately low transmissivity of 13 to 370 square feet per day. The relatively low transmissivity, compared with the volcanically derived alluvium, is caused in part by the fact that this alluvium has been partially cemented by calcium carbonate and clay minerals

(Madden-McGuire et al. 1991). Also along the western margin of Kelly Creek Valley is a pod of alluvium that is derived from erosion of the granodiorite intrusion in the Osgood Mountains. No aquifer test data are available for this unit.

Two other alluvium units, Eden Valley alluvium and Midas trench alluvium, were distinguished by location, not composition. The Eden Valley alluvium unit occurs in Eden Valley, along the Little Humboldt River drainage below the Chimney Reservoir, and in the Chimney Creek drainage. The Eden Valley alluvium consists of both basaltic and metasedimentary material and is generally coarser-grained than the alluvium found in the Kelly Creek Basin. Aquifer tests indicate a transmissivity range of 50 to 36,000 square feet per day (HCI 1996).

The Quaternary alluvium in the Midas trough, located immediately south of the Midas Fault (***Figure 3-2***), is primarily derived from the Snowstorm Mountains volcanic rock assemblage. Aquifer test data from one well show a transmissivity of 160 square feet per day (HCI 1996).

Crop irrigation in the hydrologic study area is dependent on ground water withdrawal from the Eden Valley alluvial aquifer and alluvial aquifers located in the southwestern portion of the Kelly Creek Valley. The locations of water supply wells for various uses are discussed below.

Regional Fault Zone

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

All known or inferred major regional fault structures are located in ***Figure 3-2***. Based on apparent discontinuities in the water table surface, or changes in hydraulic gradient, HCI (1996) has identified three faults that appear to behave as low- permeability hydrostructural zones:

- The range-bounding fault along the western flank of the Osgood Mountains in Eden Valley
- The range-bounding fault that runs parallel to the bedrock-alluvium contact on the western flank of the Snowstorm Mountains
- A fault block immediately east of the lower reaches of Jake Creek

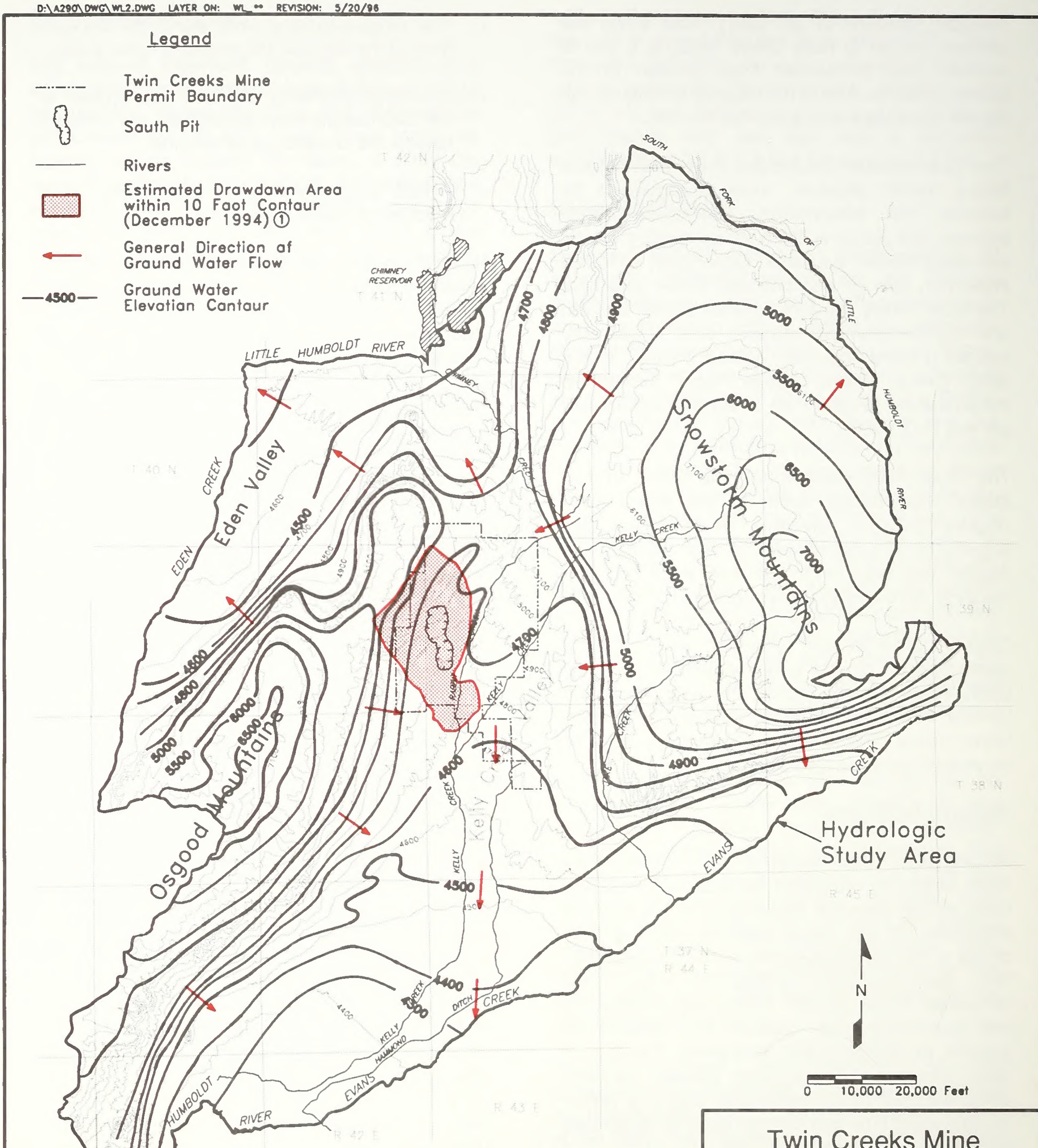
None of the other identified regional faults appear to behave as barriers or conduits to flow. However, other faults in the region indirectly influence the ground water flow patterns where they offset or truncate major hydrostratigraphic units.

Water Levels

Water level data were compiled from SFPG and Nevada Division of Water Resources records for 149 monitoring wells and water supply wells located throughout the hydrologic study area. These data were used to produce the ground water elevation map presented in ***Figure 3-17*** (Figure 19 in HCI 1996). Because of the scarcity of data in higher altitude areas, water levels beneath the Osgood and Snowstorm Mountains were generally inferred. For the purposes of the EIS, the water level elevation map is assumed to represent the approximate water level conditions that existed as of December 31, 1994.

As shown in ***Figure 3-17***, the ground water surface tends to mimic the topography with steep gradients in the mountain ranges and gentler gradients in the basins. The water level contours also indicate that for the upper aquifers, the crest of the Osgood Mountains, Dry Hills, and the Snowstorm Mountains generally behave as ground water divides. The water level contours also show that ground water generally flows from the crest of the mountains toward the axis of the basins and then down the axis of the basins where it either discharges to streams or exits the hydrologic study area as basin underflow.

Mine dewatering activities at the Twin Creeks Mine were initiated in 1990. Maximum water level drawdown beneath the South Pit as of December 1994 was approximately 600 feet. The estimated existing area that has been affected by 10 feet or more of drawdown is shown in ***Figure 3-17.*** Declines of 10 feet or more are generally restricted to the immediate vicinity of the mine.



Twin Creeks Mine

Figure 3-17

Existing Ground Water Elevations and Drawdown

Note: ① This map is intended to show the general elevation of the surface of the regional ground water system over the hydrologic study area. Detailed water level contours near the South Pit from dewatering are not shown.

② Ground Water Elevations in Mountains are Inferred from Topography

Source: Hydrologic Consultants, Inc. 1996

Aquifer Recharge and Discharge

The primary source of aquifer recharge is precipitation and stream runoff from snowmelt. Where streams emerge from the mountains, a percentage of the stream flow is lost as water infiltrates and recharges the alluvium. The bedrock aquifers receive infiltration of rainfall and snowmelt to fractures in bedrock outcrops. Other sources of recharge include agricultural irrigation and mine reinfiltration basins.

Recharge to the ground water system from direct precipitation was estimated using an empirically derived relationship between precipitation, recharge, and altitude (Maxey and Eakin 1949). This method assumes that a percentage of total precipitation within a specified altitude zone becomes ground water recharge. The estimated annual precipitation and percentage of recharge for each altitude zone is presented in ***Table 3-6***. Using this method, the average annual recharge rate is approximately 22,000 acre-feet per year for the hydrologic study area (HCI 1996).

Ground water discharges in the hydrologic study area by several mechanisms, including evapotranspiration, stream and spring discharge, and pumping. In areas where the depth to ground water is relatively shallow (less than 20 feet), water is lost from the water table surface through evapotranspiration. Ground water discharge by evapotranspiration includes losses from bare soil evaporation and transpiration from phreatophytic vegetation. Based on soil and vegetation surveys and depth to ground water, the southern portion of the hydrologic study area, including the lower Kelly Creek basin and areas adjacent to the Humboldt River, was delineated as an area of substantial ground water discharge through evapotranspiration. Using assumed evapotranspiration rates, the estimated ground water loss through evapotranspiration is 11,200 acre-feet per year (HCI 1996).

Flow in perennial streams and springs is dependent in part on discharge from the ground water system. Discharge of ground water into streams results in increased flows in the Little Humboldt River and the South Fork of the Little Humboldt River along stream reaches within the hydrologic study area. The Hot Springs area near Evans Creek is also a major ground water discharge area. Other identified springs represent discharge of ground water that may or may not be connected to the regional ground water system. Based on measured and estimated gains and losses along stream reaches and springs, the estimated net ground water discharge to surface waters is 6,800 acre-feet per year.

Ground water is withdrawn from the hydrologic study area by mining and agriculture. Of the total active appropriation of 16,620 acre-feet per year, 60 percent (10,089 acre-feet) is used by the

TABLE 3-6
Estimated Average Annual Ground Water Recharge from Precipitation

Altitude Zone (feet above sea level)	Area (acres)	Estimated Annual Precipitation			Estimated Recharge	
		Range (inches)	Average (feet)	Average (acre-feet)	Assumed Percentage of Precipitation	Acre Feet per Year
Above 7,600	6,700	20 - 25	1.9	13,000	25	3,300
6,500 - 7,600	42,600	15 - 20	1.4	60,000	15	9,000
5,800 - 6,500	45,800	12 - 15	1.1	50,000	7	4,000
4,600 - 5,800	237,400	8 - 12	.9	210,000	3	6,000
Below 4,600	80,300	7 - 8	.6	48,000	0	0
Total (rounded)	**412,800**			**380,000**		**22,000**

Source: Based on information provided in HCI 1996.

mining industry and 40 percent (6,531 acre-feet) is used for crop irrigation. Most of the pumped water is consumed; however, some infiltrates and recharges the ground water system.

Water Supply Wells

An inventory of water supply wells was conducted to provide information on the location and status of wells within the hydrologic study area. According to Nevada Division of Water Resources records, a total of 80 water supply wells have current permits or certificate status; these are the only wells in the study area that have active water rights status with the State of Nevada. Other wells exist in the study area, including monitoring wells around the mines, but these do not have active water rights status. Information on these wells is summarized in ***Table 3-7;*** the well locations are shown in ***Figure 3-18***.

The majority of the wells are clustered in agricultural areas in Eden Valley, in the south-central portion of the Kelly Creek Basin, and near the Pinson, Twin Creeks, and Getchell mines. There are three major agricultural ground waterusers in the hydrologic study area: Nevada First Corporation, Adams Peak Properties, and Milchem Inc. Nevada First Corporation (well numbers 61-80, ***Figure 3-18***) owns all existing water rights for pumping ground water from the Eden Valley alluvium. Adams Peak Properties (well numbers 46-64, ***Figure 3-18***) and Milchem Inc. (well numbers 46-64, ***Figure 3-18***) own the majority of the existing water rights for agricultural pumping in the Kelly Creek Basin.

Ground Water Quality Standards

Standards for protecting ground water used as a drinking water source have been adopted by the Nevada Bureau of Health Protection Services. Specifically, Nevada Administrative Code 445A.453 establishes primary standards in the form of maximum contaminant levels and Nevada Administrative Code 445A.455 establishes secondary standards, also as maximum contaminant levels. Primary maximum contaminant levels are established to protect human health from potentially toxic substances in drinking water, while secondary maximum contaminant levels are established to protect aesthetic qualities of drinking water, such as taste, odor, and appearance. Since ground water in the vicinity of the proposed project is used or is potentially usable as a drinking water source, Nevada primary and secondary maximum contaminant levels listed in ***Table 3-5*** would apply to the protection of area ground waters. In addition, Nevada's regulations governing mining facilities specifically state that ground water quality cannot be degraded beyond established maximum contaminant levels (Nevada Administrative Code 445A.424).

Ground Water Quality

Ground water quality in the hydrologic study area has been characterized from samples collected from 38 monitoring wells (***Figure 3-19***), 23 dewatering wells, horizontal drains, and seeps located on the project site (***Figure 3-20***). The wells and drains are completed in alluvium, oxidized bedrock, and non-oxidized bedrock. Ground water monitoring has been ongoing at the Twin Creeks Mine since March 1994 (WESTEC 1995a, 1995c, and PTI 1996). Selected water quality results from the sampling events are presented in ***Table A-2*** (Appendix A).

The general chemical characteristics of the alluvial and bedrock waters are graphically presented in ***Figure 3-21***. All bedrock ground waters sampled are calcium-magnesium-bicarbonate-type water. Ground water in the alluvial units has a large range in composition. However, water from the volcanically derived alluvium in the east and central portions of the Kelly Creek Valley generally tends to have a lower percentage of magnesium and a higher percentage of chloride than water from the other alluvial units. Specifically, three wells located in the volcanically derived alluvium Well M/O 384331-1 and Dudley Well located in the southern portion of the study area and well M/O 394329-1 located in the south tailings pond area contain higher proportions of chloride than any of the other alluvial wells.

The total dissolved solids concentrations of the ground water range from approximately 150 to 900 milligrams per liter. All wells contain total dissolved solids concentrations below the secondary standard of 500 milligrams per liter except for well M/O 384331-1 and the Dudley Well completed in the volcanically derived alluvium. The total dissolved solids concentrations in these wells range from 620 to 900 milligrams per liter. In addition, samples collected from two wells located adjacent to the infiltration basins contained total dissolved solid concentrations of 1,300 and 1,800 milligrams per liter during recent sampling.

TABLE 3-7
Water Supply Wells with Current Permit or Certificate Status

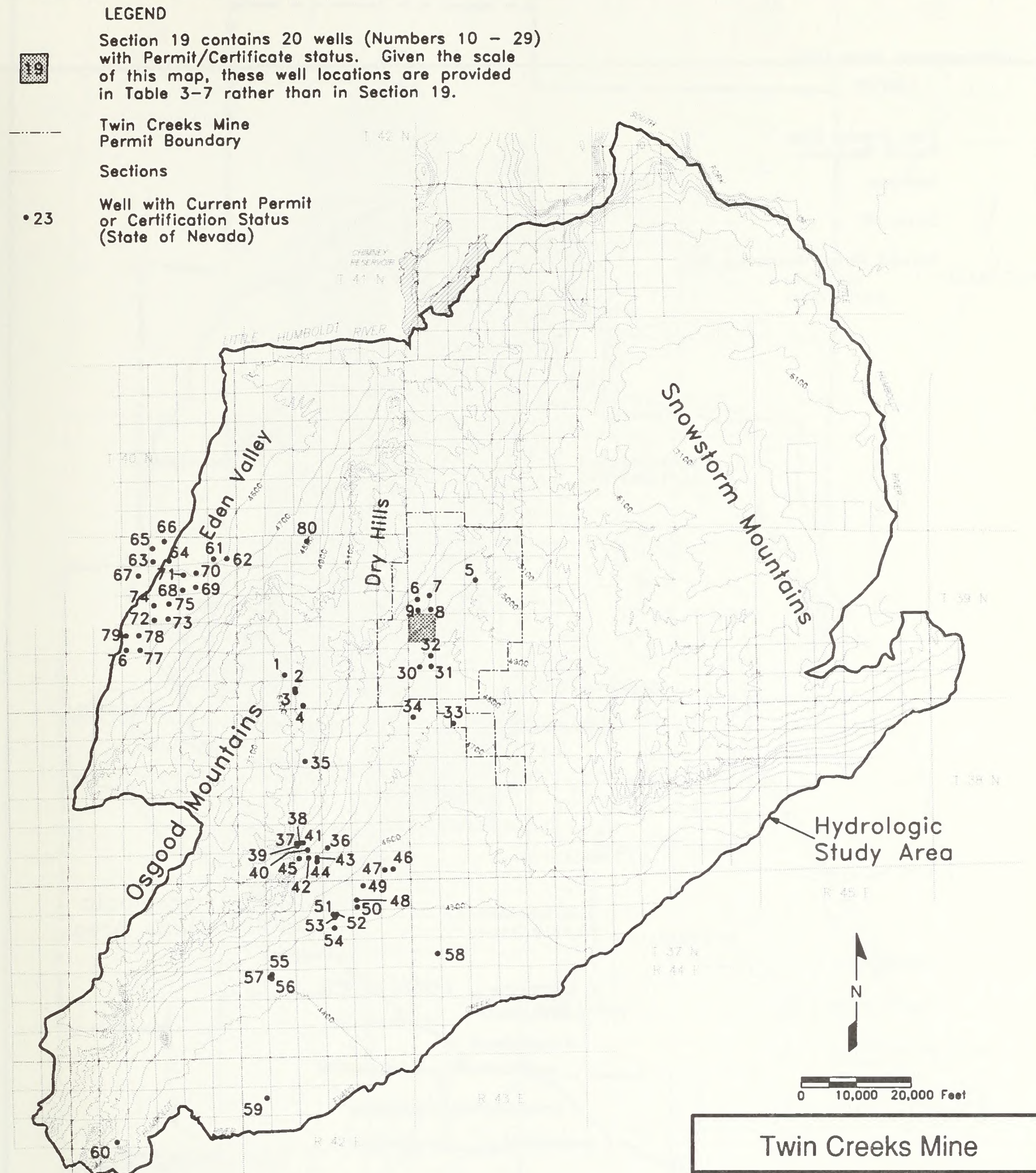
Map Location #	Application #	Status Permit/ Certificate	Certifi-cate #	Well Location	Use[1]	Owner
Basin #66 - Kelly Creek Basin						
1	45732	PER		SE 29 39N 42E	MM	First Miss Gold inc.
2	10370	CER	2758	SW NW 33 39N 42E	MM	First Miss Gold inc.
3	29075	PER		SW NW 33 39N 42E	QM	First Miss Gold Inc.
4	45730	PER		SE SW 33 39N 42E	MM	First Miss Gold Inc.
--	60052	PER		[3]LT 0824 39N 42E	DWR	Rabbit Creek Mining Inc.
--	60053	PER		[3]LT 1224 39N 42E	DWR	Rabbit Creek Mining Inc.
5	44324	CER	10855	SE SW 9 39N 43E	STK	Rabbit Creek Mining Inc.
6	60054	PER		SE NW 18 39N 43E	DWR	Rabbit Creek Mining Inc.
7	60055	PER		SE NE 18 39N 43E	DWR	Rabbit Creek Mining Inc.
8	60056	PER		SE SE 18 39N 43E	DWR	Rabbit Creek Mining Inc.
9	60057	PER		SE SW 18 39N 43E	DWR	Rabbit Creek Mining Inc.
10	58043	PER		NE SW 19 39N 43E	MM	Rabbit Creek Mining Inc.
11	58044	PER		NE NW 19 39N 43E	MM	Rabbit Creek Mining Inc.
12	58045	PER		NE NE 19 39N 43E	MM	Rabbit Creek Mining Inc.
13	60259T	[2]PER		NW SE 19 39N 43E	DWR	Rabbit Creek Mining Inc.
14	60374T	[2]PER		NW NE 19 39N 43E	DWR	SFPG
15	60679T	[2]PER		SW SE 19 39N 43E	DWR	SFPG
16	60680T	[2]PER		SW SE 19 39N 43E	DWR	SFPG
17	60681T	[2]PER		SW SE 19 39N 43E	DWR	SFPG
18	61026T	[2]PER		SW NE 19 39N 43E	DWR	SFPG
19	61027T	[2]PER		SW NE 19 39N 43E	DWR	SFPG
20	61028T	[2]PER		SE NW 19 39N 43E	DWR	SFPG
21	61029T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
22	61032T	[2]PER		SE NW 19 39N 43E	DWR	SFPG
23	61033T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
24	61034T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
25	61035T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
26	61036T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
27	61037T	[2]PER		NW SE 19 39N 43E	DWR	SFPG
28	61038T	[2]PER		NW NE 19 39N 43E	DWR	SFPG
29	58042	PER		NE SE 19 39N 43E	MM	Rabbit Creek Mining Inc.
30	60048	PER		SE SW 30 39N 43E	DWR	Rabbit Creek Mining Inc.
31	60049	PER		SE SE 30 39N 43E	DWR	Rabbit Creek Mining Inc.
32	60051	PER		SE NE 30 39N 43E	DWR	Rabbit Creek Mining Inc.
--	60050	PER		[3]LT 0830 39N 43E	DWR	Rabbit Creek Mining Inc.
33	10331	CER	2688	SW SE 5 38N 43E	MM	First Miss Gold Inc.
34	28758	PER		NW SW 6 38N 43E	MM	First Miss Gold Inc.
35	53030	PER		SE SW 9 38N 42E	MM	First Miss Gold Inc.
36	48037	PER		SW SW 27 38N 42E	MM	Pinson Mining Co.
37	51390	PER		NW SW 28 38N 42E	MM	Pinson Mining Co.
38	52464	PER		NW SW 28 38N 42E	MM	Pinson Mining Co.
39	56977	PER		NW SW 28 38N 42E	MM	Pinson Mining Co.
40	57881	PER		SE SW 28 38N 42E	MM	Pinson Mining Co.
41	57885	PER		SW 28 38N 42E	MM	Pinson Mining Co.
42	43130	CER	13070	NW NE 33 38N 42E	MM	Pinson Mining Co.
43	51388	PER		NE NE 33 38N 42E	MM	Pinson Mining Co.
44	51427	PER		NE NE 33 38N 42E	MM	First Miss Gold Inc.

TABLE 3-7 (continued)
Water Supply Wells with Current Permit or Certificate Status

Map Location #	Application #	Status Permit/ Certificate	Certificate #	Well Location	Use[1]	Owner
45	57887	PER		NW 33 38N 42E	MM	Pinson Mining Co.
46	29885	CER	9557	NE SW 36 38N 42E	IRR	Adams Peak Properties
47	29886	CER	9558	NW SW 36 38N 42E	IRR	Adams Peak Properties
48	29887	CER	9559	NW SW 2 37N 42E	IRR	Adams Peak Properties
49	29891	CER	9563	NE NW 2 37N 42E	IRR	Adams Peak Properties
50	43848	CER	10536	SW SW 2 37N 42E	IRR	Adams Peak Properties
51	29888	CER	9560	NE NW 10 37N 42E	IRR	Adams Peak Properties
52	29889	CER	9561	NE NW 10 37N 42E	IRR	Adams Peak Properties
53	41522	CER	10167	NE NW 10 37N 42E	IRR	Adams Peak Properties
54	29890	CER	9562	NE SW 10 37N 42E	IRR	John Hancock Mutual Life Ins.
55	59315	PER		NW NW 20 37N 42E	IRR	Milchem Inc.
56	59316	PER		NW NW 20 37N 42E	IRR	Milchem Inc. and D. Porter
57	59317	PER		NW NW 20 37N 42E	IRR	Milchem Inc.
58	35494	CER	11033	NE SE 18 37N 43E	IRR	Harrington, Richard Wayne
59	56891	PER		SE NE 7 36N 42E	STK	Hammond Ranch Inc.
60	45770	CER	03073	SW SE 17 36N 41E	MM	Pinson Mining Co.
--	48642	CER	13077	[3]LT 1617 36N 41E	MM	Pinson Mining Co.
--	48643	CER	13078	[3]LT 1608 36N 41E	MM	Pinson Mining Co.
Basin #67 - Little Humboldt Valley						
61	30486	CER	9444	SW SW 1 39N 41E	IRR	Nevada First Corp.
62	30487	CER		SW SE 1 39N 41E	IRR	Nevada First Corp.
63	30480	CER	9440	SW SW 3 39N 41E	IRR	Nevada First Corp.
64	30481	CER	9441	SW SE 3 39N 41E	IRR	Nevada First Corp.
65	30482	CER	9442	SW NW 3 39N 41E	IRR	Nevada First Corp.
66	35940	CER	10401	NW NE 3 39N 41E	IRR	Nevada First Corp.
67	30485	CER	9443	SW NE 9 39N 41E	IRR	Nevada First Corp.
68	30488	CER	9445	SW SW 11 39N 41E	IRR	Nevada First Corp.
69	30489	CER	9446	SW SE 11 39N 41E	IRR	Nevada First Corp.
70	30491	CER	9447	SW NE 11 39N 41E	IRR	Nevada First Corp.
71	35939	CER	10400	SW NW 11 39N 41E	IRR	Nevada First Corp.
72	30472	CER	9449	SW SW 15 39N 41E	IRR	Nevada First Corp.
73	30473	CER	9430	SW SE 15 39N 41E	IRR	Nevada First Corp.
74	30474	CER	9431	SW NW 15 39N 41E	IRR	Nevada First Corp.
75	30475	CER	9434	SW NE 15 39N 41E	IRR	Nevada First Corp.
76	30476	CER	9435	SW SW 21 39N 41E	IRR	Nevada First Corp.
77	30477	CER	9437	SW SE 21 39N 41E	IRR	Nevada First Corp.
78	30478	CER	9438	SW NE 21 39N 41E	IRR	Nevada First Corp.
79	30479	CER	9439	SW NW 21 39N 41E	IRR	Nevada First Corp.
80	47960	CER	11716	NW NE 4 39N 42E	STK	Nevada First Corp.

[1] Use
- MM -Mining/milling
- QM -Quasi-municipal
- IRR -Irrigation
- STK -Livestock watering
- DWR -Mine dewatering

[2] Temporary permit.
[3] Not located on map.
Source: Nevada State Engineer's Office 1995.

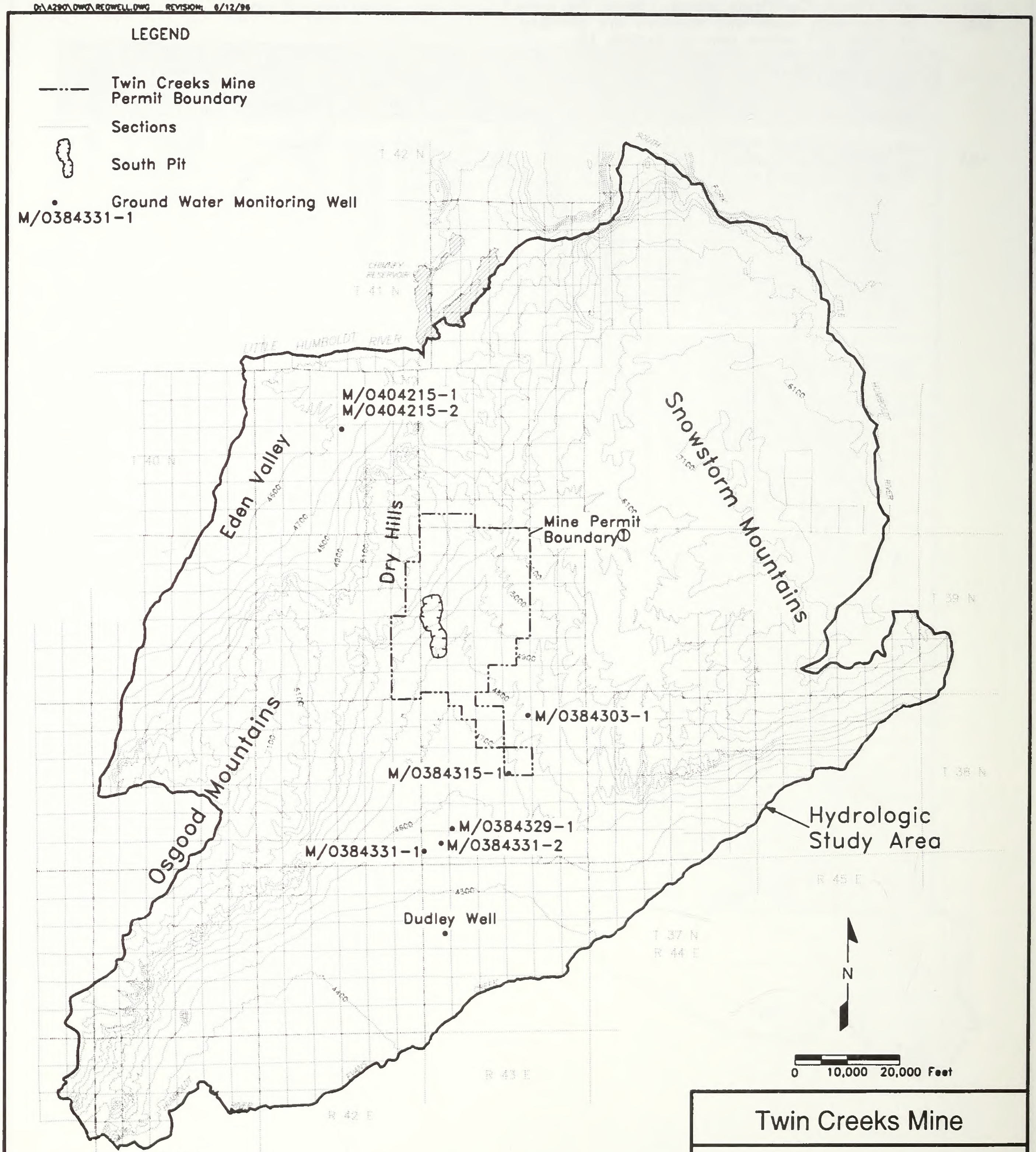


Twin Creeks Mine

Figure 3-18

Water Supply Wells

Source: Base Map from Hydrologic Consultants, Inc. 1996



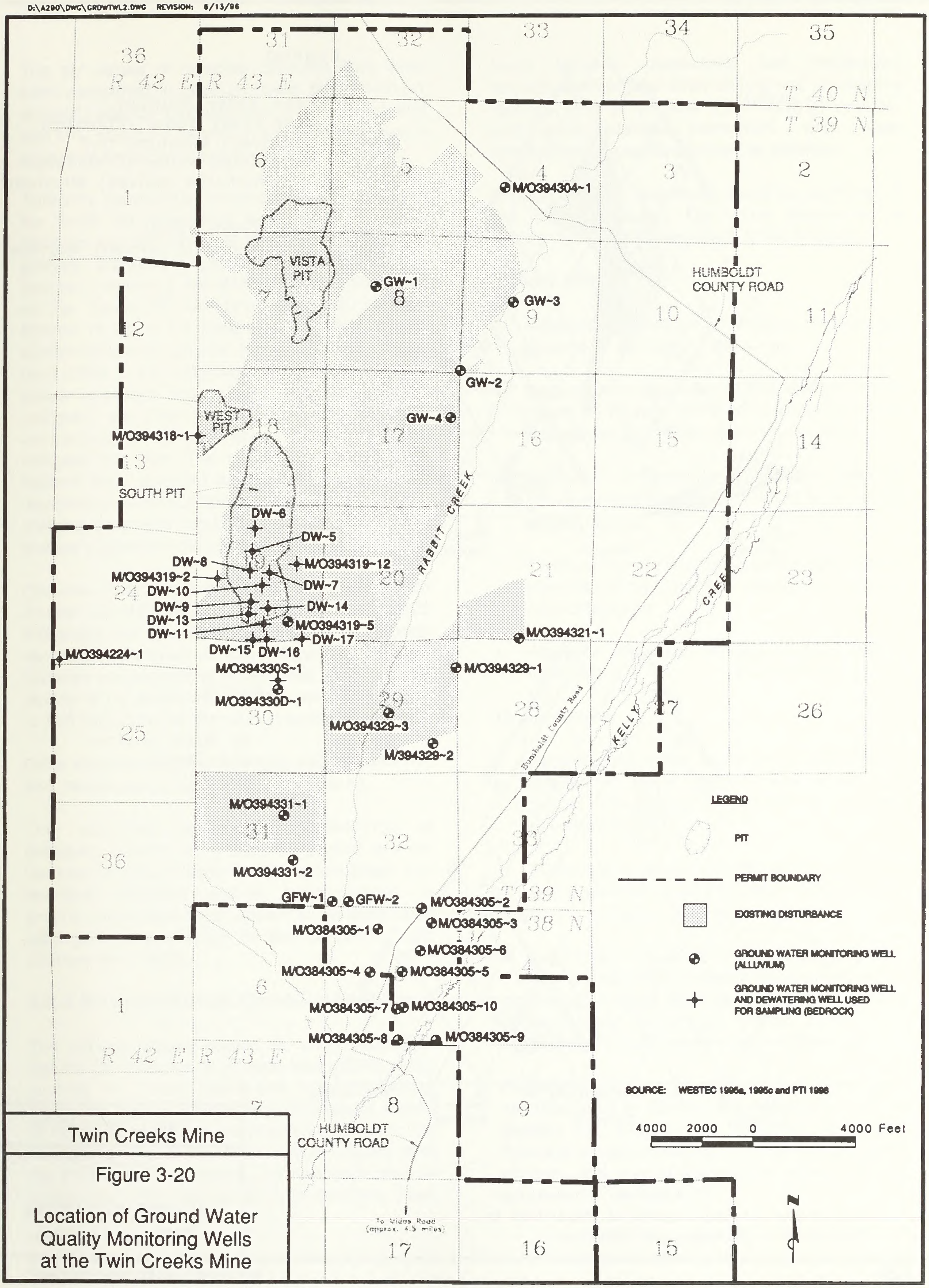
Twin Creeks Mine

Figure 3-19

Regional Ground Water Quality Monitoring Wells

Note: ① Wells within permit boundary are shown on Figure 3-20.

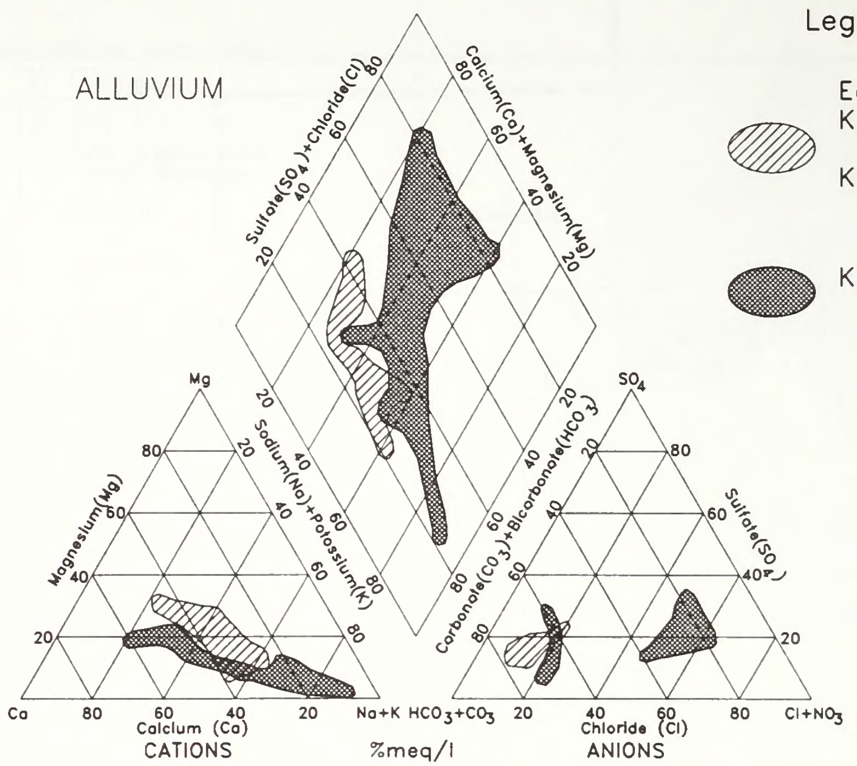
Source: Base Map from Hydrologic Consultants, Inc. 1996
Well Locations from WESTEC 1995c



Twin Creeks Mine

Figure 3-20

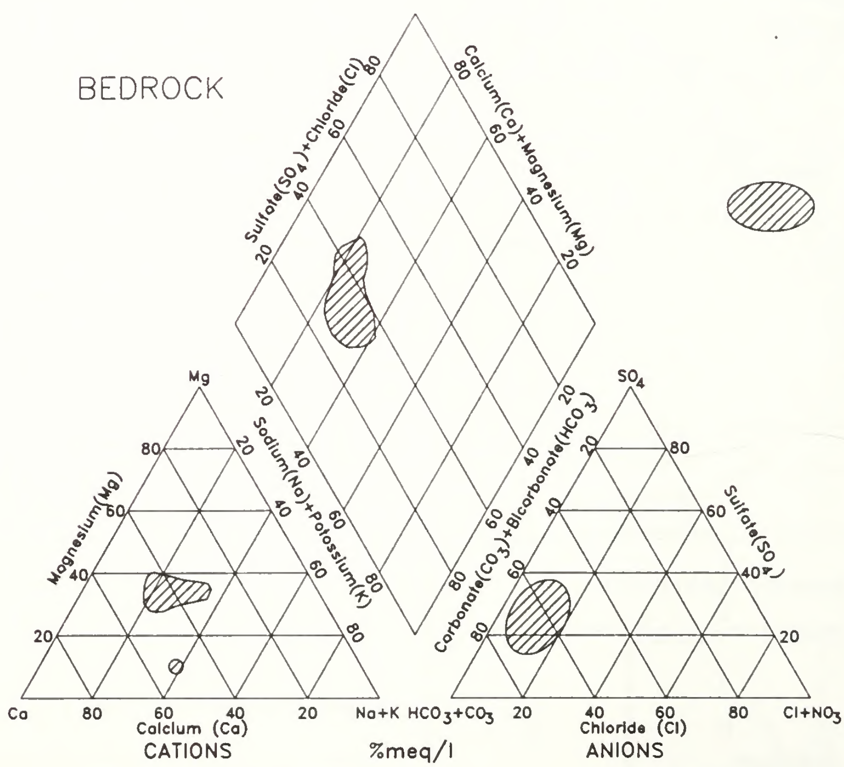
Location of Ground Water Quality Monitoring Wells at the Twin Creeks Mine



Legend

Eden Valley Alluvium,
Kelly Creek Valley (Paleozoic derived) Alluvium, and
Kelly Creek Valley (Cretaceous granodiorite derived) Alluvium[1]

Kelly Creek Valley (Volcanically derived) Alluvium[1]



Legend

All Wells, Drains, and Seeps

[1] Description of these units is described in Section 3.1, Geology and Minerals

Twin Creeks Mine

Figure 3-21

Ground Water Piper Trilinear Diagram

The pH values of samples collected from three wells completed in alluvium (wells M/O 384315-1 and M/O 384303-1 located east of Kelly Creek and well M/O 404215-1 located in Eden Valley) were in excess of the primary standard of 8.5.

Antimony concentrations in samples collected from the South Pit dewatering wells were up to 0.8 milligram per liter, which is in excess of the 0.006 primary standard. Samples collected from a bedrock monitoring well (M/O 394318-1, northwest of the South Pit) contained antimony concentrations of up to 1.4 milligrams per liter. Arsenic concentrations in ground water samples ranged from 0.003 to 1.2 milligrams per liter, and in many cases exceeded the primary standard of 0.05 milligram per liter. In alluvial wells arsenic concentrations ranged from 0.003 to 0.065 milligram per liter. The highest arsenic concentrations were detected in samples collected from dewatering wells and drains in the South Pit (1.2 milligrams per liter) and bedrock monitoring wells located adjacent to the pit (0.95 milligram per liter).

Chloride concentrations in samples collected from alluvial well M/O 384331-1 ranged from 255 to 320 milligrams per liter, exceeding the recommended secondary standard of 250 milligrams per liter. Chloride concentrations in two wells located in the vicinity of the reinfiltration basins ranged from 500 to 720 milligrams per liter during recent sampling.

Other exceedances in monitoring wells include iron and manganese (***Table A-2***; Appendix A).

The observed elevated concentrations of antimony, arsenic, iron, and manganese are not unusual for ground water in mineralized areas. For example, elevated arsenic concentrations in ground water have been shown to be associated with gold mineralization in the Getchell Trend (Grimes et al. 1995).

3.2.2 Environmental Consequences

The primary issues related to water resources include (1) reduction in surface and ground water quantity for current users and water dependent resources from pit dewatering; (2) impacts related to the water quality of the postmining pit lake; (3) impacts to ground and surface water quality from the construction, operation, and closure of mineral processing mills, tailings storage facilities, heap leach facilities, overburden and interburden storage facilities, and other mining and processing facilities; and (4) impacts from flooding, erosion, and sedimentation associated with mine construction, operation, or closure activities.

Impacts to water resources would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

Surface Water

- Measurable reduction in the flow of perennial streams or springs
- Degradation of the quality of surface water based on Nevada standards for designated or appropriate beneficial uses
- Alteration of drainage patterns or channel geometry resulting in accelerated erosion and sedimentation
- Damage to project facilities during operation or post closure as a result of inadequate drainage control features
- Alteration of surface drainage patterns due to subsidence

Ground Water

- Reduction of static water levels (10 feet or greater) in water supply wells caused by project dewatering or postmining pit lake development
- Reduction in the estimated quantity of ground water available in the hydrologic study area for current or future use
- Degradation of ground water quality such that one or more water quality constituents would exceed primary maximum contaminant levels established to protect human health from potentially toxic substances in drinking water

Potential impacts to wetlands and riparian areas are discussed in Section 3.4, Vegetation, and in Section 3.5, Wildlife and Fisheries Resources. Potential impacts resulting from the transportation, storage, and use of hazardous substances are addressed in Section 3.15.

3.2.2.1 Evaluation Methodology

This section provides a summary of the methods used and the predictive analyses performed to evaluate (1) potential hydrologic effects from pit dewatering and postmining pit lake development, (2) future pit lake water quality, and (3) the potential for acid generation and/or release of metals from materials permanently or temporarily stored on the site.

<u>Pit Dewatering and Pit Lake Development</u>

The premine water table elevation was approximately 4,700 feet in the vicinity of the South Pit. The floor of the South Pit currently extends below the regional water table. Dewatering is required to limit the amount of inflow into the pit and maintain pit wall stability. Pit dewatering in the South Pit commenced in 1990 and is projected to continue through the end of mining for both the No Action alternative and the Proposed Action. Dewatering is accomplished primarily by a system of in-pit wells and sumps designed to maintain water levels below the floor of the pit as the pit is deepened.

As of mid-1995, the pit floor elevation was approximately 4,300 feet above mean sea level, approximately 400 feet below the premine water table. The average discharge from the dewatering system was approximately 4,300 gallons per minute. The use, discharge, and treatment of the dewatering water is described in Section 2.3.9.

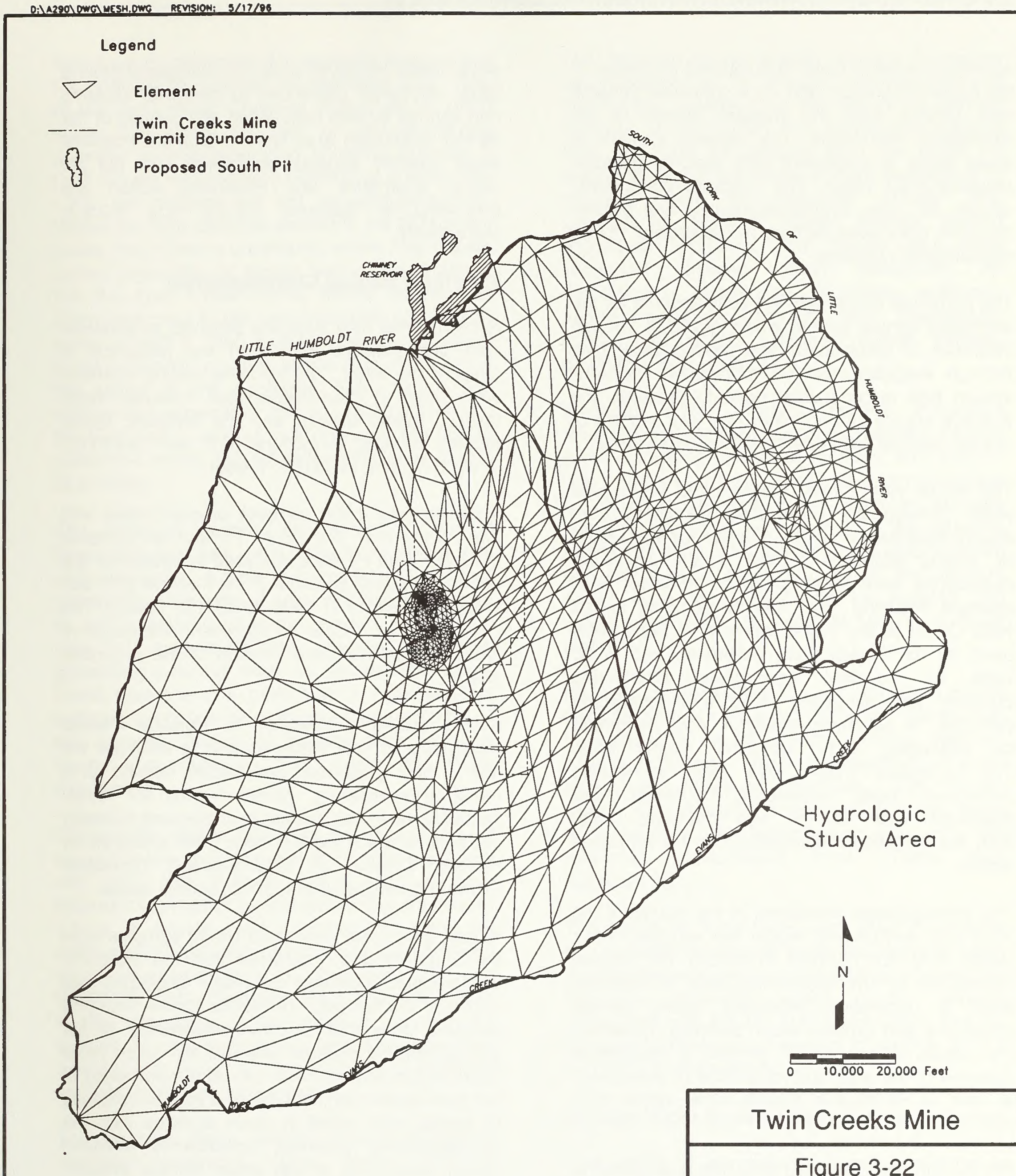
For the No Action alternative, the final pit bottom elevation at closure would be approximately 3,900 feet. The additional mining would require lowering the water table an additional 500 feet (total of 800 feet). For the Proposed Action, the final pit bottom elevation would be approximately 3,700 feet, and would require lowering the water table an additional 200 feet below that required for the No Action alternative (total of 1,000 feet).

Ground water withdrawal for pit dewatering would continue to lower the ground water levels in the area. In addition, once dewatering activities cease, a pit lake would develop primarily because of the inflow of ground water. The continual withdrawal of ground water from the regional aquifer system by mine dewatering during operation and pit lake inflows after closure would result in lowering of ground water levels (drawdown) both at the mine and in the surrounding area. Any water supply wells, springs, and streams that are within the drawdown area (and hydraulically connected to the regional ground water system) could potentially be affected.

Numerical Flow Modeling. The general dewatering requirements, projected area of drawdown of ground water levels, and postclosure pit lake development were estimated using the numerical ground water flow model MINEDW. MINEDW is a three-dimensional finite element code developed by Hydrologic Consultants, Inc. (HCI) to simulate mine dewatering. MINEDW has been documented and validated (HCI 1992a) and used to predict hydrologic effects associated with dewatering at the Newmont Gold Company's Gold Quarry Mine (HCI 1992b), and SFPG's Lone Tree Mine (HCI 1995). The modeling for the Twin Creeks Mine was performed by HCI, and the details regarding the conceptual model, model design, calibration, simulations and sensitivity analysis are presented in HCI's technical report (1996), which is available for review at the BLM's Winnemucca District and Nevada State offices.

The model domain and finite element mesh are illustrated in ***Figure 3-22***. The modeled area encompasses the entire 640-square-mile hydrologic study area. The model mesh is variably spaced with finer spacing in the pit area. The boundaries of the numerical model were designed to coincide with major drainage divides and surface water divides to simulate the general hydrologic boundary conditions. Details regarding the boundary types specified in the model for all layers are provided in HCI's technical report (HCI 1996). The hydrostratigraphic conditions were simulated with four regional layers that extend from 8,680 feet above mean sea level along the mountain crest to -500 feet below sea level. The four regional layers transition to nine layers locally to provide enhanced detail in the vicinity of the south pit.

The known hydrostratigraphic and hydrostructural conditions were incorporated into the model; the hydraulic conductivity values were assigned based on available aquifer test results conducted in specific units or were inferred based on published hydrologic parameters for similar materials (HCI 1996). Three regional faults were included in the model as discrete, relatively low hydraulic conductivity zones. These faults include (1) a northeast trending block fault located on the west side of the Osgood Mountains; (2) a north to



Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-22

Numerical Flow Model Domain and Finite Element Mesh northeast trending block fault located southeast of the project boundary, and (3) a northwest trending fault located near the western margin of the Snowstorm Mountains. The general location of these faults is consistent with regional geologic mapping (HCI 1996). The hydraulic conductivity values for the hydrostratigraphic and hydro-structure units were refined, as necessary, during the calibration process

The numerical model was set up to account for the estimated annual ground water recharge through infiltration of precipitation and ground water loss through evapotranspiration processes. Historical stream flow records were used to establish the average annual ground water flow into and out of stream reaches within the hydrologic study area.

The model was initially calibrated to pre-ground water development water level conditions (i.e., steady state before pumping began for agricultural or mining purposes). Time series (transient) calibrations were then performed to water level changes resulting from historic pumping in the Kelly Creek Basin. Water levels in 44 wells were used for the steady state calibration and in 30 wells for transient calibrations. Dewatering pumping was simulated along with agricultural pumping. A sensitivity analysis was performed by evaluating eight additional model runs. The calibrated model was used to assess drawdown from dewatering activities and postclosure as the pit lake develops under both the No Action alternative and the Proposed Action.

The hydrogeologic conditions in the vicinity of the mine and surrounding region are complex. As a result, it is not possible to predict the precise boundaries of the drawdown area. In addition, there is uncertainty regarding future climatic conditions and ground water pumping. However, the results of the model provide a reasonable estimate of the area and magnitude of drawdown, as well as postmining ground water inflow rates that could potentially occur.

For the EIS, the estimated area that is predicted to experience a decline in ground water levels of 10 feet or more was selected as the general area for consideration of potential ground water impacts. Drawdown of the water table of less than 10 feet was not considered in the analysis because these changes would probably be indistinguishable from natural seasonal and annual fluctuations in ground water levels. However, potential changes in ground water discharge (baseflow) to perennial streams and springs located both within and outside of the 10-foot drawdown area were evaluated. Potential water quantity impacts associated with the No Action alternative and Proposed Action are presented in Sections 3.2.2.2 and 3.2.2.3, respectively.

Mine Rock Material Characterization

Rock material may have the potential to generate acid and mobilize metals in the presence of oxygen and water. The following testing methods were used to characterize rock material: static testing, kinetic testing, and the Meteoric Water Mobility Testing Procedure (PTI and WESTEC 1996; PTI 1996; WESTEC 1995d).

Approximately 4,500 samples of overburden and interburden from the South Pit and 90 samples from the Vista Pit were analyzed to determine the net neutralization potential of the material (PTI and WESTEC 1996; PTI 1996; WESTEC 1995d). The samples were chosen to represent the range of types of rock materials present in the proposed pits.

Kinetic testing is designed to simulate intense weathering of rock materials and to estimate the rate of acid generation and metals release as a result of weathering. Kinetic testing for representative mine rock consisted of 20-week humidity cell tests in which the leachates were analyzed for Nevada Division of Environmental Protection Profile II constituents at 1, 5, 10, and 20 weeks.

Kinetic tests were conducted on 46 samples from the South Pit and 5 samples from the Vista Pit. The samples represent the major lithologies that dominate the two pits. The results for the South Pit samples show that oxidative weathering of net acid-generating material releases ten times more trace metals and acid than oxidative weathering of net acid-neutralizing material. The highest releases of metals were noted in shale samples with net acid-generating potential; constituents released during weathering of the shale include arsenic, sulfate, iron, and aluminum. Oxidative weathering of an acid-generating basalt sample from the Vista Pit showed a release of trace metals, including arsenic, cadmium, and chromium.

Acid-base accounting procedures using the results of static tests are commonly used as a screening technique to determine if a geologic material has the potential to generate or neutralize acid. The BLM's Acid Rock Drainage Policy (BLM 1996) states that where the ratio of acid-neutralizing potential to acid-generating potential exceeds 3 (and the net neutralization potential is greater than +20), the material will not be acid-generating. Where the ratio does not exceed 3, the BLM policy states that "there is uncertainty which may require further evaluation by kinetic testing" (BLM 1996). For the Twin Creeks mine, kinetic testing was performed, prior to the implementation of this BLM policy on April 2, 1996, to determine which material could potentially produce acid and to characterize the nature of any discharge. Even though this testing was undertaken before implementation of the BLM policy on acid rock drainage, the testing performed meets the full letter and intent of the BLM policy.

The State of Nevada, Department of Natural Resources also has testing criteria for waste rock and overburden. A material is considered non-acid generating if the ratio of acid-neutralizing potential to acid-generating potential exceeds 1.2. If the ratio of acid-neutralizing potential to acid-generating potential does not exceed this value, kinetic testing is to be performed on representative samples to confirm the acid-generating potential of the material. Testing of material from both the South and Vista Pit fully meets this State requirement.

Site-specific kinetic test data on 51 samples of representative rock material from both the South and Vista Pits indicate that a ratio of acid-neutralizing potential to acid-generating potential of 1.2 is a reliable (and conservative) cutoff for distinguishing between potentially acid-neutralizing and acid-generating rock materials (PTI and WESTEC 1996). Therefore, the 1.2 ratio was used in this document as the cutoff to quantify the amount of acid-neutralizing and acid-generating material that would be stored in the overburden and interburden storage areas.

The Meteoric Water Mobility Testing Procedure simulates conditions under which infiltrating precipitation (rainwater and snowmelt) may leach constituents present in the overburden and interburden. Analytical results were compared with established maximum contaminant levels to evaluate if any constituents in the overburden and interburden have the potential to mobilize and transport to surface or ground water.

The Meteoric Water Mobility Testing Procedure was conducted on 127 samples of overburden and interburden material from the South Pit and 68 samples of overburden and interburden material from the Vista Pit. Results from the South Pit testing show that the basalt is more susceptible to leaching than the alluvium (***Table A-5***, Appendix A). Meteoric Water Mobility Testing Procedure leachates from basalt and shale exceeded drinking water standards for the following constituents: aluminum, antimony, arsenic, beryllium, cadmium, iron, manganese, mercury, nickel, pH, selenium, sulfate, thallium, and total dissolved solids.

Meteoric Water Mobility Testing Procedure leachates for alluvium samples exceeded drinking water standards for arsenic, mercury, and thallium. The highest arsenic leachate concentrations for alluvium samples were found in samples collected within 60 vertical feet of the alluvium-bedrock contact. The spatial relationship between elevated arsenic and the base of the alluvium would allow this material to be isolated and selectively handled to avoid its use as a cover material.

Meteoric Water Mobility Testing Procedure results from 68 samples of overburden and interburden from the Vista Pit indicate that arsenic, mercury, antimony, thallium, selenium, aluminum, manganese, pH, beryllium, cadmium, iron, nickel, sulfate, total dissolved solids, and zinc may leach from the rock at concentrations exceeding the maximum contaminant level (***Table A-5***, Appendix A).

The results of these tests were used to evaluate the potential for ground water and surface water degradation resulting from the storage of mine rock materials. Potential water quality impacts associated with the No Action alternative and the Proposed Action are presented in Section 3.2.2.2 and 3.2.2.3, respectively.

Pit Lake Water Quality Evaluation

The bottom of the Vista Pit is not anticipated to extend below the water table surface and is expected to remain dry following mine closure. However, for both the No Action alternative and the Proposed Action, a permanent lake is predicted to develop in the South Pit. Postmining conditions in existing mine pit lakes vary widely from high-quality, pH-neutral conditions to metal-bearing, highly acidic conditions; therefore, site-specific characterizations are important to predict pit lake water quality and potential impacts to waters of the state.

The predicted water quality evolution of the pit lake is described in a geochemical modeling report prepared by PTI (1996). As illustrated in ***Figure 3-23***, the conceptual model for the pit lake geochemistry assumes that the pit lake water is primarily affected by the composition of inflowing ground water, releases from oxidized pit wall rock, surface water runoff from the pit walls above the lake, and leachate from surfaces containing residue from blasting operations. Chemical reactions predicted to occur in the pit lake include acid-neutralization by carbonate alkalinity, adsorption of metals onto iron hydroxides that precipitate, precipitation of minerals, and coprecipitation of trace constituents with minerals. In addition, these reactions may be strongly influenced by the pit lake limnology, including hydrodynamic mixing and biological productivity.

Pit Water Balance Conditions. A mass balance approach was used to predict the final pit lake elevation. The water level in the lake would depend on the amount of ground water inflow, surface water runoff from the pit walls, direct precipitation onto the lake surface, ground water outflow, and evaporation from the lake surface. The predicted hydrology of the pit lake under the No Action alternative and the Proposed Action has been described in a report prepared by HCI (1996).

Flow of ground water into the pit from various zones was predicted using the numerical ground water flow model (HCI 1996). Precipitation was assumed to average 9 inches per year over the lake surface (PTI 1996). The amount of surface runoff from the pit walls was estimated by considering the pit wall geometry at various lake elevations (PTI 1996). The U.S. Army Corps of Engineers' one-dimensional lake model CE-THERM-R1 (a component of CE-QUAL-R1), coupled with evaporation data collected from natural lakes in Nevada, was used to estimate a gross evaporative loss from the pit lake of 42 inches per year (PTI 1996).

Ground Water Inflow. Ground water would contribute solutes present in the ground water itself as well as solutes leached from inundated wall rock. Ground water inflow to the pit lake is assumed to be a composite of water from five geochemical zones, weighted by their volumetric inflow rates. Water quality data collected from 22 wells, 1 horizontal drain, and 2 in-pit seeps were used in the geochemical model to represent ground water inflow from these lithochemical zones.

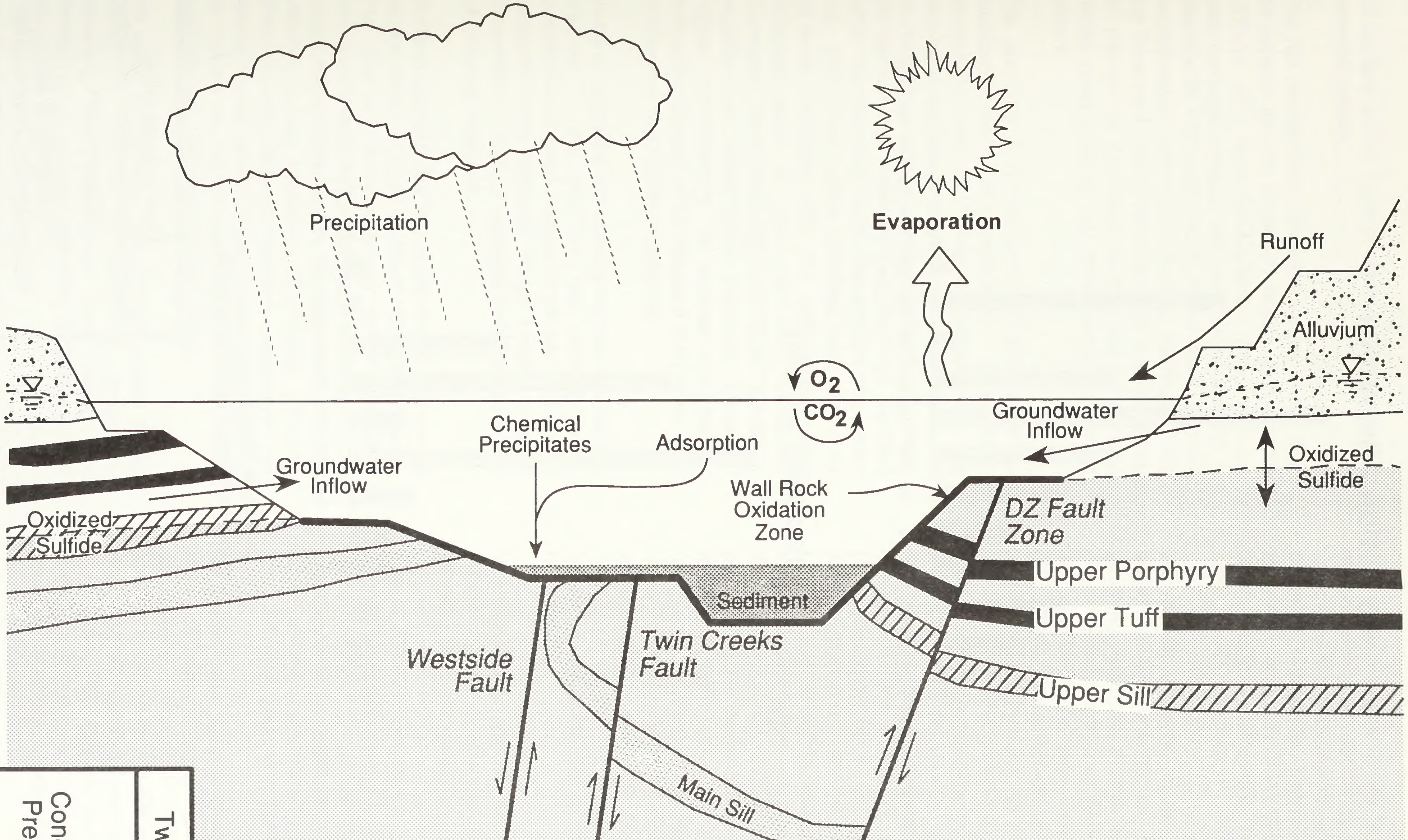
Pit Wall Rock. Pit wall rock would contribute solutes to the pit lake. Therefore, the type of rock comprising the pit walls and its potential for generating acid and mobilizing metals is an important component of pit lake water quality predictions.

The rock units that would be exposed in the No Action and Proposed Action pit surfaces include alluvium, basalt, and limestone and intermixed meta-igneous rocks and calcareous sedimentary rocks (***Figures 3-5*** and ***3-6***). Although no dolomite- or limestone-dominant lithologies would be exposed in the final pit surfaces, the calcareous nature of both the alluvium and the sedimentary rocks would assist in mitigating the acid and metals released by oxidative dissolution of pyrite (PTI 1996). A more detailed description of the pit area stratigraphy, including a geologic map and a cross section of the pit, is presented in Section 3.1.1, Geology and Minerals.

Excavation of the pit would expose sulfide minerals in the pit surface to atmospheric oxygen. Subsequent oxidation of wall rock minerals, particularly pyrite, would result in the formation of sulfuric acid and could potentially mobilize metals. These oxidation products would ultimately be flushed into the pit lake by inflowing ground water.

In order to characterize the potential generation of acid and release of metals from the pit walls, 6,933 samples of pit wall rock were classified in terms of sulfide sulfur content and carbonate carbon content to determine their net neutralization potential (PTI 1996). ***Figure 3-24*** presents the range of net neutralization potential values for the No Action alternative and the Proposed Action.

The net neutralization potential values in the final pit surface for the No Action alternative ranged from -320 to +629 tons $CaCO_3$/kiloton rock, with an area-weighted average wall rock net neutralization potential of +141 tons $CaCO_3$/kiloton rock. The net neutralization potential frequency distribution for the No Action alternative indicates that approximately 81 percent of the rocks in the final

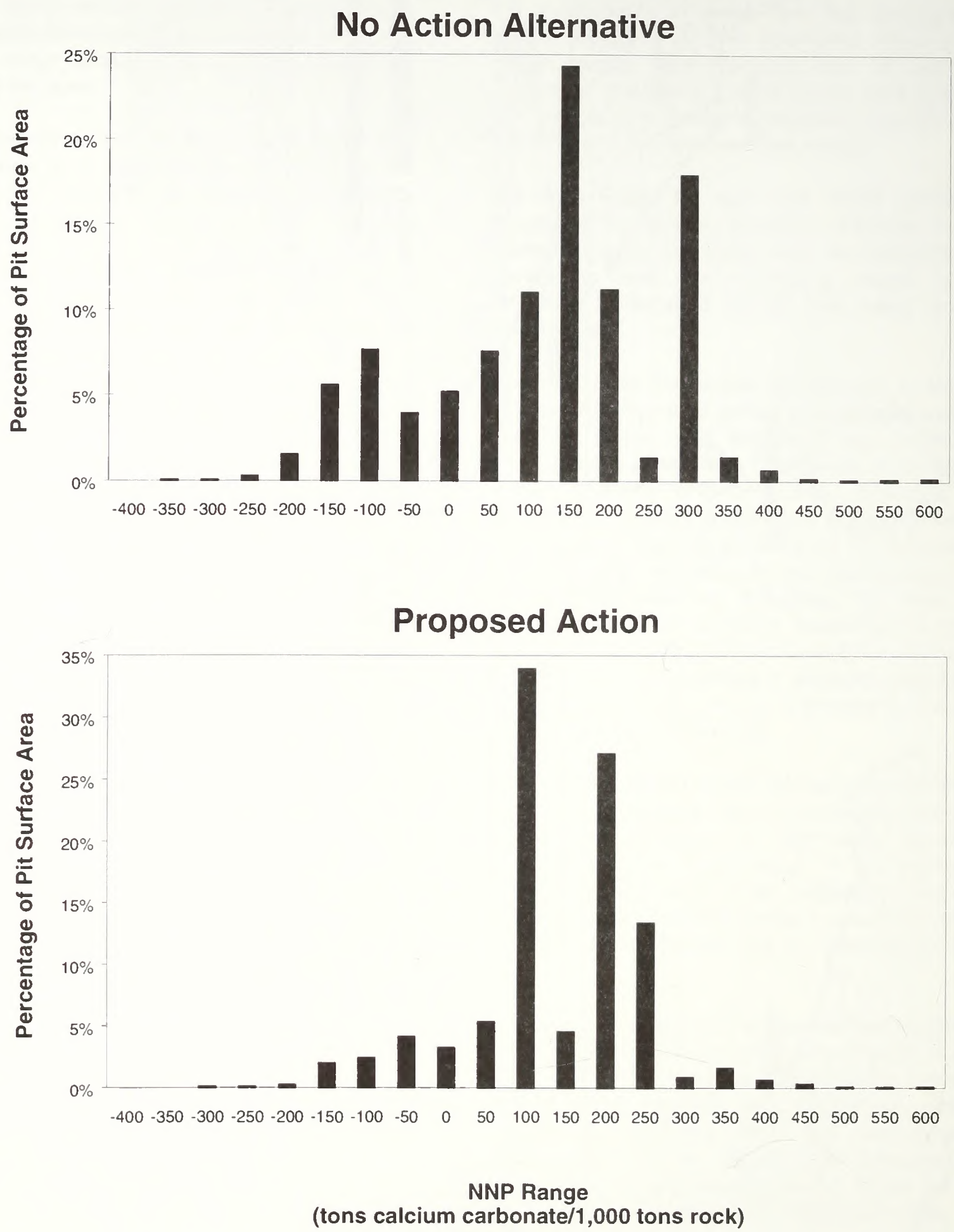


Source: PTI 1996

Twin Creeks Mine

Figure 3-23

Conceptual Model for Predicting Pit Water Quality



Source: PTI 1996

Twin Creeks Mine

Figure 3-24

Histogram of Net Neutralization Potential for Final Submerged Pit Surfaces pit surface would have positive net neutralization potential values.

The net neutralization potential values in the final pit surface for the Proposed Action ranged from -350 to +671 tons $CaCO_3$/kiloton rock, with an area-weighted average wall rock net neutralization potential of +162 tons $CaCO_3$/kiloton rock. The net neutralization potential frequency distribution for the Proposed Action indicates that approximately 91 percent of the rocks in the final pit surface would have positive net neutralization potential values.

The amounts of metals and acid that would be released from acid-generating and acid-neutralizing wall rock were estimated using the results of 46 kinetic (humidity cell) tests. Samples for humidity cell testing were selected to represent the various rock materials that would be exposed within the final pit surface. The amount of arsenic, iron, and other metals released from wall rock generally correlate with the net neutralization potential value of the rock (i.e., increased chemicals were released from rocks exhibiting negative net neutralization potential). However, higher concentrations of several constituents, including antimony were released from rocks with positive net neutralization potential.

Blasting activities can create nitrogen-containing residues in the pit floor and benches. The contribution of blast residue to pit lake water was estimated from Meteoric Water Mobility Testing Procedure of 12 rock samples collected from the pit floor and benches.

Surface Runoff. Surface water runoff into the pit would contain solutes leached from the pit walls. The chemical composition of runoff originating from the pit walls was assumed to be similar to the composition of leachates from Meteoric Water Mobility Testing Procedure (PTI 1996). Meteoric Water Mobility Testing Procedure results from 110 samples were used to approximate concentrations of solutes in runoff from oxidized rock, non-oxidized rock, and alluvium (PTI 1996).

Pit Lake Limnology. The pit lake water quality would be affected by limnologic processes, including lake stratification and mixing, the distribution of oxygen, biological productivity, and the degree of ice cover.

The oxygen concentration in the pit lake would depend upon the degree of mixing in the water column and the biological and chemical oxygen demands in the lake. Limnologic processes were simulated using CE-QUAL-W2, a numerical water quality model developed by the U.S. Army Corps of Engineers (PTI 1996).

The results from the model indicate that under either pit lake alternative, the lake would be thermally stratified in the spring and summer, would undergo complete turnover (mixing) in late fall, and would become isothermal in the winter (PTI 1996). The predicted yearly turnover of the lake would reoxygenate the entire water column in the late fall. The water column is predicted to remain uniformly oxygenated through the winter and spring until the onset of summer stratification. The pit lake is predicted to be most productive during the early simulation period (less than 5 years after the end of mining) under both the No Action alternative and the Proposed Action. Limnological analyses indicate that during this initial period, oxygen would likely be depleted in the deeper portions of the pit lake in the summer prior to lake turnover and mixing. At later simulation times, the pit lake is predicted to have low biological productivity, and oxygen levels would remain high throughout the water column even in the summer months. Additional details regarding the predicted lake limnology are presented in PTI's technical report (PTI 1996).

In summary, the pit lake (in either alternative) is predicted to be completely oxygenated throughout the year with the exception of the summer/spring period during the early stages of infilling, and the assumptions of complete mixing and an oxygenated water column were therefore incorporated into the predictions of pit lake water quality. Model predictions for temperature and dissolved oxygen stratification are consistent with data collected from two existing pit lakes (PTI 1996).

Pit Lake Water Quality Modeling. Water quality in the pit lake was approximated using a series of quantitative models to simulate the chemical loading processes described above and the ongoing chemical reactions that would occur in the lake water. The chemical load from oxidized wall rock was modeled as a function of the surface area of inundated rock, the thickness of the oxidized zone, and the total mass of solutes released from the wall rock. The thickness of the oxidized zone was predicted using the Davis Ritchie model (PTI 1996) based on the estimated porosity of the rock, the moisture content, and duration of exposure of wall rock to the atmosphere. The duration of exposure of wall rock to the atmosphere was calculated as the time between initial pit excavation and inundation by the pit lake. The total solute release was measured in humidity cell tests (PTI 1996).

Chemical reactions, including solution speciation, precipitation, and adsorption in the pit lake were determined using the U.S. Environmental Protection Agency equilibrium geochemical model, MINTEQA2. The modeling approach is based on a series of input parameters and assumptions. Some of the parameters used represent best estimates based on the available information, while other parameters were selected to be environmentally conservative (e.g., iron hydroxide was assumed to be the only available sub-strate for metals sorption). The following specific assumptions were incorporated into the modeling.

- Wall rock would oxidize in the time interval between excavation and inundation due to pit filling.
- After wall rock is submerged in the lake, oxidation of sulfide material stops, and all leachate generated by the oxidation is flushed into the lake. This assumption is consistent with previous studies showing that following submergence, wall rock oxidation effectively ceases (PTI 1996).
- Neutralization of acidity in the pit lake water by contact with wall rock is zero, and carbonate alkalinity in the ground water is the only source of pH buffering.
- The entire pit lake is oxygenated (see the discussion of pit lake limnology).
- Precipitated or adsorbed chemicals are removed completely from the pit lake by settling and burial in geochemically stable sediment.

The composition of ground water does not change over the period being modeled.

- The rates of evaporation and precipitation do not change significantly over the period being modeled.

The predicted water quality of the No Action alternative and Proposed Action are presented in Sections 3.2.2.2 and 3.2.2.3, respectively.

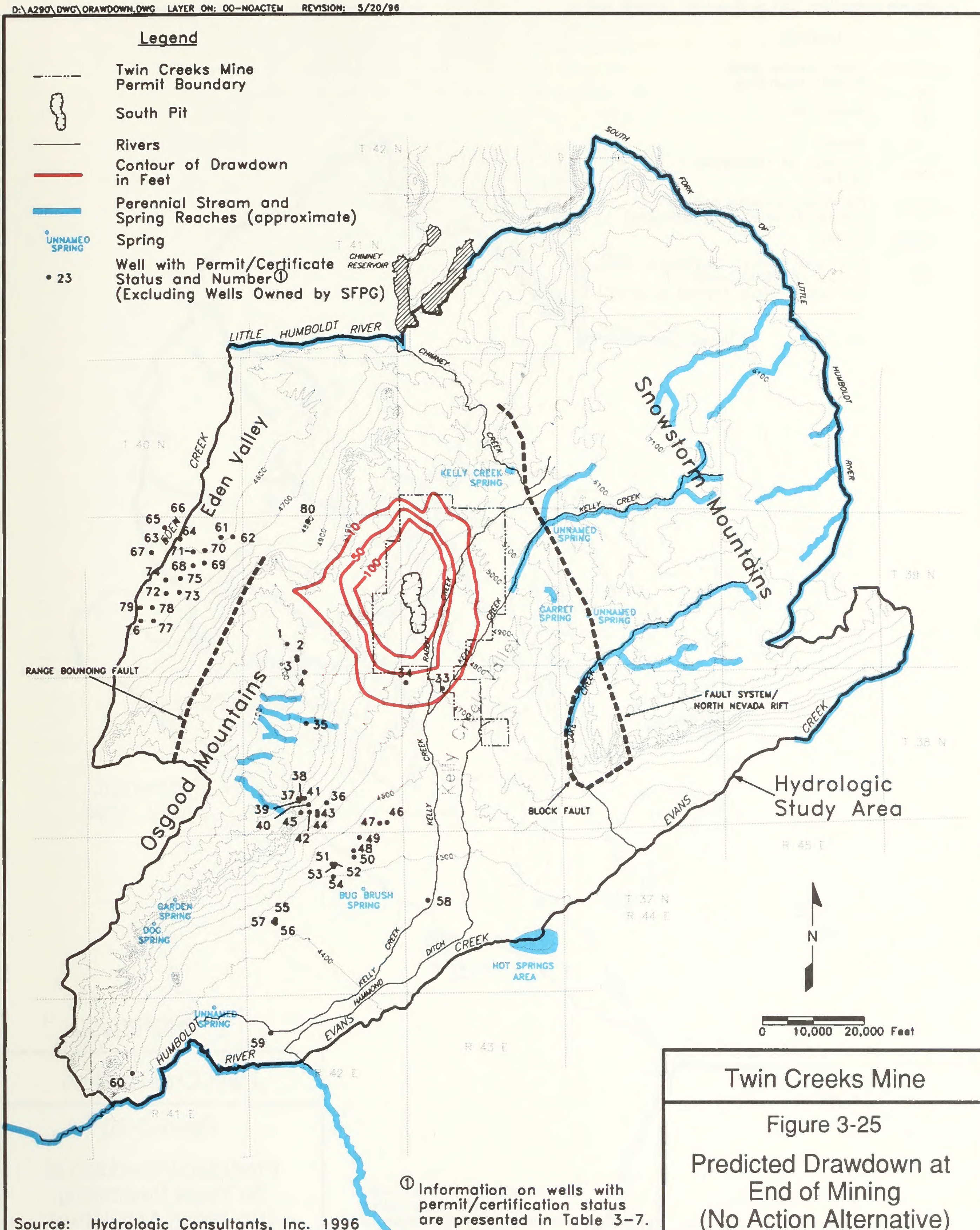
3.2.2.2 No Action Alternative

<u>Water Quantity Impacts</u>

Under the No Action alternative, ground water pumping would continue through the year 2000 to dewater the South Pit. The estimated dewatering rate over this period is predicted to increase from approximately 5,000 to 8,000 gallons per minute. Approximately 4,300 gallons per minute of the water produced would be consumed by the mining and milling operations; surplus water would be discharged to Rabbit Creek and a series of reinfiltration basins.

Ground Water Levels. The area and magnitude of drawdown was predicted using a calibrated numerical flow model (HCI 1996) described in Section 3.2.2.1. As shown in ***Figure 3-25***, at the end of mining, the drawdown area as defined by the 10-foot drawdown contour, is predicted to extend up to 4 miles from the center of the pit. Once dewatering activities cease, ground water would discharge into the pit and form a pit lake that would exist for the foreseeable future. After the pit lake water levels reach equilibrium, the ground water would continue to discharge into the pit to replace water lost through evaporation. Because of passive inflow of ground water into the pit lake, the cone of depression is predicted to expand in the postclosure period. After 50 years (***Figure 3-26***), the cone is predicted to have expanded in all directions. At this point in time, the area affected by 10 feet or more of drawdown is predicted to extend on the order of 5 to 7 miles from the center of the pit. Between the 50- to 100-year postmining period (***Figure 3-27A***), the area of drawdown would essentially remain unchanged except toward the southeast, where the cone of depression is predicted to expand an additional 2 miles.

Numerical modeling indicates that infiltration would potentially increase the water levels in the vicinity of the infiltration ponds up to a maximum of approximately 30 feet. However, even at maximum



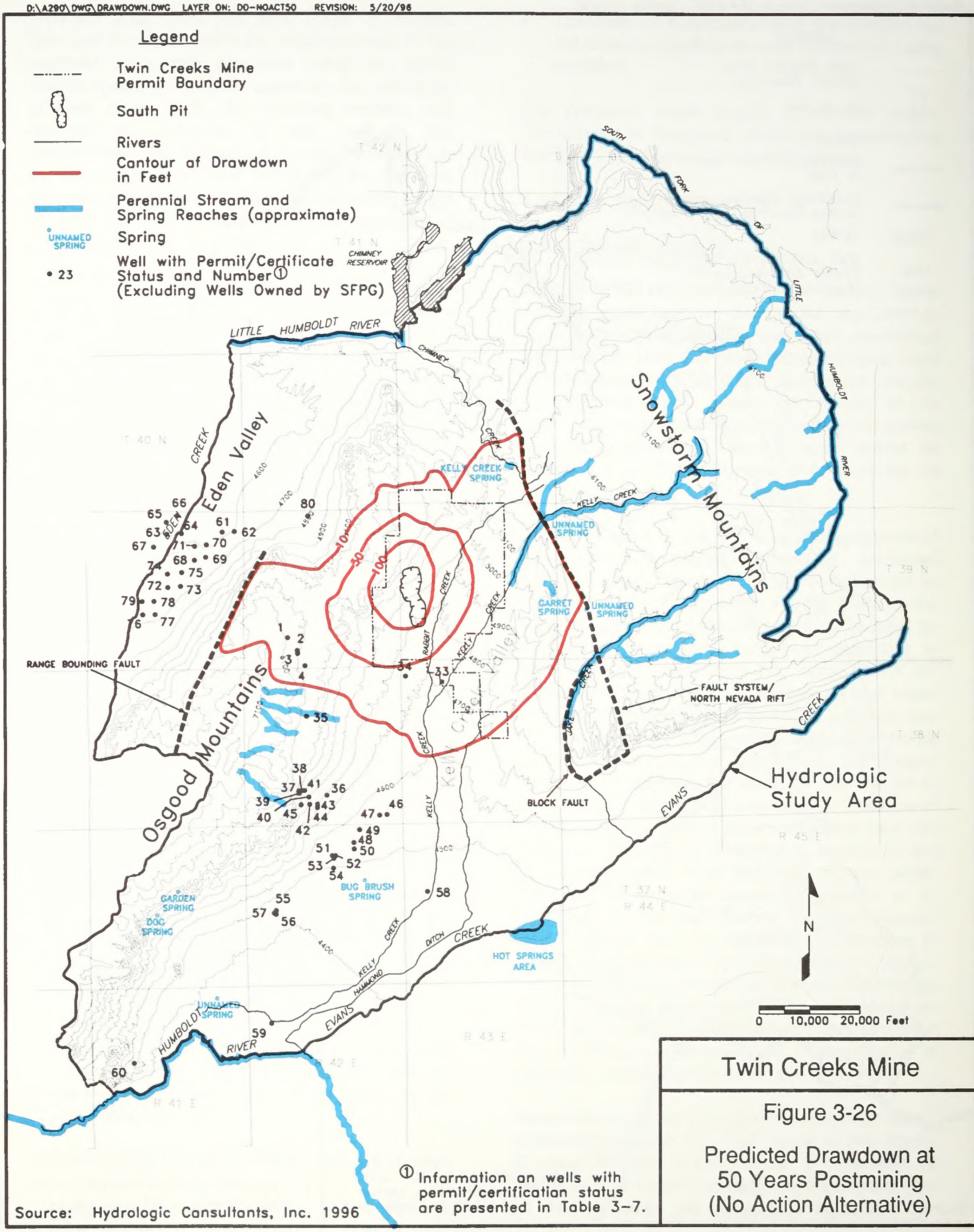
① Information on wells with permit/certification status are presented in Table 3-7.

Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-25

Predicted Drawdown at End of Mining (No Action Alternative)



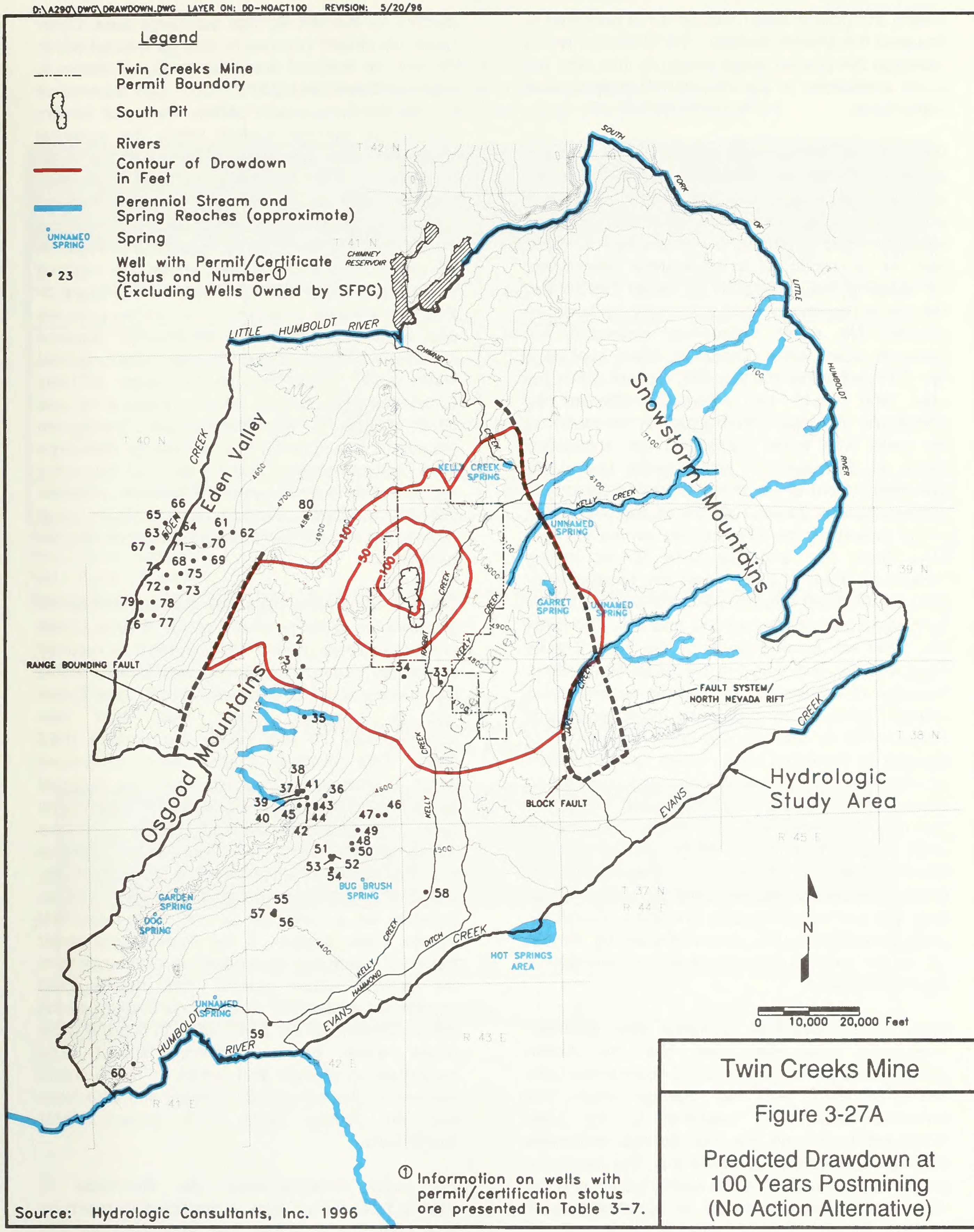
Twin Creeks Mine

Figure 3-26

Predicted Drawdown at 50 Years Postmining (No Action Alternative)

① Information on wells with permit/certification status are presented in Table 3-7.

Source: Hydrologic Consultants, Inc. 1996



Twin Creeks Mine

Figure 3-27A

Predicted Drawdown at 100 Years Postmining (No Action Alternative) height, the ground water mound is not predicted to intersect the ground surface. The infiltration would recharge the ground water system in this area but is not anticipated to significantly influence surface water flows.

Impacts to Wells. The results of the model simulations indicate that the water levels in six wells not associated with the Twin Creeks Mine with water rights status (four permitted and two certified) could potentially be lowered by 10 to 50 feet as a result of mine-induced drawdown. Considering the uncertainty of model predictions, the actual drawdown could potentially be larger or smaller. No water rights are necessary for domestic water wells. Therefore, there may be a few domestic wells that are also located within the area and could be potentially affected by drawdown. Available information on the depth of the wells with water rights and the anticipated range of drawdown in water levels that could potentially occur at the three simulated periods is summarized in ***Table 3-8***. All of the wells that would potentially be affected are owned by First Miss Gold, Inc. and are used for its mining operations. Four of these wells are located at or near the Getchell Mine and include water pumped from excavated shafts, sumps, and pits. The other two wells are located south of the Twin Creeks mine and are completed in the basin fill alluvium. Because of incomplete data on the current pump settings, yield, depth, and static water levels, it is not possible to estimate the potential severity of impacts to individual wells, which are dependent on the site-specific conditions, well completion details, and timing of the drawdown. However, lowering the water levels in these water supply wells could potentially reduce yield, increase pumping costs, or, if the water level is lowered below the pump setting or below the bottom of the well, the well would become unusable. Therefore, wells located within the areas affected by 10 feet or more of drawdown could experience a significant impact.

Impacts to Perennial Streams and Springs. Drawdown associated with the No Action alternative is predicted to reduce flows in the Little Humboldt River and Hot Springs area. The predicted change in baseflow to the Little Humboldt River and the Hot Springs discharge area are summarized in ***Table 3-9***. The maximum predicted baseflow reduction during mining and the 100-year postmining period is approximately 8 percent for the Little Humboldt River and 12 percent for the Hot Springs discharge area. Other perennial stream reaches or springs located within or near the mapped drawdown area, as shown in ***Figures 3-27A*** and ***3-27B,*** could also experience a reduction or cessation of flow. Perennial stream reaches or springs located within the potential drawdown area are summarized in ***Table 3-10***. Comparison of the regional water level information and the surface elevation of the streams and springs indicates that the lower perennial reach of Kelly Creek and the three springs listed in ***Table 3-10*** are located 250-400 feet above the regional water table. Other springs identified in ***Figure 3-27B*** that are near or within the drawdown area are also apparently located a considerable distance (hundreds of feet) above the interpreted regional water table. Hence, flow in this reach of Kelly Creek, the three springs listed in ***Table 3-10***, and other springs in the Osgood and Snowstorm mountains are apparently sustained by discharge from localized aquifers that are perched above the regional ground water system. Therefore, potential impacts to these surface waters from mine dewatering and pit lake induced drawdown are not anticipated.

There is uncertainty regarding the interconnection between the lower perennial reach of Jake Creek and the regional ground water system. A recently completed bedrock monitoring well located within 0.5 mile but at a higher elevation than Jake Creek had a measured water level that was approximately 78 feet below the surface (HCI 1996). This relatively shallow depth to ground water in this area suggests that the regional ground water table and the flows in Jake Creek may be interconnected. However, flow measurements during low flow periods indicate that this section of Jake Creek is a losing reach, suggesting the lower perennial reach behaves primarily as a recharge source to the regional ground water system. If the flows in the lower perennial reach are dependent on discharge from the ground water system, this reach could experience a reduction of flows, particularly during the postmining period. A reduction in flows to Jake Creek would be a significant impact. The magnitude of change and length of reach would depend on the site-specific stream characteristics and on surface water and ground water interactions.

Pit Lake Development. As illustrated in ***Figure 3-28***, the pit lake is predicted to reach its final elevation of 4,580 feet approximately 130

TABLE 3-8
State Permitted or Certified Water Supply Wells
Located within the Predicted Drawdown Area (No Action Alternative)

Map Location Number	Application Number	Use[1]	Well Type	Well Screen	Total Depth	Recorded Static Water Level	No Action Estimated Drawdown (End of Mining)	No Action Estimated Drawdown (+50yrs)	No Action Estimated Drawdown (+100yrs)
1	45732	MM	Excavated Sump	-	-	-	<10	10-50	10-50
2	10370	MM	Dug Mine Shaft	-	400	-	<10	10-50	10-50
3	29075	QM	Dug Mine Shaft	-	400	-	<10	10-50	10-50
4	45730	MM	No Well Log is available	-	-	-	<10	10-50	10-50
33	10331	MM	No Well Log is available	-	400	-	10-50	10-50	10-50
34	28758	MM	14-inch	120-594	601	108	10-50	10-50	10-50

dash (-) indicates data are unavailable.
[1]MM = mining and milling.
QM = quasi municipal.
Source: Based on information presented in HCI 1996 and on file with the Nevada State Engineer's Office (1996).

TABLE 3-9
Hydrologic Effects to the Little Humboldt River and Hot Springs
No Action Alternative

	End of Mining		50 Years After End of Mining		100 Years After End of Mining	
	Change in Baseflow	Percent Change in Baseflow	Change in Baseflow	Percent Change in Baseflow	Change in Baseflow	Percent Change in Baseflow
Little Humboldt River	-0.02 cfs	-0.4 %	-0.45 cfs	-8.0 %	-0.41cfs	-7.3 %
Hot Springs	0.00 cfs	0.0 %	-0.06 cfs	-4 %	-0.19 cfs	-12.4 %

Source: HCI 1996.

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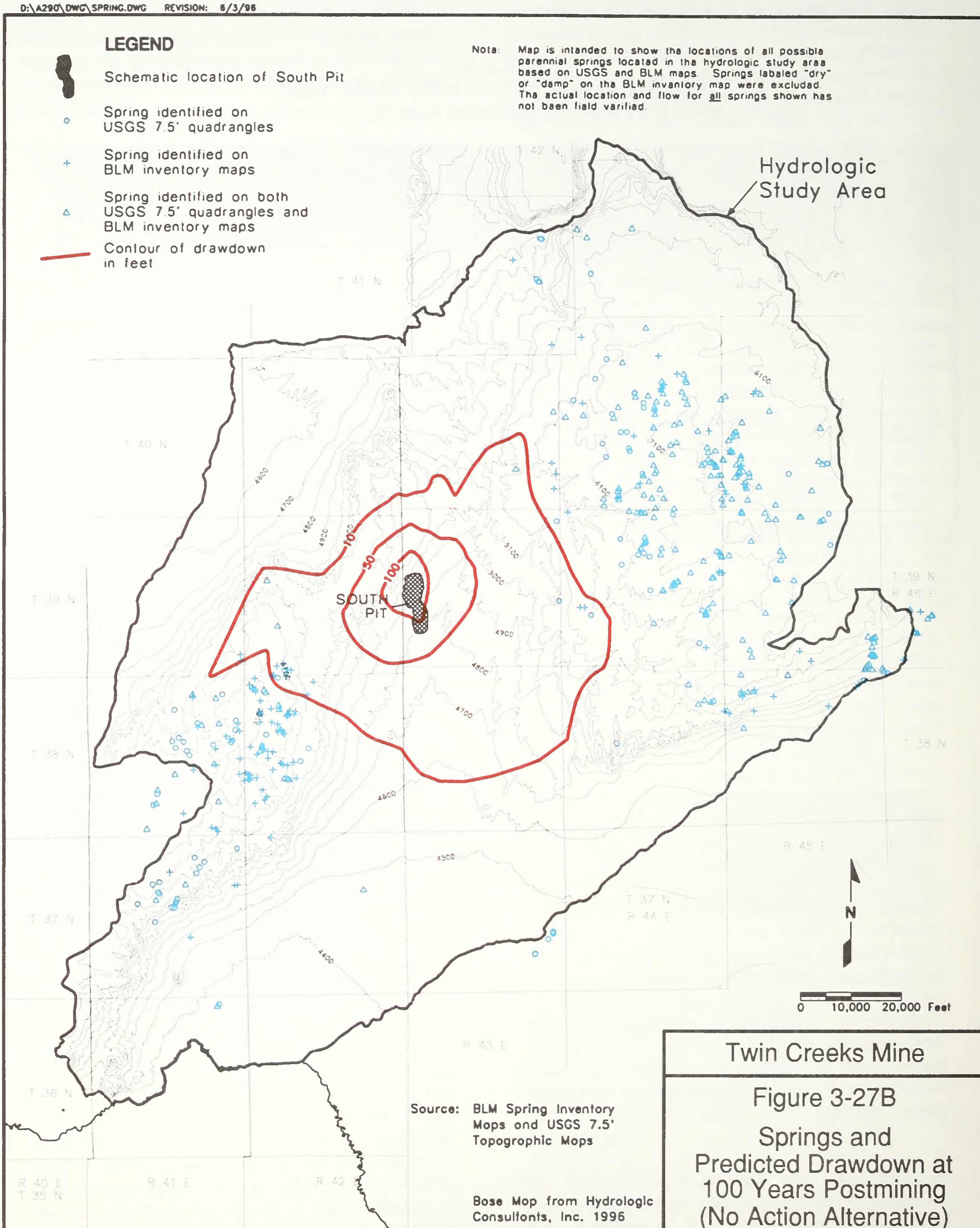


Twin Creeks Mine

Figure 3-27B

Springs and Predicted Drawdown at 100 Years Postmining (No Action Alternative)

TABLE 3-10
Other Perennial Streams
and Springs within the Predicted Drawdown Area
No Action Alternative

Stream or Spring	Approximate Ground Surface Elevation (feet)	Estimated Regional Water Table Elevation (feet)[1]	Connected to Regional Water Table	Estimated Baseflow[2] (gpm)[3]	Potential Impacts from Drawdown of Regional Water Table
Kelly Creek (SW-2)	5,040	4,760	Unlikely	383	Not anticipated
Jake Creek (SW-5) (SW-6)	5,240 4,780	5,150 4,710	Unknown Unknown	482 439	Possible reduction of baseflow[4]
Garret Spring (SPG-4)	5,[illegible]40	4,760	Unlikely	6	Not anticipated
Kelly Creek Spring (SPG-5)	5,140	4,890	Unlikely	0.7	Not anticipated
Spring NW of Hammond Ranch (SPG-8)	5,360	5,000	Unlikely	0.4	Not anticipated

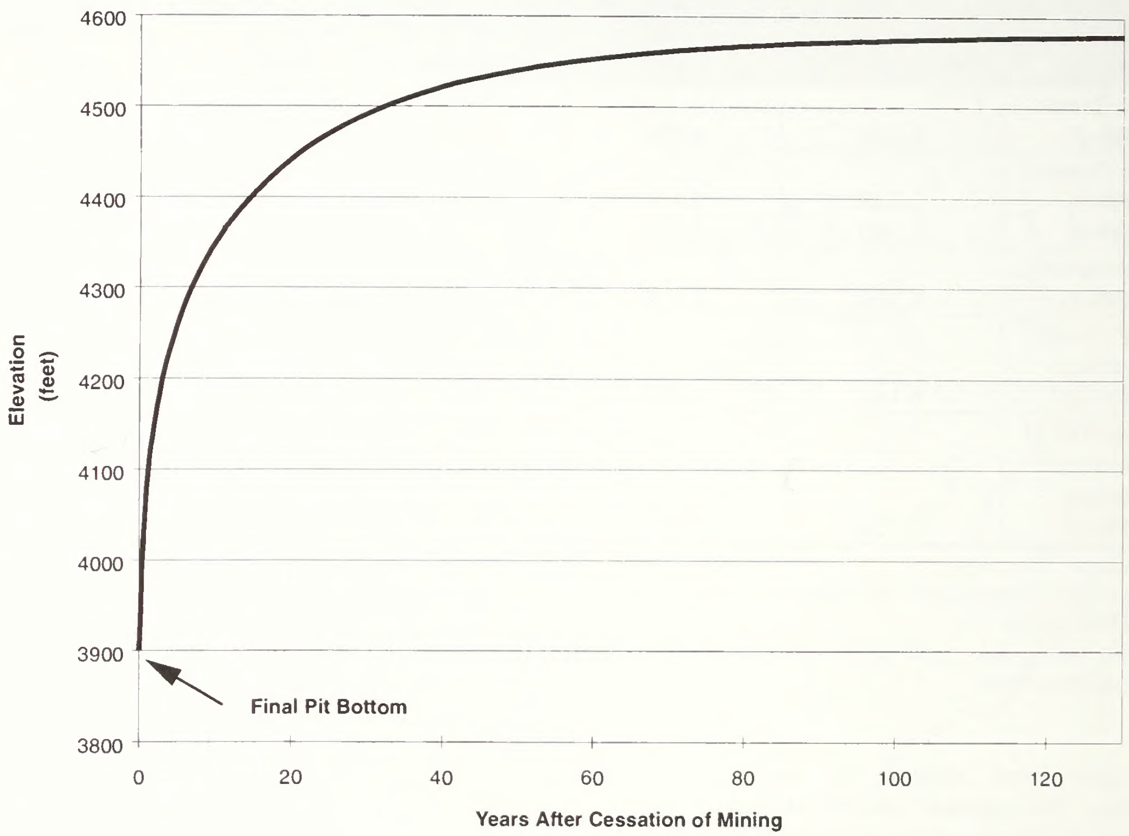
[1]HCI 1996.
[2]Based on flow measurement recorded on 11/15/95, WESTEC 1995b.
[3]Gallons per minute.
[4]Reduction would only occur if the lower perennial flows in Jake Creek are dependent on discharge from the regional groundwater system.

years after mine closure. In the No Action alternative, two separate lakes (referred to as the north and south lobes) would exist for the first 6 years of pit infilling. After 6 years, the north and south lobes of the pit lake are predicted to merge and form a single lake (PTI 1996). After full recovery, the final pit lake is predicted to have a surface area of 420 acres, a maximum depth of 680 feet, and a volume of 130,000 acre-feet. After the lake fills, an estimated 1,500 acre-feet per year would be lost through evaporation.

As the mine begins to fill, inflow to the pit would be composed of approximately 99 percent ground water and 1 percent precipitation and surface runoff. After the pit lake reaches its equilibrium water level, the inflow would be composed of approximately 77 percent ground water, 22 percent direct precipitation, and less than 1 percent surface runoff. Modeling indicates that inflow rates to the pit lake would decrease from 3,600 gallons per minute at the time the pit begins to fill to approximately 700 gallons per minute after full recovery of the pit lake (HCI 1996; PTI 1996).

The pit lake would fill to an elevation where losses from the pit by evaporation equal the surface water and ground water entering the pit. Once the pit lake fills, the surface of the lake is predicted to be at least 100 feet below the regional water table in all directions. Therefore, the pit lake is predicted to behave as a hydrologic sink where no net outflow to either ground or surface waters is anticipated (HCI 1996).

A sensitivity analysis was conducted to evaluate changes in the pit lake level and the potential for outflow form the pit lake resulting form changes in the mean annual evaporation rate (HCI 1996). For the sensitivity analysis, the mean annual evaporation rate used in the model (42 inches per



Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-28

Pit Lake Elevation over Time (No Action Alternative) year) was reduced by approximately two standard deviations using historic evaporation data for the region. Using the reduced evaporation rate (17 inches per year), the numerical model predicted that the final pit lake water level for the No Action alternative would rise approximately 49 feet. The model also predicted that, because water levels in the region around the pit would not recover to the premining water levels, the pit lake would still have a continued inward gradient, and no outflow would occur (HCI 1996).

Water Quality Impacts

Pit Lake Water Quality Modeling Results. Pit lake water quality modeling results for three stages of pit lake filling corresponding to 5, 27, and 130 years after mine closure are presented in ***Table 3-11*** (PTI 1996). The water quality was modeled to 130 years following the cessation of mining to correspond to the time when the pit lake is predicted to reach approximate hydraulic steady state. Uncertainty in the predictions was estimated using the Monte Carlo method, where uncertainties in key parameters were propagated through the model calculations to estimate confidence intervals for all predicted water quality parameters (PTI 1996). It is important to note that because of uncertainties of future climatic conditions, ground water flow rates, and ground water chemistry, the confidence in the predictions of pit lake water quality decreases with increasing time after the end of mining. Therefore, predictions made for several decades into the future should be viewed as indicators of relative trends in concentrations, rather than absolute values.

Model results indicate that wall rock exerts its greatest influence on water quality at early stages, when the ratio of inundated wall rock area to lake volume is relatively high, and the constituent releases from wall rock are subject to a proportionately smaller degree of dilution in the pit lake. At later stages, the pit lake chemistry becomes dominated by ongoing inflows from ground water and runoff, coupled with the effects of evaporative concentration.

The variations in median concentrations with time for pH, total dissolved solids, arsenic, and antimony are illustrated in ***Figure 3-29***. The pH of the pit lake is predicted to rise from a median value of approximately 8.2 to a median value of approximately 8.5 standard units over the 130-year model period. The predicted increase in pH is caused by the diminishing influence of acid releases from wall rock, the ongoing addition of carbonate alkalinity from ground water inflows, and evaporative concentration. Beyond 1 year after mining, the modeling indicates a greater than 90 percent probability that the pit lake would have a pH above 7. Thus, it is highly unlikely that the pit lake would be acidic.

The concentrations of total dissolved solids, antimony, and arsenic are predicted to increase over time. Total dissolved solids in the lake are predicted to increase from an initial concentration of approximately 350 milligrams per liter at year 5 to approximately 480 milligrams per liter at year 130. The concentration of antimony is predicted to be approximately 0.97 milligrams per liter in the north lobe and 0.08 milligrams per liter in the south lobe at year 5 and reach a concentration of 0.78 milligrams per liter at year 130. Arsenic concentrations are predicted to be 0.17 and 0.13 milligrams per liter in the north and south lobes, respectively, at year 5 and would increase to 0.33 milligrams per liter at year 130.

More than 50 percent of the arsenic contributed by wall rock releases during the early stages of pit infilling would be removed from the pit lake by adsorption onto hydrous ferric oxide. At later stages, when ground water inflow dominates the lake chemistry and less iron is available to remove arsenic, evaporative concentration would cause arsenic concentrations to rise. In addition, arsenic sorption is favored at lower pH, so as the lake pH increases, the amount of arsenic adsorption decreases. Experiments designed to simulate evaporative concentration show that arsenic is also removed from solution via coprecipitation with calcite, and this removal mechanism for arsenic was incorporated into the geochemical modeling (PTI 1996).

Based on the predicted concentrations, the primary and secondary enforceable maximum contaminant levels in Nevada would be exceeded for aluminum, antimony, and arsenic. However, because the pit lake is not predicted to discharge to surface or ground waters, the pit lake is not expected to degrade surrounding waters of the state. Therefore, maximum contaminant levels are not applicable. As the pit lake develops, the lake water itself would become a water of the State of Nevada. Water quality standards applicable to the

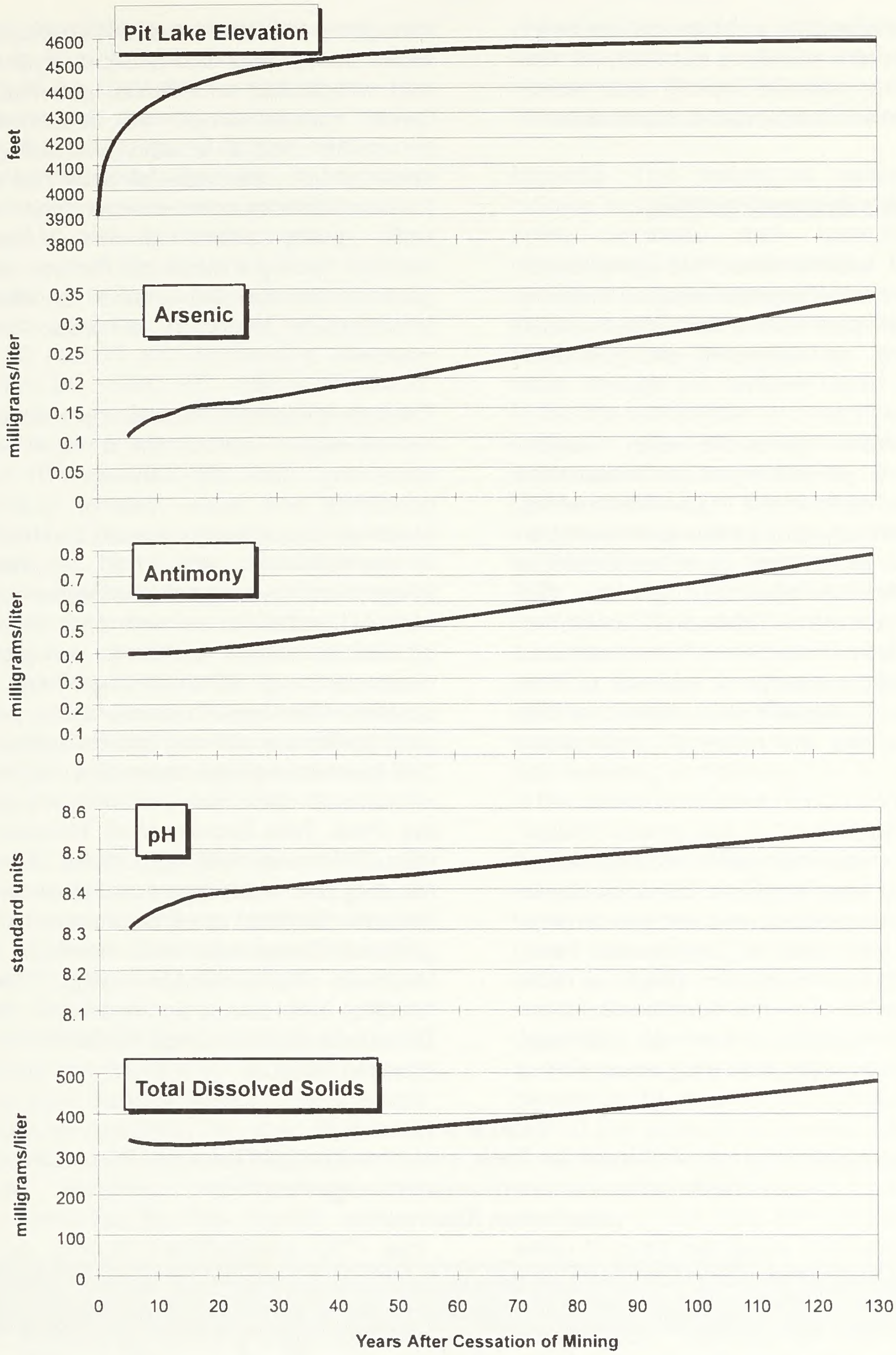
TABLE 3-11
Median Predicted Chemical Concentrations in the No Action Alternative Pit Lake

		Years After Mine Closure			
	Units	5 (north lobe)	5 (south lobe)	27	130
pH	s.u.	8.2	8.5	8.4	8.5
Total dissolved solids	mg/l	360	330	330	480
Alkalinity	mg/l as $CaCO_3$	43	76	67	97
Hardness	mg/l as $CaCO_3$	220	160	170	220
Aluminum	mg/l as Al	0.84	0.10	0.43	0.39
Antimony	mg/l as Sb	0.97	0.077	0.43	0.78
Arsenic	mg/l as As	0.17	0.10	0.17	0.39
Barium	mg/l as Ba	0.021	0.028	0.027	0.022
Cadmium	mg/l as Cd	0.0006	0.0026	0.0008	0.0043
Calcium	mg/l as Ca	40	12	40	8.7
Chloride	mg/l as Cl	17	18	20	36
Chromium	mg/l as Cr	0.0005	0.0007	0.0007	0.0007
Copper	mg/l as Cu	0.0005	0.0069	0.0007	0.0006
Fluoride	mg/l as F	1.2	0.85	0.97	8.5
Iron (II)	mg/l as Fe^{2+}	<0.0001	<0.0001	<0.0001	<0.0001
Iron (III)	mg/l as Fe^{3+}	0.0004	0.0069	0.0008	0.0006
Lead	mg/l as Pb	<0.0001	0.0019	<0.0001	0.0001
Magnesium	mg/l as Mg	29	31	31	49
Manganese	mg/l as Mn	<0.0001	<0.0001	<0.0001	<0.0001
Mercury[2]	mg/l as Hg	0.0001	0.0069	0.0001	0.0002
Nickel	mg/l as Ni	0.046	0.028	0.032	0.037
Potassium	mg/l as K	8.5	11	8.3	12
Selenium[2]	mg/l as Se	0.040	0.0091	0.018	0.018
Silver	mg/l as Ag	0.0035	0.0046	0.0031	0.0043
Sodium	mg/l as Na	34	42	44	75
Sulfate	mg/l as SO_4	170	120	120	170
Thallium[2]	mg/l as Tl	0.022	0.0061	0.012	0.021
Zinc	mg/l as Zn	0.014	0.018	0.012	0.0094

[1]Each concentration is the median of 1,000 realizations. Therefore, reported concentrations do not necessarily represent a single water chemistry.
[2]The increase in concentration of these elements is an artifact of using detection limits for samples in which the element was not detected.
Source: PTI 1996.

lake under the current Nevada Administrative Code would depend on the potential beneficial uses of the lake.

At closure, a rocky berm would be constructed around the perimeter of the pit to restrict access into the pit by humans, livestock, and wildlife. In addition, as part of final closure, the ramp leading down into the pit would be blasted to further preclude access to the lake. The lake is not intended to be a drinking water source for humans or livestock or to be used for recreational swimming. Therefore, standards to protect the lake as a drinking water source, livestock water supply, or for recreational swimming are not applicable. Aquatic standards are also not applicable because there is no intention to use the lake as a fisheries resource. The only anticipated beneficial use for the lake water is as a water source for wildlife. A risk assessment of potential pit water quality



Notes:

1. Concentrations for the 0-5 year postmining period are not shown because the pit lake would consist of two separate lakes with differing concentrations (See Table 3-11).
2. Concentrations presented are median predicted values for 1,000 realizations. The entire range of concentrations bracketed by the 5th and 95th percentile is presented in PTI 1996.

Source: PTI 1996

Twin Creeks Mine

Figure 3-29

Trends in Concentration of Selected Water Quality Constituents over Time (No Action Alternative) impacts to terrestrial wildlife and humans has been performed (Parametrix 1996); a summary of the risk assessment and potential impacts to terrestrial wildlife and humans is presented in Appendices C and D.

Mine Rock Material Storage Facilities

Overburden and Interburden. Past operation of the mine has generated approximately 315 million tons of overburden and interburden. This material consists primarily of alluvium and oxidized material.

Currently permitted operations (No Action alternative) involve generating an additional 692 million tons of overburden and interburden, including approximately 610 million tons from the South Pit and 82 million tons from the Vista Pit. The net neutralization potential data for this material are summarized in ***Table 3-12***. Under the No Action alternative, analysis of the samples indicates that approximately 11 percent of the South Pit material and less than 1 percent of the Vista Pit material has the potential to generate acid.

As discussed in Section 2.3.3, the general design of the overburden and interburden storage areas would consist of at least a 50-foot thick basal layer composed of oxidized overburden and interburden overlain by 50-foot lifts of overburden and interburden reaching a maximum height of 400 feet. The overburden and interburden would be placed on the storage piles in the order that they are removed from the pits. Following closure of a storage area, the overburden and interburden would be covered with a 5-foot layer of alluvium and revegetated to minimize potential infiltration. Cover material would be selectively handled to ensure that it is acid-neutralizing and that leachate from the material does not exceed the Nevada Division of Environmental Protection's water quality criteria for the Meteoric Water Mobility Testing Procedure. Surface water would generally be diverted around the storage areas to minimize infiltration of water through the material.

The type of net acid-neutralizing material used and the thickness of the basal layer would vary depending on the site-specific subsurface conditions and oxide material availability. The basal layer was designed such that the basal layer in combination with the neutralizing and attenuation capacity of the native alluvial and bedrock materials beneath the facilities would provide a similar protection to ground water resources for all of the overburden and interburden facilities. The specific basal layers proposed for each facility are summarized in Section 2.3.3, and the geochemical characteristics for the different alluvial and oxide rock materials are presented in the Final Twin Creeks Mine Materials Handling Plan (PTI and WESTEC 1996). The materials handling plan was prepared in accordance with the Nevada Division of Environmental Protection's guidance documents and the BLM Acid Rock Drainage Policy (BLM 1996). The materials handling plan was approved by the Nevada Division of Environmental Protection in April 1996 (Carlson 1996).

TABLE 3-12
Amount of Alluvium, Oxidized Bedrock, and Non-Oxidized Bedrock Placed in Overburden and Interburden Storage Facilities
No Action Alternative

	South Pit (million tons)	%	Vista Pit (million tons)	%
Alluvium	215	35	10	12
Oxidized Bedrock	184	30	66	81
Non-Oxidized Bedrock				
Acid-neutralizing (ANP/AGP >1.2)	143	23	5.9	7
Acid-generating (ANP/AGP <1.2)	68	11	0.4	<1
Total	610	99	82.3	100

Source: Swanson 1996

Approximately 40 million tons of flotation grade ore from the South Pit and 0.46 million tons from the Vista Pit would be removed as part of the No Action alternative; this material may or may not be processed in the future, depending on costs and processing technologies. Because it contains sulfides, the flotation grade ore is potentially acid-generating and would be handled accordingly. The flotation grade ore storage areas would be located on top of existing or proposed overburden and interburden storage areas and would be underlain by at least 50 feet of acid-neutralizing alluvium (PTI and WESTEC 1996; PTI 1996b). Flotation grade ore would be placed in two 50-foot lifts within overburden and interburden storage areas (SFPG 1995a; PTI and WESTEC 1996).

Site Conditions. The current depth to ground water beneath the No Action alternative overburden and interburden storage facilities ranges from a minimum of 120 feet to over 350 feet. Once the pit lake reaches equilibrium in the postclosure period, the predicted depth to ground water beneath these facilities would be at least as deep, or deeper than the existing conditions for all of the overburden and interburden storage areas (HCI 1996).

Overburden and interburden storage areas B, F, H, and K are underlain by at least 100 feet of unsaturated alluvium. All of these facilities, with the exception of a portion of storage area B located east of Rabbit Creek, are underlain by alluvium derived from Paleozoic carbonate and clastic rocks. The portion of storage area B located east of Rabbit Creek is underlain by alluvium derived predominantly from Tertiary rhyolite. The average net neutralization potential of the Paleozoic carbonate-derived alluvium is 270 tons of $CaCO_3$/kiloton, whereas the average net neutralization potential for the rhyolite derived alluvium is 59 tons of $CaCO_3$/kiloton (PTI and WESTEC 1996). The thickness of alluvium generally thins towards the northwest corner of the project area. Paleozoic derived alluvium beneath storage areas J, M, and N generally ranges from 0 to greater than 100 feet. Bedrock exposed at the surface or beneath the alluvium consists of oxidized Paleozoic rocks that include limestone, chert, greenstone, tuff, and other volcanic rocks. Average net neutralization potential for the column of rocks under these overburden and interburden storage areas ranges from approximately 56 to 539 tons of $CaCO_3$/kiloton (PTI and WESTEC 1996). The net neutralization data indicate that all of the facilities would be underlain by materials that have the ability to neutralize acid; areas underlain by Paleozoic derived alluvium or limestone would have the greatest acid neutralization capacity.

Impacts. The results of geochemical testing indicate that there is the potential for generation of acidic leachate and leachates containing constituents at concentrations in excess of maximum contaminant levels for some rock types in the overburden and interburden and in the flotation grade ore. However, the infiltration of water through the facilities would be minimal due to the low precipitation and high evaporation rates. Infiltration would be further minimized by covering and establishing vegetation on the surface. Water balance modeling of the storage facilities indicates that percolation from the base of the facility would be near zero for at least several hundred years (PTI and WESTEC 1996); however, beyond several hundred years, the facilities would develop a continuous long-term downward flow that could result in the slow downward migration of acid and leached constituents. However, the slow migration would allow for water-rock interactions, such as acid buffering and attenuation, to reach equilibrium in the unsaturated zone (PTI and WESTEC 1996).

A statistical modeling technique was applied to estimate the probability of acid production at the base of the storage facilities over a long-term period (assuming all of the sulfide oxidized, which would probably require thousands of years or more). Results of the simulation indicate that, depending on the material in the storage facility and the basal layer design, approximately 2 to 15 percent of the base of the facilities could release acid to the subsurface at some time in the future. Probabilistic modeling also indicates that 99 percent of any acid released through the base of the facility in the long term would be neutralized within 5 to 56 feet below the base of the storage area. For the flotation grade ore storage pile, an estimated 5 percent of the base of the pile could release acid; however, 99 percent of any acid released through the base of the facility would be neutralized within 23 feet below the base of the storage area. Because the depth to ground water is predicted to be greater than 120 feet under the overburden and interburden storage areas, there is not a realistic probability that acid leachate would reach ground water.

In summary, excess buffering and neutralization capacity in the constructed basal layer and existing alluvial materials and rocks beneath the basal layer is predicted to neutralize any acid produced and minimize the mobilization of arsenic, antimony, and other constituents from these materials (PTI and WESTEC 1996). Based on the site conditions, low precipitation, depth to ground water, design of the facilities, and neutralization and attenuation capacity of the constructed basal layer and alluvium and oxide rocks beneath the facilities, potential surface or ground water degradation resulting from the overburden and interburden storage areas is not anticipated.

Sulfide Ore Stockpile

Operation. The sulfide ore would be stored as described in Section 2.3.4. Approximately 19 million tons of sulfide mill grade ore would be removed from the South Pit and approximately 0.4 million tons of sulfide ore would be removed from the Vista Pit as part of the No Action alternative. A portion of the ore mined from the South Pit may be temporarily stored in locations adjacent to the existing Juniper Mill and the proposed Sage Mill (***Figure 2-3***). Ore from the Vista Pit would be processed immediately and would not require storage.

Geochemical Characterization. Static acid-base testing of 31 ore samples from the South Pit indicates that the ore generally has a net acid-generating capacity (WESTEC 1995d). The weighted average (based on tons of material represented by each sample) net neutralization potential for the 31 samples is -67 tons $CaCO_3$/kiloton of rock.

Impacts. The potential for discharge to surface or ground water resources is minimal because of the selective handling and short storage period for the material. Therefore, storage of sulfide ore under the No Action alternative is not anticipated to have significant impact on surface water or ground water quality.

Heap Leach Facilities

Operation. There are approximately 61 million tons of material in existing heap leach pads, and an additional 72 million tons of material would be placed on heap leach pads as part of the No Action alternative.

As described in Section 2.3.7, leach pads would be designed with geosynthetic/soil liner systems and leak detection systems (SFPG 1995a). Solution ponds would be double-lined and also equipped with leak detection systems (SFPG 1995a).

Closure and Reclamation. Neutralization of the heap leach pads would begin after the economic gold values have been recovered. As described in Section 2.4.11.8, heaps would first be allowed to drain freely; during drainage the solution would be collected, and the volume would be reduced through evaporation in the process ponds. Fresh water would then be added to the solutions. This rinse would be recirculated through the heaps to flush out residual leach solution until the following conditions are met: (1) the weak acid dissociable cyanide level of the spent ore is 0.2 milligrams per liter or less, (2) the pH of the solution stabilizes between 6 and 9, and (3) the solution meets or exceeds primary drinking water standards (SFPG 1995a). If neutralization by rinsing does not achieve the required closure criteria, then SFPG would submit a proposal to the Nevada Division of Environmental Protection for an alternative heap leach pad closure method.

As described in Section 2.4.11.9, solutions in the process ponds, sediment ponds, water treatment ponds, and tailings reclaim ponds would be disposed of through evaporation. Precipitates and sludges in the bottoms of these storage area structures would be analyzed and disposed of in accordance with appropriate regulations.

Impacts. Operation and closure of the heap leach facilities is not anticipated to have significant impact on water quality because the facilities are designed to operate at zero discharge by incorporating diversion channels, soil liners, drainage collection sights, and leak detection (SFPG 1995a). In addition, if leakage of materials from the heap leach facilities were to occur, the potential for significant impacts is considered minimal because of naturally occurring conditions at the site, including low annual precipitation, depth to ground water in excess of 170 feet, and the attenuation capacity of the underlying alluvial materials.

Mill and Tailings Facilities

Operation. There are approximately 20 million tons of material in existing tailings storage areas; an additional 45 million tons of material would be placed in tailings storage areas as part of the No Action alternative.

As described in Section 2.3.6, tailings would be discharged to lined tailings storage areas, and seepage and reclaim solutions would be stored in double-lined ponds. Tailings impoundment and solution pond facilities would be designed for zero discharge to surface water or ground water and to fully contain precipitation and runoff resulting from the 25-year, 24-hour storm event combined with normal operating volumes.

Reclamation. As described in Section 2.4.11.5, reclamation of the tailings facilities would include creating a free-draining stable surface and installing a revegetated cover to reduce erosion and infiltration of meteoric waters. Surface water run-on would be diverted around the tailings storage areas. Underdrain solution from the tailings storage areas would be collected in the reclaim ponds, and the solutions in the reclaim ponds would be allowed to evaporate. Ponds would be reclaimed as described in Section 2.4.11.9.

Geochemical Characterization. The acid-generating and acid-neutralizing potentials of tailings material were determined by static testing of eight samples. The composition of leachate was determined by conducting the Meteoric Water Mobility Testing Procedure on eight samples. In addition, tailings slurry samples were filtered, and the resulting filtrate was analyzed for metals and water quality parameters (SFPG 1995a).

Results of static acid-generating and acid-neutralizing potential testing indicate that none of the tailings samples are potentially acid-generating. The Meteoric Water Mobility Testing Procedure results indicate that several metal constituents, including arsenic, cadmium, chromium, mercury, and lead have the potential to leach from the tailings solids. Analysis of the tailings filtrate confirms the presence of these metals, as well as copper, selenium, silver, zinc, and chloride.

Impacts. Operation and closure of the mill and tailings facilities are not anticipated to have significant impact on water quality because the facilities are designed to operate at zero discharge (SFPG 1995a). In addition, if materials were to leach from the mill and tailings facilities, the potential for significant impacts is considered minimal because of naturally occurring conditions at the site, including low annual precipitation, depth of ground water in excess of 170 feet, and the attenuation capacity of the underlying alluvial materials.

<u>Treated Dewatering Water</u>

A portion of the water from the South Pit dewatering operation is treated with ferric sulfate to remove arsenic then discharged to Rabbit Creek and the reinfiltration basins. Under the No Action alternative, the estimated discharge to Rabbit Creek would range from 500 to 3,700 gallons per minute. A portion of the water discharged to the Rabbit Creek drainage is consumed through evapotranspiration processes along the drainage corridor; the remainder infiltrates the unsaturated zone and eventually the water table. Discharge to the reinfiltration basins would range from 0 to 3,200 gallons per minute. Water discharged to the reinfiltration basins is treated in a filtration plant. The basins are designed to promote infiltration of the dewatering water into the ground water system. However, a small portion of the water would be lost through evaporation off the surface of the ponded water.

The quality of the treated discharge to Rabbit Creek and the reinfiltration basins is presented in ***Tables A-3*** and ***A-4*** (Appendix A). Water discharged to Rabbit Creek has generally been within permit limits, but occasional exceedances of total dissolved solids, total suspended solids, and iron have occurred. One sample of treated discharge to the reinfiltration basins contained an antimony concentration of 0.039 milligrams per liter which is in excess of the primary maximum contaminant level of 0.006 milligrams per liter. Under the permit to discharge (Nevada Division of Environmental Protection 1995c), monitoring of antimony concentrations in either the treated discharge or wells designed to collect background water quality data was not required. Constituent concentrations in ground water samples collected in the vicinity of the reinfiltration basins do not exceed primary or secondary standards, with the exception of chloride and total dissolved solids which were exceeded in samples collected from two wells during November 1995 (WESTEC 1995a).

Impacts. The discharge of treated water to Rabbit Creek and the reinfiltration basins is expected to have limited impact on water quality. Baseline data for antimony concentrations in ground water beneath the reinfiltration basins are not available.

Without background water quality data, it is not possible to determine if antimony concentrations in the discharge water exceed the background concentrations in the ground water system beneath the reinfiltration basins. If the antimony concentrations of the discharge exceed the background concentrations in the ground water, then the infiltration of the treated water could impact the water quality of the ground water system beneath and downgradient of the reinfiltration basins.

Sludge generated in the water treatment and filtration plants would be disposed of in a lined tailings facility. The geochemical characteristics of the sludge generated by the water treatment plant were evaluated by subjecting a representative sample of the sludge to the U.S. Environmental Protection Agency's Toxicity Characteristic Leaching Procedure. The Toxicity Characteristic Leaching Procedure is used to determine if a material is classified as hazardous. Characterization of the sludge using this procedure and the U.S. Environmental Protection Agency's evaluation criteria indicates that the sludge does not exhibit hazardous characteristics. Based on the geochemical characteristics of the material and the proposed disposal methodology, the potential for adverse effects to water quality from sludge disposal is considered minimal.

Bioremediation Site

Bioremediation facilities, as described in Section 2.3.13, would actively remediate hydrocarbon-contaminated soils and hydrocarbon-contaminated material from sumps (***Figure 2-3***). Test-scale bioremediation facilities are located on an existing lined leach pad (WESTEC 1995h). The expanded facilities would be constructed over a liner with a permeability of less than 10^{-7} centimeters per second. The expanded facilities would also include berms, drainage sumps, and run-on/run-off controls, which would result in zero discharge from the facilities.

Closure of the facilities would include analysis of all soils contained in the cell(s) to determine if the material is below 100 milligrams per kilogram total petroleum hydrocarbons, removal and disposal of the drainage sumps, regrading of the surface to premining topography, and revegetation of the pad (WESTEC 1995h).

Impacts. Limited or no impact to water quality is expected to occur from the bioremediation facilities.

Watershed Yield, and Erosion and Sedimentation

Stormwater Control. Development and expansion of overburden and interburden storage areas would affect drainage patterns within the project area and may create small changes in stormflows immediately downgradient because of changes in infiltration and runoff. In general, these effects would be minor.

Overburden and interburden storage area B would block the lower Rabbit Creek drainage in Section 29 and provide an area for storm water to collect behind and within the lower layers of overburden and interburden storage area B. Approximately 10.5 square miles of undisturbed watershed area and slightly more than 2 square miles of disturbed drainage area would be affected by the overburden and interburden storage area B expansion. During a 2-year, 24-hour storm event, no runoff is anticipated to collect behind the storage area. However, during a 10-year, 24-hour storm event, an estimated 38 acre-feet of stormwater runoff could temporarily collect upstream of overburden and interburden storage area B. During a 100-year, 24-hour storm event, an estimated 192 acre-feet of stormwater runoff could temporarily collect upstream of overburden and interburden storage area B. Given the channel configuration in this locale, pools from large storms would be deep enough to be present for an extended time. Ultimately, surface flows would be affected as runoff volumes from large storm or snowmelt events were lost through seepage and evaporation. Temporary collection of surface water flows could potentially reduce intermittent flows in Rabbit Creek downstream from the project. Impacts from flow reductions are not anticipated to be significant. Materials placed in the drainage may be subject to piping or surface erosion. If this were to cause a portion of the overburden and interburden storage area to fail, downstream impacts to water quality and sedimentation would occur locally in Rabbit Creek.

For process components, stormwater management facilities under the No Action alternative are planned to meet federal and state regulatory requirements. Process components would be designed to fully contain all process fluids including the runoff accumulated from a 25-year, 24-hour storm event, and to withstand the runoff from a 100-year, 24-hour storm event. The fluid management system must be functional for a period of 5 years after the projected operating life of the component and permanent closure period. Given the design and location of the components in relation to the existing channel system, no impacts to or from stormwater discharges are anticipated from heap or tailings facilities constructed and reclaimed under the No Action alternative.

Surface Disturbance. Revegetation, erosion and sedimentation controls, roadway reclamation, and drainageway restoration are described in the plan of operations and reclamation plan. Implementation of the plan would minimize potential impacts to surface water resources from sheet and rill erosion of upland disturbed areas.

Up to approximately 15.5 square miles of watershed area within the Rabbit Creek drainage would be permanently withdrawn from contributing to surface water yields. Expansion of the Vista and South Pits would remove approximately 528 acres of contributing area from the Rabbit Creek drainage and the overall Kelly Creek watershed. Approximately 10.5 square miles of undisturbed watershed area and slightly more than 2 square miles of disturbed drainage area upgradient of the overburden and interburden storage area B expansion would be permanently blocked from Rabbit Creek. An additional 2.2 square miles may be withdrawn by drainageway effects from tailings area C.

The contributing area potentially withdrawn from Rabbit Creek is approximately 36 percent of its drainage at the confluence with Kelly Creek. The area withdrawn represents 3.1 percent of the overall Kelly Creek drainage. The arid or semi-arid low-elevation watershed zone that would be disturbed does not typically contribute substantial flow to stream channels. Since Rabbit Creek is an ephemeral or intermittent stream, and Kelly Creek does not contribute directly to flows in the Humboldt mainstem, impacts to surface water quantities associated with the removal of contributing watershed from the No Action alternative would not be significant. However, within the immediate project vicinity, changes in surface water yields and possible effects on the timing of flows may affect other resources.

Under the No Action alternative, 2.24 acres of jurisdictional waters of the U.S. would be affected by project development. Mitigation of these effects is not required under 1993 Nationwide Permits.

As discussed in Section 3.1.2, ground subsidence is predicted to occur resulting from the drawdown of the regional water table. Subsidence would lower the channel floor of Rabbit Creek by 2 to 3 feet in the area of Section 29, Township 39 North, Range 43 East. However, reversals of flow direction are not anticipated because the channel gradients are 25 to 40 feet per mile in the area. The Rabbit Creek base level would be effectively lowered in the vicinity, which would induce degradation and gullying upstream in the Rabbit Creek watershed and may cause localized degradation and aggradation downstream. Significant channel readjustments would be further encouraged by potential drainage blockages from the overburden and interburden storage area. Such accelerated watershed instability would create local impacts from erosion and sedimentation within the Rabbit Creek drainage, which would need to be controlled. Subsidence effects on Kelly Creek are anticipated to be minimal.

Surface Discharge. Continued discharge into Rabbit Creek from pit dewatering would induce degradation in the low-flow channel. The distance of channel geometry changes outside the immediate outfall area is unknown. When dewatering discharges cease, erosion and sediment transport within the remaining channel network would ultimately re-establish a dynamic equilibrium.

The potential for gullying and headcut migration would be increased over the life of operations. Erosion and sediment controls and a reclamation monitoring period for the site have been committed to in the plan of operations, and when implemented would reduce the potential for related impacts from dewatering discharge to a level of no significance within the disturbed area. However, effects on channel downcutting and bank stability may occur for 1 to 2 miles downstream of the project area, creating localized off-site erosion and sedimentation impacts.

Development of the reinfiltration basins is not anticipated to have a significant impact on surface water flows (HCI 1996).

3.2.2.3 Proposed Action

Water Quantity Impacts

For the Proposed Action, ground water pumping would continue through the year 2011 to dewater the South Pit. The estimated dewatering rate over this period is predicted to increase from approximately 5,000 to a maximum predicted rate of 12,300 gallons per minute (HCI 1996). Approximately 4,300 gallons per minute of the water produced would be consumed by the mining and milling operations; surplus water would continue to discharge to Rabbit Creek and a series of reinfiltration basins.

The area and magnitude of drawdown was predicted using a calibrated numerical flow model (HCI 1996) described in Section 3.2.2.1. As illustrated in ***Figure 3-30***, at the end of mining the drawdown area (as defined by the area enclosed within the 10-foot drawdown contour) is predicted to extend from 3 to 7 miles from the center of the pit. The reinfiltration of ground water southeast of the mine would tend to restrict the expansion of the cone in a southeast direction. Once dewatering activities cease, ground water would discharge into the pit and form a pit lake that would exist for the foreseeable future. After the pit lake water levels reach equilibrium, the ground water would continue to discharge into the pit to replace water loss through evaporation. Because of the passive inflow of ground water into the pit lake, the cone of depression is predicted to expand in the postclosure period. After 50 years (***Figure 3-31***), the cone is predicted to expand to encompass an area that extends from 4 to 7 miles from the center of the pit. Between the 50- to 100-year postmining period (***Figures 3-32A and 3-32B***), the area of drawdown would remain essentially unchanged in the north and northwest, but would expand up to an additional 1 to 2 miles toward the east and south.

The incremental difference between the predicted magnitude and area of drawdown for the No Action alternative and the Proposed Action was determined by comparing the predicted drawdown cones at the end of mining and at 50 and 100 years postmining. With respect to areas potentially affected by 10 feet (or more) of drawdown, the difference between the No Action and Proposed Action is illustrated in ***Figures 3-33*** and ***3-34***. At mine closure, the cone of depression resulting from the Proposed Action would extend approximately 0.5 to 3 miles farther than drawdown from the No Action alternative (***Figure 3-33***). The difference is most pronounced in areas located northeast and southwest of the mine. In the postmining period (***Figure 3-34***), the drawdown cone is predicted to extend up to an additional 2 to 3 miles compared to the No Action alternative.

Numerical modeling indicates that infiltration would potentially increase the water levels in the vicinity of the reinfiltration ponds up to a maximum of approximately 70 feet. This represents an increase of approximately 40 feet in the height of the ground water mound as compared to the No Action alternative. As with the No Action alternative, the ground water mound is not predicted to intersect the ground surface in the vicinity of the infiltration area.

Impacts to Wells. With respect to wells not associated with the mine, the results of the model simulations indicate that the water levels in nine wells with water rights status (five permitted and four certified) could potentially be lowered as a result of mine-induced drawdown. No water rights are necessary for domestic water wells; therefore, there could potentially be a few domestic wells that are also located within the area of drawdown. Available information on the depth of the wells with water rights and the anticipated range of drawdown in water levels that could potentially occur at the three simulated periods is summarized in ***Table 3-13***. Considering the uncertainty of model predictions, the actual drawdown could potentially be larger or smaller. The identified wells include seven wells owned by First Miss Gold, Inc. used for its mining operations.

Five of these wells are located in bedrock at or near the Getchell Mine and include water pumped from excavated shafts, sumps and pits. Two wells are completed in alluvium in the Kelly Creek Basin south of the Twin Creeks Mine. Mine-induced dewatering from the Proposed Action is predicted to reduce the water levels in the two alluvial wells ranging from of 50 to 150 feet. Overall, the Proposed Action is predicted to increase the drawdown in the First Miss Gold wells an average of approximately 50 feet more than drawdown expected under the No Action alternative.

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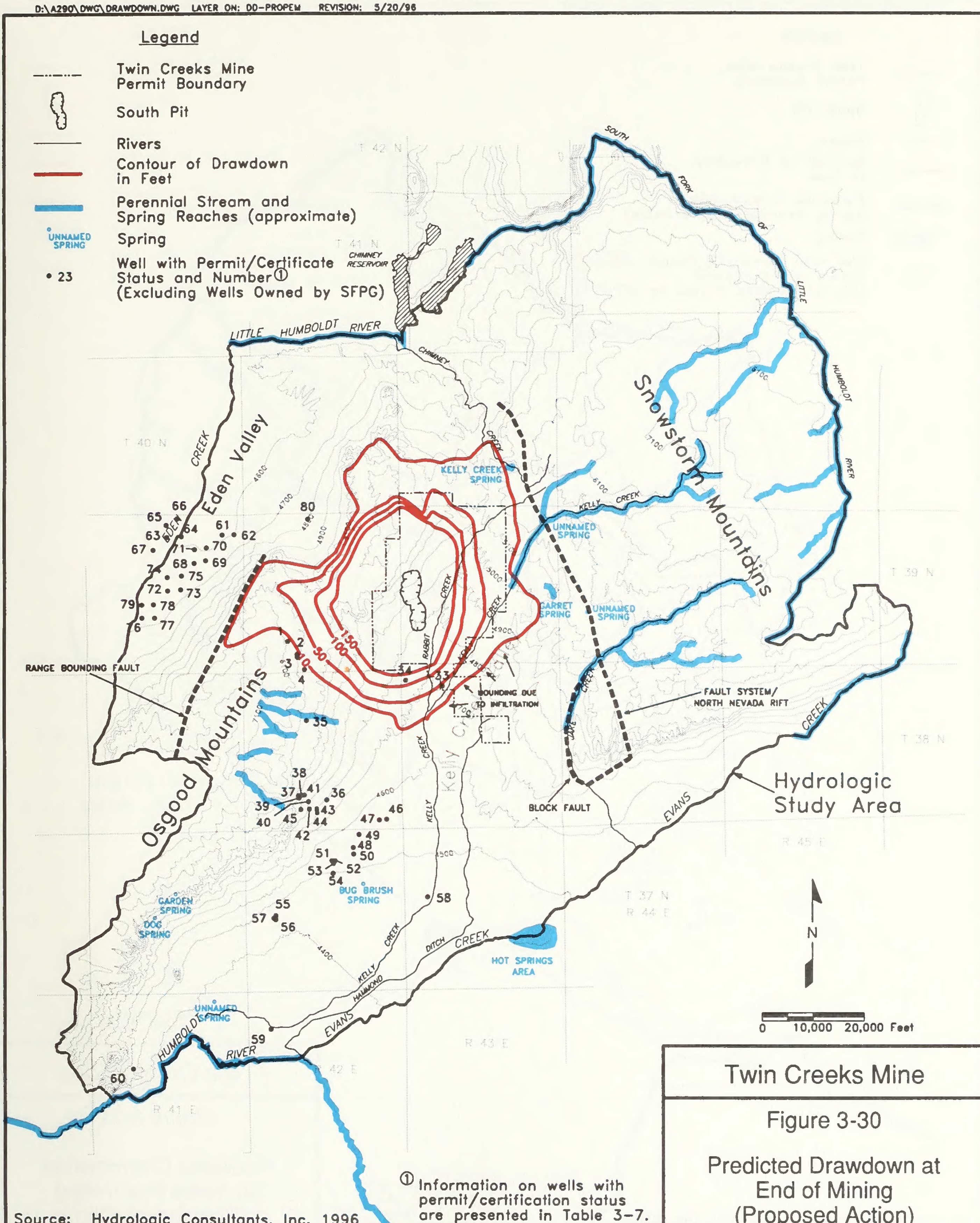
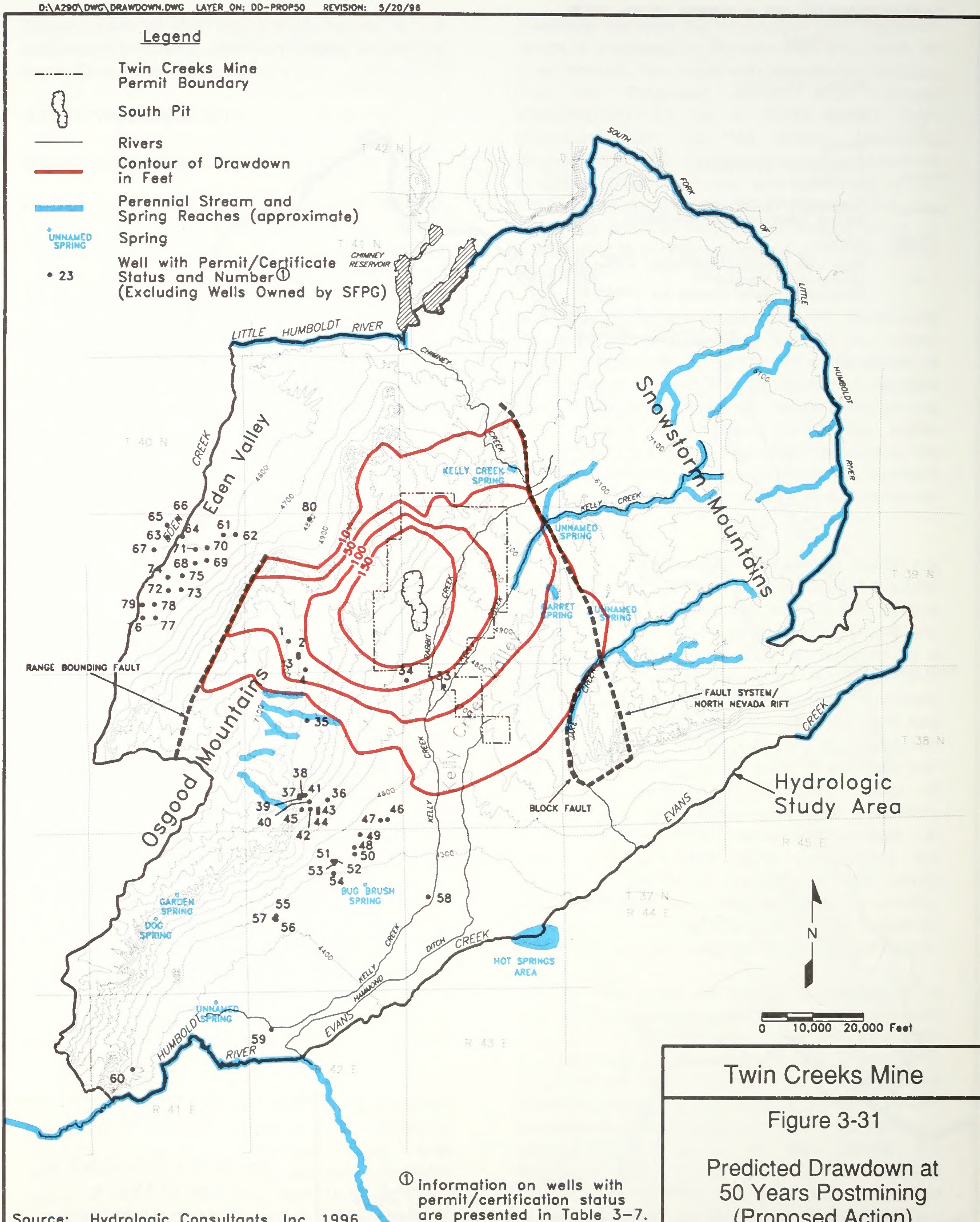


Twin Creeks Mine

Figure 3-30

Predicted Drawdown at End of Mining (Proposed Action)



Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-31

Predicted Drawdown at 50 Years Postmining (Proposed Action)

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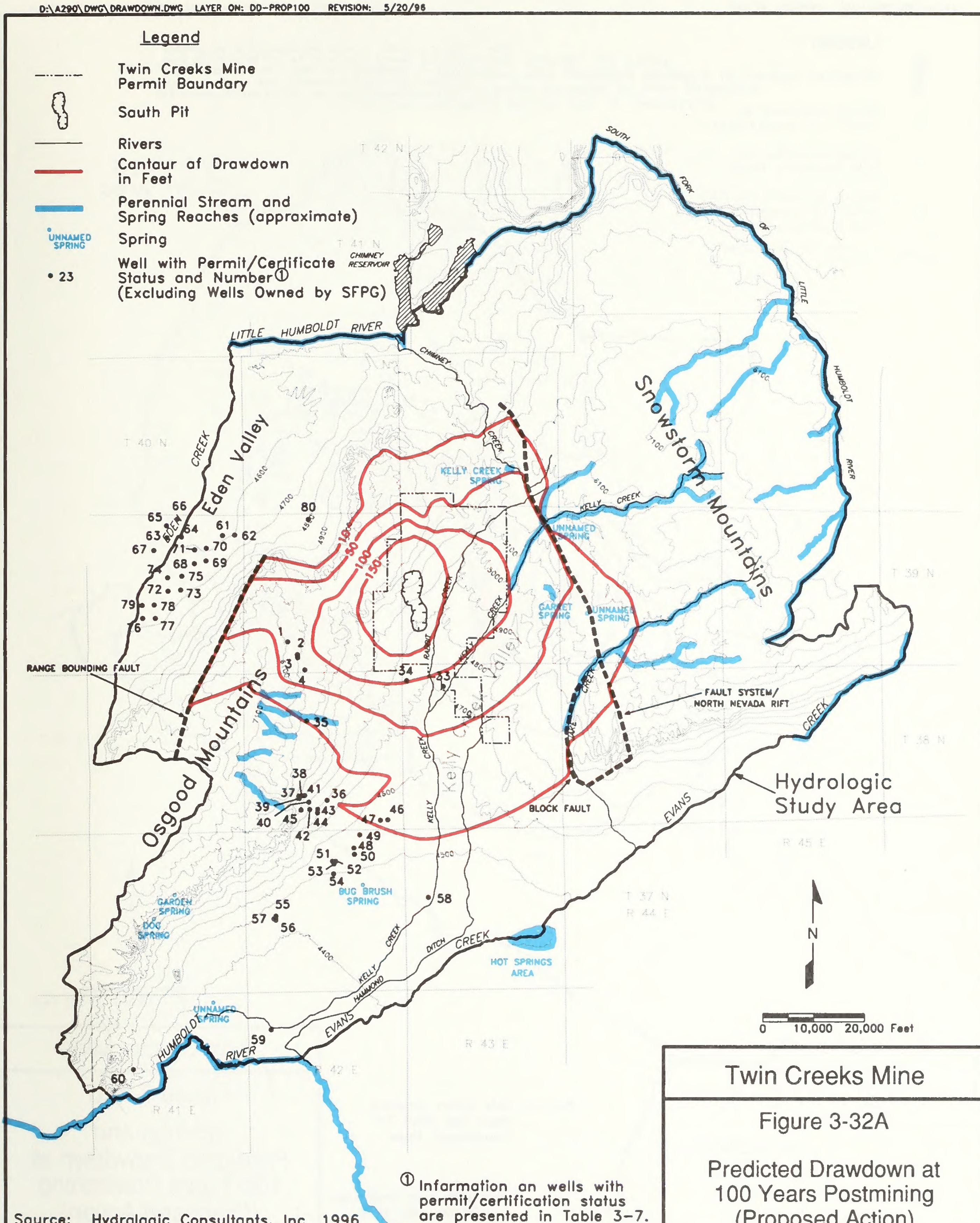

Twin Creeks Mine

Figure 3-32A

Predicted Drawdown at 100 Years Postmining (Proposed Action)

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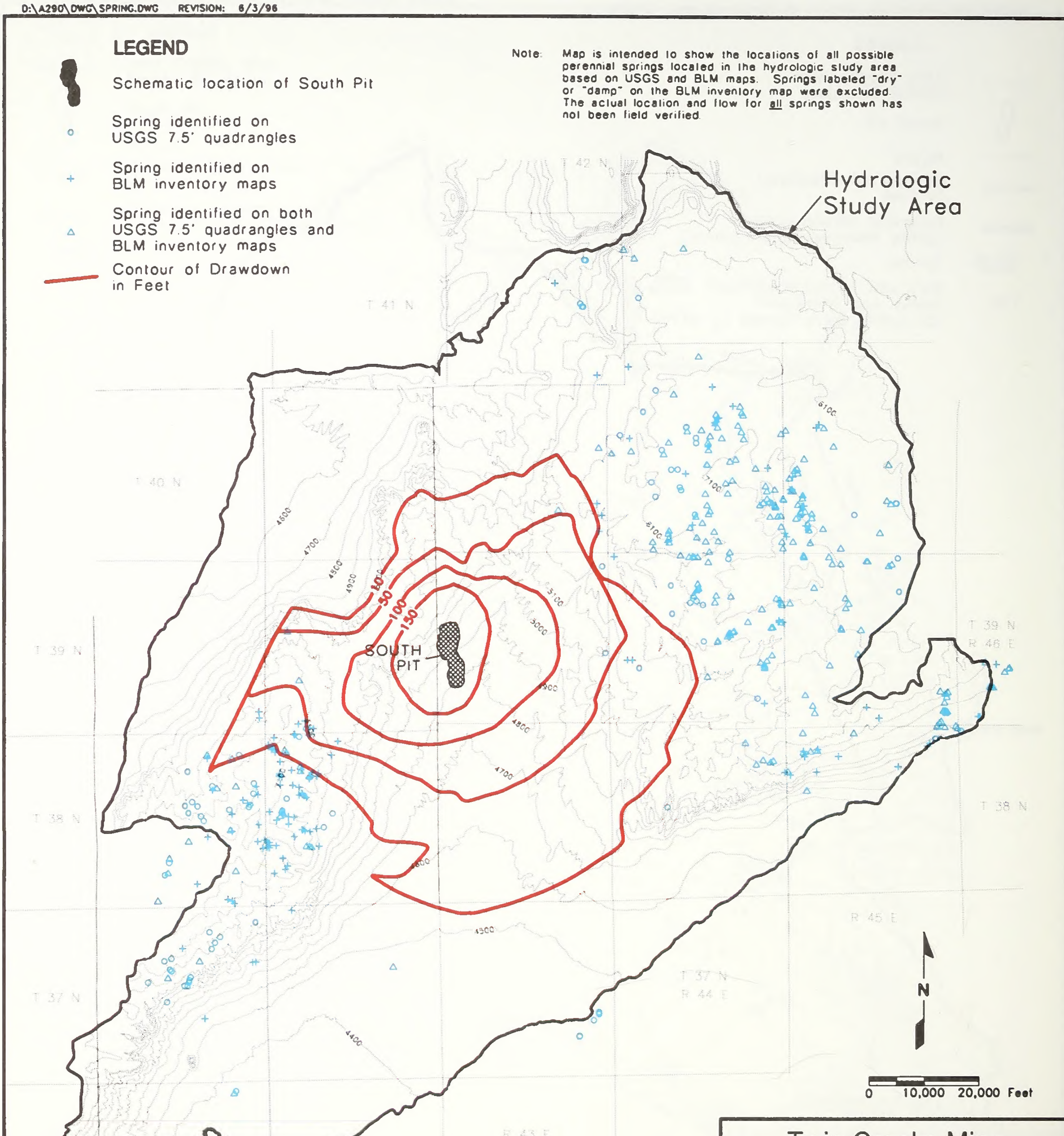

Source: BLM Spring Inventory Maps and USGS 7.5' Topographic Maps

Base Map from Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-32B

Springs and Predicted Drawdown at 100 Years Postmining (Proposed Action)

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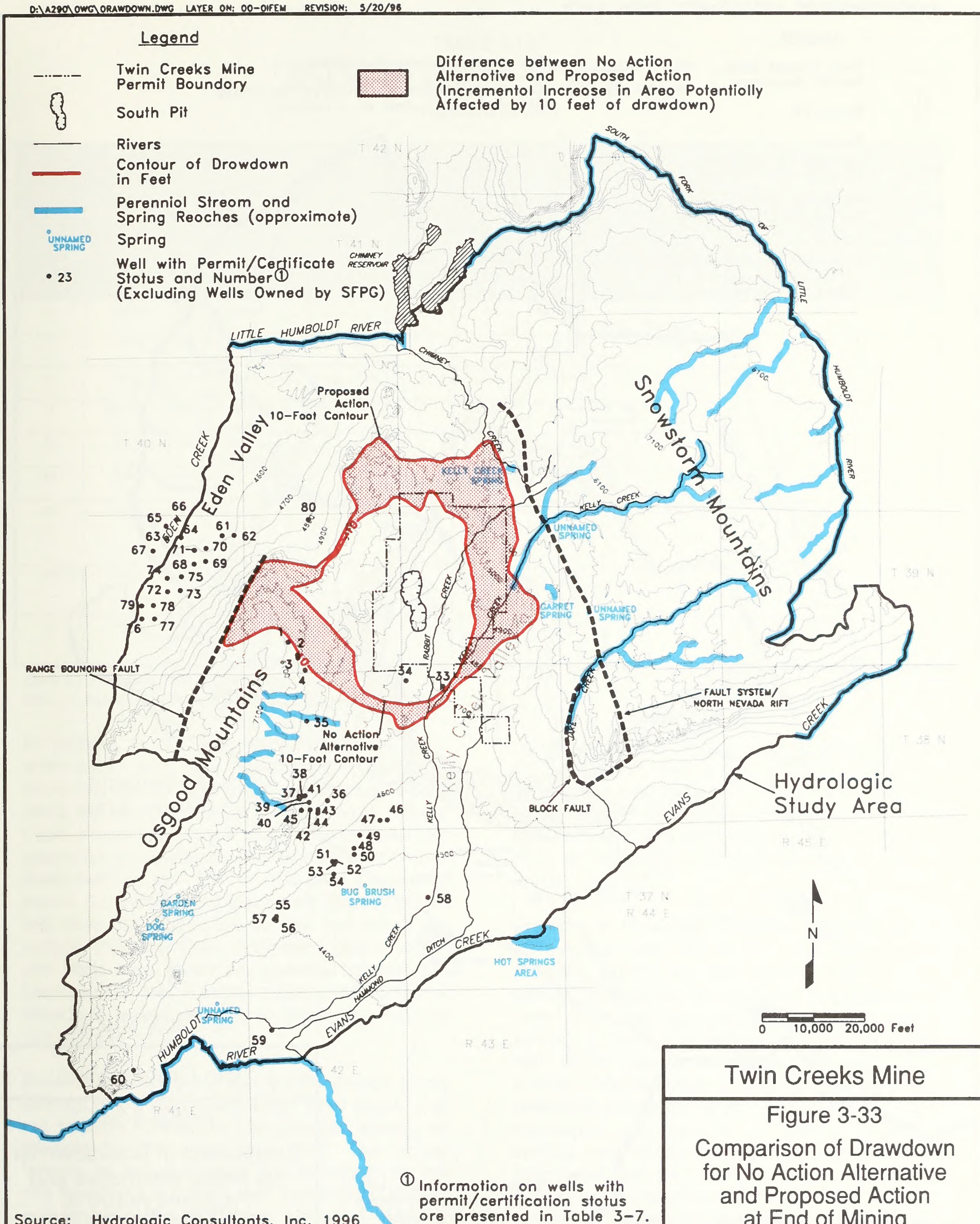

① Informotion on wells with permit/certificotion stotus ore presented in Toble 3-7.

Source: Hydrologic Consultonts, Inc. 1996

Twin Creeks Mine

Figure 3-33
Comparison of Drawdown for No Action Alternative and Proposed Action at End of Mining

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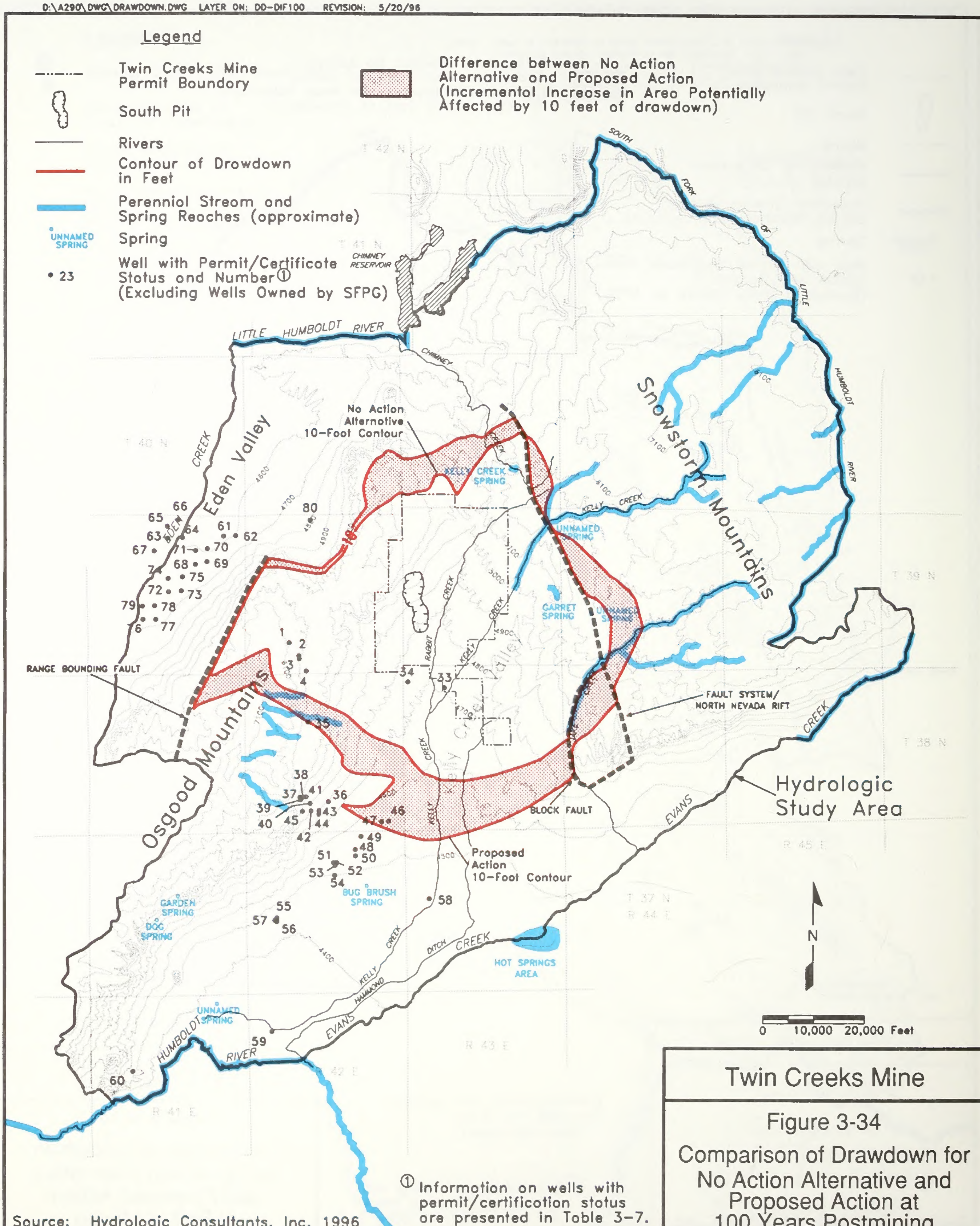


Twin Creeks Mine

Figure 3-34

Comparison of Drawdown for No Action Alternative and Proposed Action at 100 Years Postmining

Source: Hydrologic Consultants, Inc. 1996

① Information on wells with permit/certification status are presented in Table 3-7.

TABLE 3-13
State Permitted or Certified Water Supply Wells Located Within the Predicted Drawdown Area Proposed Action

Map Location Number	Application Number	Use	Well Type	Well Screen	Total Depth	Recorded Static Water Level	Proposed Action Estimated Drawdown (end of mining)	Proposed Action Estimated Drawdown (+50 yr.)	Proposed Action Estimated Drawdown (+100 yr.)	Estimated Incremental Increase in Drawdown From Proposed Action (end of mining)	Estimated Incrementa l Increase in Drawdown From Proposed Action (+50 yr.)	Estimated Incremental Increase in Drawdown From Proposed Action (+100 yr.)
-	45732	MM	Excavated Sump	-	-	-	10	50-100	50-100	10	50	50
2	10370	MM	Dug Mine Shaft	-	400	-	10	50-100	50-100	10	50	50
3	29075	QM	Dug Mine Shaft	-	400	-	10	50-100	50-100	10	50	50
-	45730	MM	No Well Log is Available	-	-	-	10	50-100	50-100	10	50	50
33	10331	MM	No Well Log is Available	-	400	-	50	50-100	50-100	<50	50	50
34	28758	MM	14-inch.	120-594	601	108	100-150	100-150	100	50	50	50
35	53030	MM	Floating Barge with Pump in Pit Lake	-	-	-	<10	<10	10	<10	<10	10
46	29885	IRR	16-inch Wells, Pump at 280 Feet	141-490	604	26	<10	<10	10	<10	<10	10
47	29886	IRR	16-inch Wells, Pump at 280 Feet	150-435	530	-	<10	<10	10	<10	<10	10

dash (-) indicates data are unavailable.
Source: Nevada State Engineers Office 1996; HCI 1996.

In addition to the First Miss Gold wells, it is anticipated that the postmining drawdown (occurring 50 to 100 years postmining) would affect two alluvial irrigation wells owned by Adams Peak Properties. These two irrigation wells are estimated to experience approximately 10 feet of drawdown in the 50- to 100-year postmining period. Considering that these wells are 500 to 600 feet deep, the pumps are set 280 feet below the surface (Nevada State Engineer's Office 1996), and static water levels are probably considerably less than 100 feet, it seems unlikely that 10 feet of drawdown would significantly impact the yield or use of these wells.

Because of incomplete data on the current pump settings, yield, depth, and static water levels, it is not possible to estimate the potential severity of impacts to other individual wells. The actual impacts to individual wells are dependent on the site-specific conditions, well completion details, and timing of the drawdown. However, lowering the water levels in these water supply wells could potentially reduce yield, increase pumping costs, or, if the water level is lowered below the pump setting or below the bottom of the well, the well would become unusable. Therefore, other wells located within the areas affected by 10 feet or more of drawdown could experience a significant impact.

Impacts to Perennial Streams and Springs. In an average year, the stream and spring flows recorded during the late summer through fall period are controlled by discharge of ground water from either the regional ground water aquifer system, or from more isolated or perched aquifers that reside above the regional ground water system. Any reduction in ground water flow can potentially reduce the length of the perennial reach associated with streams or springs, eliminate springs, and reduce the riparian/wetlands areas associated with the perennial source. Therefore, any potential reduction in baseflow to either a stream or spring is considered a potentially significant impact.

Drawdown associated with the Proposed Action would potentially reduce the baseflow (ground water discharge) in some perennial streams and springs. The predicted change in baseflow to the Little Humboldt River and the Hot Springs area are summarized in ***Table 3-14***. The maximum predicted baseflow reduction during the mining and 100-year postmining period is approximately 19 percent for the Little Humboldt River and 27 percent for the Hot Spring area. Compared to the No Action alternative (***Table 3-9***), the Proposed Action is predicted to reduce baseflows an additional 11 percent for the Little Humboldt River and 15 percent for the Hot Springs area.

In addition to flow reductions, the Hot Springs discharge is predicted to increase in the 5- to 40-year postmining period. In this period, flows from the Hot Springs discharge area are predicted to increase up to a maximum of approximately 10 percent over the estimated premining baseflow discharge rates (HCI 1996). The increase is predicted to result from migration of ground water mounding from reinfiltration activities that would cease at mine closure. This increased discharge could potentially decrease the temperature of the Hot Springs discharge.

Other perennial stream reaches or springs located within or near the mapped drawdown area, as shown in ***Figures 3-32A*** and ***3-32B***, could also experience a reduction or cessation of flow. Perennial stream reaches or springs located within the potential drawdown area are summarized in ***Table 3-10***. Potential impacts to these perennial streams and springs are generally similar to impacts for the No Action alternative. Excluding the lower perennial reach of Jake Creek, other springs located in the Osgood and Snowstorm mountains are located a considerable distance (hundreds of feet) above the interpreted regional water table. These springs are apparently sustained by discharge from local or perched aquifers; therefore, potential impacts to theses springs from mine-induced drawdown are not anticipated.

As discussed previously for the No Action alternative, additional data are required to fully understand the relationship between Jake Creek and the potentially impacted regional ground water system. If the flows in the lower perennial reach are dependent on discharge from the ground water system, this reach could experience a reduction of flows, particularly during the postmining period. A reduction in flows to Jake Creek would be a significant impact. The magnitude of change and length of reach would depend on the site-specific stream characteristics and surface water-ground water interaction dynamics.

Pit Lake Development

As illustrated in ***Figure 3-35*** the pit lake is predicted to reach its final elevation of 4,480 feet approximately 230 years after mine closure. In the Proposed Action, two separate lakes (referred to as the north and south lobes) would exist for the first 27 years of lake filling. After 27 years, the north and south lobes of the pit lake are predicted to merge and form a single lake (PTI 1996). After full recovery, the final pit lake is predicted to have a surface area of approximately 870 acres, a maximum depth of approximately 780 feet, and a volume of 460,000 acre-feet. The surface area of the Proposed Action pit lake is predicted to be approximately two times larger than the surface area of the No Action alternative pit lake. After the lake fills, an estimated 3,100 acre-feet per year (1,900 gallons per minute) of water would be lost through evaporation off the lake surface.

As the mine begins to fill, inflow to the pit would comprise approximately 98 percent ground water and 2 percent precipitation and surface runoff. After the pit lake reaches its equilibrium water level, the inflow would comprise approximately 77 percent ground water, 22 percent direct precipitation, and 1 percent surface runoff. Modeling indicates that inflow rates to the pit lake would decrease from approximately 4,500 gallons per minute at the time the pit begins to fill to approximately 1,500 gallons per minute after full recovery of the pit lake (HCI 1996; PTI 1996).

The relationship between the predicted lake and the regional ground water elevation is illustrated in ***Figure 3-36***. Once the lake reaches hydraulic steady state, the surface of the lake is predicted to be approximately 200 feet below the premining water table surface. The pit lake would fill to an elevation where losses from the pit by evaporation equal the surface water and ground water entering the pit. Modeling of final ground water levels, flow rates, and predicted precipitation and evaporation rates suggest that the pit lake would have no net outflow to either ground or surface waters (HCI 1996).

TABLE 3-14
Hydrologic Effects to the
Little Humboldt River and the Hot Springs
Proposed Action

	End of Mining		50 Years After End of Mining		100 Years After End of Mining	
	Change in Baseflow	Percent Change in Baseflow	Change in Baseflow	Percent Change in Baseflow	Change in Baseflow	Percent Change in Baseflow
Little Humboldt River	-0.55 cfs	-9.9 %	-1.05 cfs	-18.8 %	-0.94 cfs	-16.8 %
Hot Springs	-0.01 cfs	-0.9 %	-0.02 cfs	-1.3 %	-0.42 cfs	-27.3 %

cfs=cubic feet per second.
Source: HCI 1996.

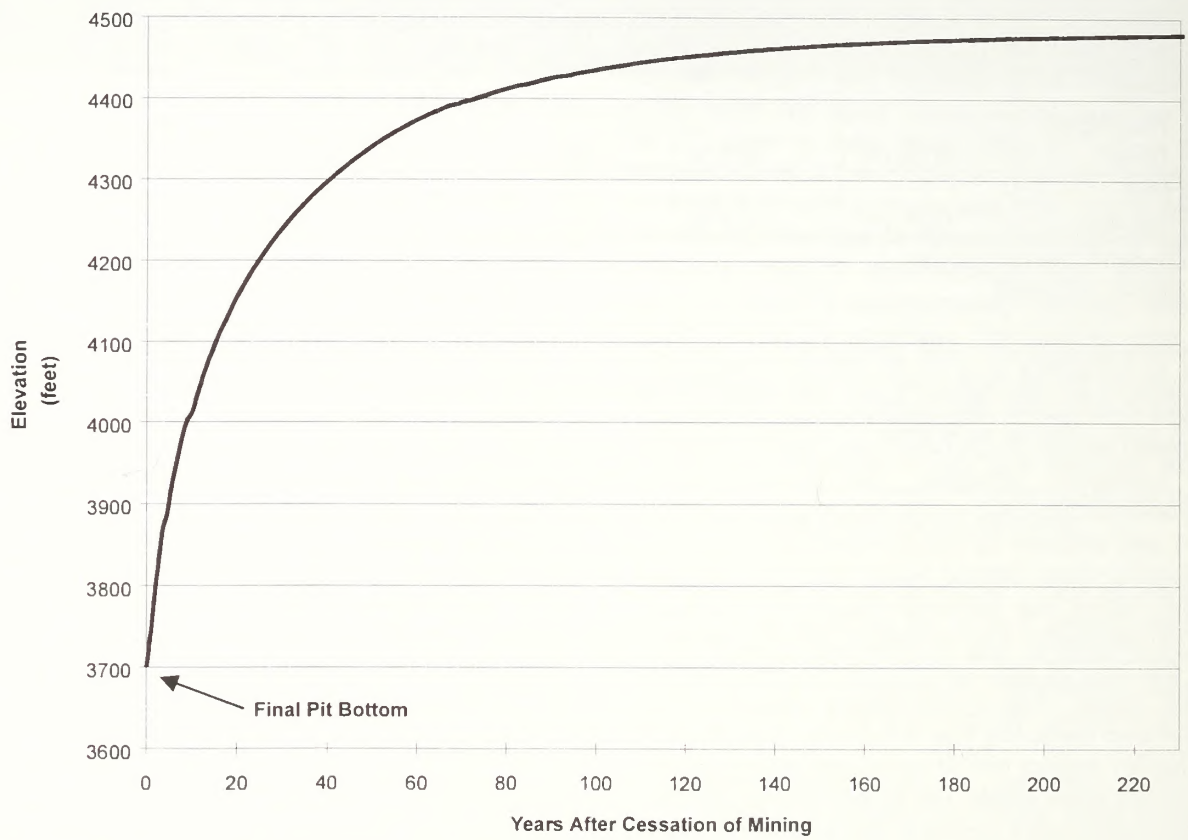
A sensitivity analysis was conducted to evaluate changes in the pit lake level and the potential for outflow from the pit lake resulting from changes in the mean annual evaporation rate (HCI 1996). For the sensitivity analysis, the mean annual evaporation rate used in the model (42 inches per year) was reduced by approximately two standard deviations using historic evaporation data for the region. Using the reduced evaporation rate (17 inches per year), the numerical model predicted that the final pit lake water level for the Proposed Action would rise approximately 72 feet. The model also predicted that, because water levels in the region around the pit would not recover to the premining water levels, the pit lake would still have a continued inward gradient, and no outflow would occur (HCI 1996).

<u>Water Quality Impacts</u>

Pit Lake Water Quality Modeling Results. The pit lake water quality modeling results for four stages of pit lake filling corresponding to 5, 27, 130, and 230 years after mine closure are presented in ***Table 3-15*** (PTI 1996). The water quality was modeled to 230 years following the cessation of mining to correspond to the time when the pit lake is predicted to reach hydraulic steady state. It is important to note that because of uncertainties of future climatic conditions, ground water flow rates, and ground water chemistry, the confidence in the predictions of pit lake water quality decreases with increasing time after the end of mining. Therefore, predictions made for several decades in the future should be viewed as indicators of relative trends in concentrations, rather than absolute values.

The general median concentration trends over time for pH, total dissolved solids, arsenic, and antimony are illustrated in ***Figure 3-37***. The pH of the pit lake is predicted to rise from a median value of approximately 8.2 to a median value of approximately 8.7 standard units over the 230-year model period. The predicted increase in pH is caused by the diminishing influence of acid releases from wall rock, the ongoing addition of carbonate alkalinity from ground water inflows, and evaporative concentration. Beyond 1 year after mining, the modeling indicates a greater than 90 percent probability that the pit lake would have a pH above 7. Thus, it is highly unlikely that the pit lake would be acidic.

The concentrations of total dissolved solids, antimony, and arsenic are predicted to increase over time. Total dissolved solids in the lake are predicted to increase from an initial concentration of approximately 330 milligrams per liter at year 5 (volume-weighted average of total dissolved solids concentrations in the north and south lobes) to approximately 520 milligrams per liter at year 230. The concentration of antimony is predicted to be approximately 0.97 milligram per liter in the north lobe and 0.08 milligram per liter in the south lobe at year 5, and would reach a concentration of 0.66 milligram per liter at year 230. Arsenic concentrations are predicted to be 0.16 and 0.22

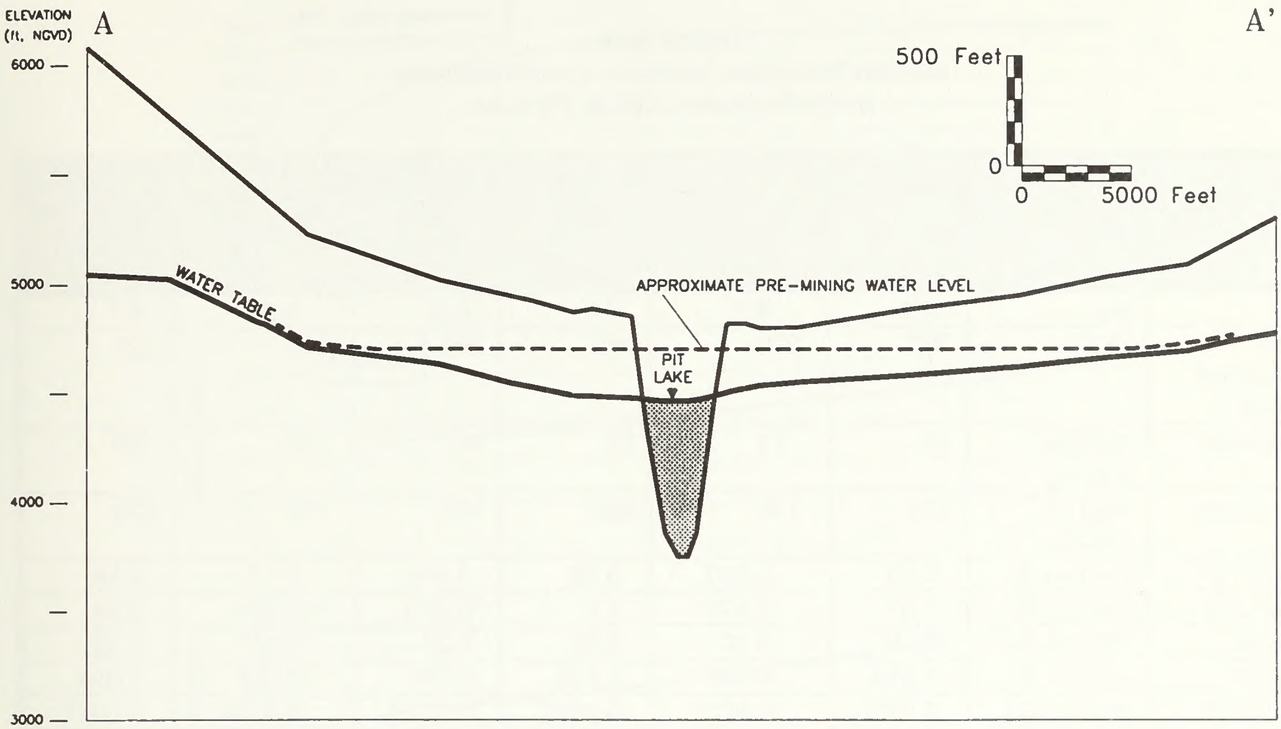


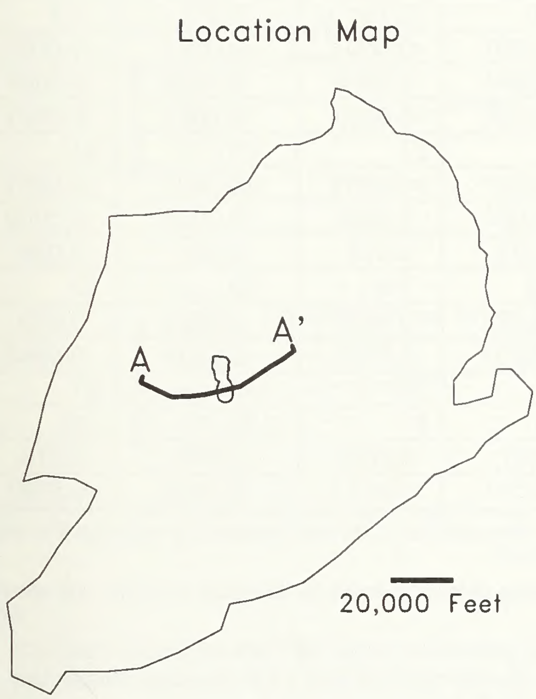
Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-35

Pit Lake Elevation over Time (Proposed Action)





Source: Hydrologic Consultants, Inc. 1996

Twin Creeks Mine

Figure 3-36

Relationship Between Postmining Pit Lake and Regional Water Table

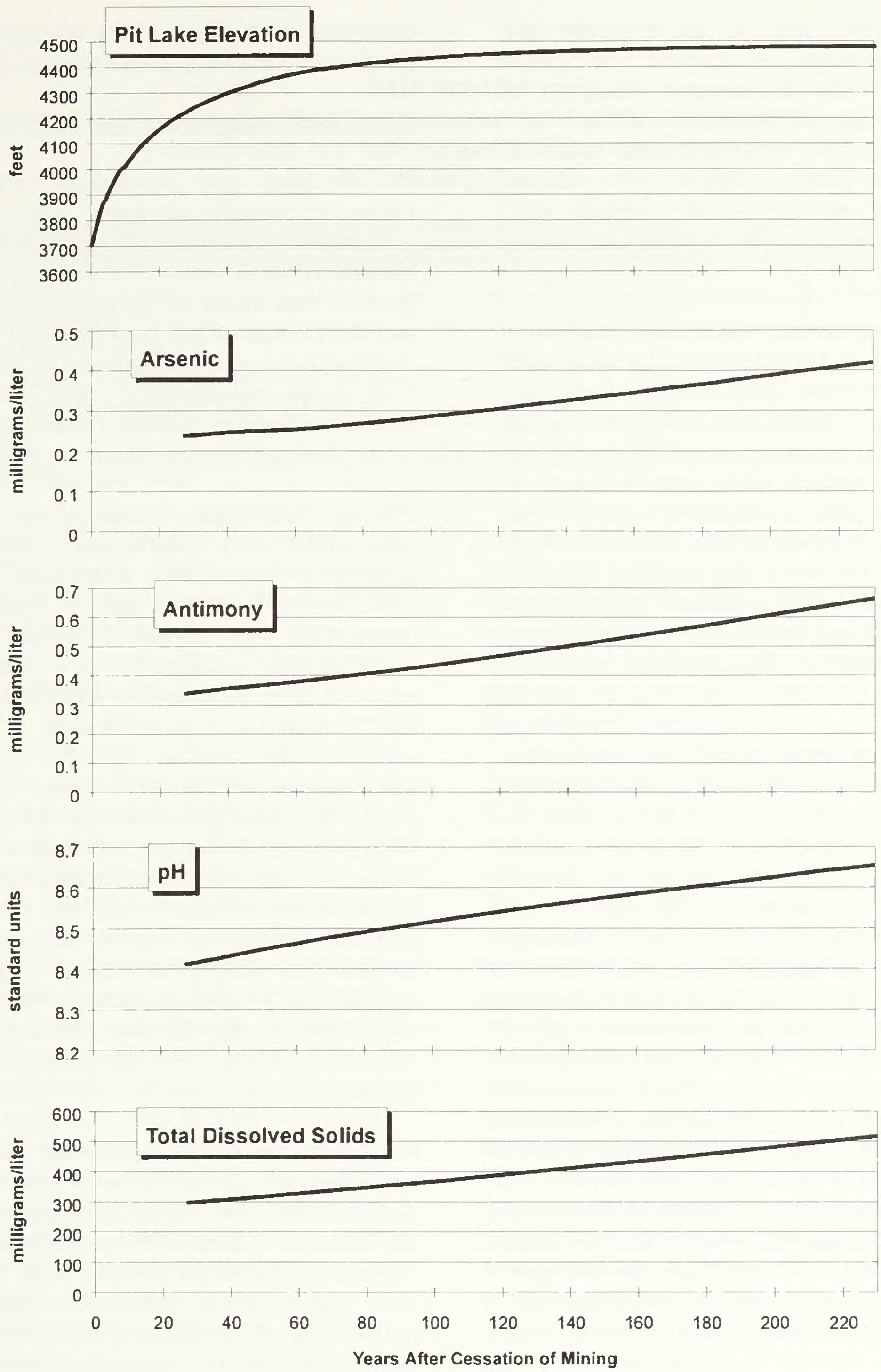
TABLE 3-15
Median Predicted Chemical Concentrations in the Proposed Action Pit Lake

	Units	Years After Mine Closure					
		5 (north lobe)	5 (south lobe)	27 (north lobe)	27 (south lobe)	130	230
pH	s.u.	8.2	8.4	8.3	8.5	8.6	8.7
Total Dissolved Solids	mg/l	390	270	340	280	400	520
Alkalinity	mg/l as $CaCO_3$	40	71	50	80	97	130
Hardness	mg/l as $CaCO_3$	240	140	200	130.	190	230
Aluminum	mg/l as Al	0.86	0.030	0.52	0.040	0.17	0.18
Antimony	mg/l as Sb	0.97	0.078	1.1	0.073	0.48	0.66
Arsenic	mg/l as As	0.16	0.22	0.32	0.21	0.31	0.42
Barium	mg/l as Ba	0.019	0.036	0.023	0.037	0.027	0.024
Cadmium	mg/l as Ca	0.0006	0.0029	0.0006	0.0018	0.0014	0.0017
Calcium	mg/l as Ca	46	13	29	10	8.1	5.4
Chloride	mg/l as Cr	17	25	29	21	29	40
Chromium	mg/l as Cr	0.0006	0.0004	0.0007	0.0007	0.0007	0.0007
Copper	mg/l as Cu	0.0005	0.0040	0.0004	0.0025	0.0007	0.0007
Fluoride	mg/l as F	1.2	0.77	1.0	0.79	1.1	1.5
Iron (II)	mg/l as Fe^{2+}	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Iron (III)	mg/l as Fe^{3+}	0.0004	0.0005	0.0004	0.0005	0.0006	0.0007
Lead	mg/l as Pb	<0.0001	0.0004	<0.0001	0.0003	0.0001	0.0001
Magnesium	mg/l as Mg	34	25	31	27	41	54
Manganese	mg/l as Mn	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury[2]	mg/l as Hg	0.0004	0.0004	0.0001	0.0003	0.0002	0.0042
Nickel	mg/l as Ni	0.052	0.014	0.033	0.013	0.025	0.029
Potassium	mg/l as K	10	8.3	8.6	7.6	10	12
Selenium[2]	mg/l as Se	0.045	0.0042	0.023	0.0038	0.0034	0.016
Silver	mg/l as Ag	0.0044	0.0029	0.0033	0.0026	0.0034	0.0042
Sodium	mg/l as Na	34	32	39	36	59	81
Sulfate	mg/l as SO_4	190	85	150	81	130	160
Thallium[2]	mg/l as Tl	0.026	0.0041	0.022	0.0034	0.012	0.016
Zinc	mg/l as Zn	0.014	0.0094	0.0074	0.011	0.0073	0.0097

[1] Each concentration is the median of 1,000 realizations. Reported concentrations do not necessarily represent a single water chemistry.
[2] The increase in concentration of these elements is an artifact of using detection limits for samples in which the element was not detected.
Source: PTI 1996.

milligram per liter in the north and south lobes, respectively, at year 5, and would increase to 0.42 milligram per liter at year 230.

More than 50 percent of the arsenic released by wall rock during the early stages of pit infilling would be removed from the pit lake by adsorption onto hydrous ferric oxide. At later times, when ground water inflow dominates the lake chemistry and less iron is available to remove arsenic, evaporative concentration would cause arsenic concentrations to rise. In addition, arsenic sorption



Notes:

1. Concentrations for the 0-27 year postmining period are not shown because the pit lake would consist of two separate lakes with differing concentrations (See Table 3-15).
2. Concentrations presented are median predicted values for 1,000 realizations. The entire range of concentrations bracketed by the 5th and 95th percentile is presented in PTI 1996.

Source: PTI 1996

Twin Creeks Mine

Figure 3-37

Trends in Concentration of Selected Water Quality Constituents over Time (Proposed Action) is favored at lower pH, so as the lake pH increases, the amount of arsenic adsorption decreases (PTI 1996). Experiments designed to simulate evaporative concentration at the Twin Creeks Mine show that arsenic is also removed from solution via coprecipitation with calcite, and this removal mechanism for arsenic was incorporated into the geochemical modeling (PTI 1996).

The primary and secondary enforceable maximum contaminant levels in Nevada would be exceeded for aluminum, antimony, and arsenic. However, because modeling indicates that the pit lake would not discharge to surface or ground waters, development of a surface water body in the pit is not expected to degrade surrounding waters of the state. As the pit lake develops, the lake water itself would become a water of the State of Nevada (Livak 1996). Water quality standards applicable to the lake under the current Nevada Administrative Code would depend on the potential beneficial uses of the lake.

At closure, a rocky berm would be constructed around the perimeter of the pit to restrict access into the pit by humans, livestock, and wildlife. In addition, as part of final closure, the ramps leading down into the pit would be blasted to further preclude access to the lake. The lake is not intended to be a drinking water source for humans or livestock, or to be used for recreational swimming. Therefore, standards to protect the lake as a drinking water source, livestock water supply, or for recreational swimming are not applicable. Aquatic standards are also not applicable because there is no intention to use the lake as a fisheries resource. The only anticipated beneficial use for the lake water would be as a water source for wildlife. A risk assessment of potential pit water quality impacts to terrestrial wildlife and humans has been performed. A summary of the risk assessment and potential impacts to wildlife and humans is presented in Appendices C and D.

Comparison of No Action and Proposed Action Pit Lake Water Quality. The No Action alternative and Proposed Action pit lakes are both predicted to have no outflow to surface or ground water. The predicted water quality of the No Action and Proposed Action pit lakes are very similar. However, at 130 years after mining ceases, the concentrations of some constituents (e.g., aluminum, antimony, nickel, sodium, sulfate, and zinc) are predicted to be higher in the No Action alternative pit lake than the Proposed Action pit lake.

<u>Mine Rock Material Storage Facilities</u>

The facilities and processes included in the Proposed Action represent continuations and expansions of the facilities and processes discussed as part of the No Action alternative. The geochemical characteristics of rock materials that would be removed from the South Pit as part of the Proposed Action are discussed in Section 3.2.2.1. The same geochemical data were used to characterize rock materials from the No Action alternative and Proposed Action pits.

The net neutralization potential for the additional overburden and interburden that would be generated with the Proposed Action was represented by properties of materials located nearest to the expanded zones (PTI 1996) (***Table 3-16***). Based on the analysis, approximately 8 percent of the South Pit material has the potential to generate acid.

Overburden and Interburden. The Proposed Action includes generation of an additional 1.7 billion tons of overburden and interburden from the South Pit. No additional overburden and interburden would be generated from the Vista Pit as part of the Proposed Action. The South Pit overburden and interburden material generated as part of the Proposed Action would consist of approximately 39 percent alluvium, 15 percent oxidized bedrock, and 46 percent non-oxidized bedrock.

As for the No Action alternative, the type of net acid-neutralizing material used and the thickness of the basal layer would vary depending on the site-specific subsurface conditions and oxide material availability. The basal layer was designed such that the basal layer in combination with the neutralizing and attenuation capacity of the native alluvial and bedrock materials beneath the storage areas would provide a similar protection to ground water resources for all of the overburden and interburden storage areas. The specific basal layer for each storage area is summarized in Section 2.4.3, and the geochemical characteristics for the different alluvial and oxide rock materials are presented in the Final Twin Creeks Mine Materials Handling Plan (PTI and WESTEC 1996). The materials handling plan was prepared in

TABLE 3-16
Amount of Alluvium, Oxidized Bedrock and Non-Oxidized Bedrock Placed In Overburden and Interburden Storage Facilities
Proposed Action

	Million Tons	Percent
Alluvium	667	39
Oxidized Bedrock	268	15
Non-Oxidized Bedrock		
Acid-neutralizing (ANP/AGP >1.2)	672	39
Acid-generating (ANP/AGP <1.2)	125	7
TOTAL	**1,732**	**100**

Source: Swanson 1996.

accordance with the Nevada Division of Environmental Protection's guidance documents and the BLM Acid Rock Drainage Policy (BLM 1996). The materials handling plan was approved by the Nevada Division of Environmental Protection in April 1996 (Carlson 1996).

Under the Proposed Action, storage area D and a portion of storage area B would be constructed over existing or proposed lined tailings facilities C, D, and E. As described in Section 3.2.2.2, overburden and interburden material would be placed directly on the tailings facility without an additional basal layer. Approved closure plans for the tailings and associated facilities would be obtained for Nevada Division of Water Resources, Dam Safety Permit(s) and Nevada Division of Environmental Protection, Water Pollution Control Permits prior to placement of the overburden and interburden material on the tailings (PTI and WESTEC 1996). Seepage generated from loading of the tailings would be captured by the tailings subdrain system and/or approved seepage collection/control systems. Any collected seepage would be discharged to other process facilities (i.e., leach pads or tailings facilities), evaporated, or treated prior to discharge (PTI and WESTEC 1996).

Flotation Grade Ore Stockpile. The Proposed Action includes generation of an additional 34 million tons of flotation grade material from the South Pit. The design of flotation grade ore storage piles would be the same as the No Action alternative.

Site Conditions. The current depth to ground water beneath the Proposed Action overburden and interburden storage areas ranges from a minimum of 120 feet to over 350 feet. Based on numerical flow modeling (HCI 1996), once the pit lake reaches equilibrium in the postclosure period, the general depth to ground water is predicted to increase an average of approximately 130 feet from existing conditions.

Overburden and interburden storage areas B, D, E, F, I, K, L, and the southeast one-half of H are underlain by at least 100 feet of unsaturated alluvium. All of these facilities located west of Rabbit Creek are underlain by alluvium derived from Paleozoic carbonate and clastic rocks, while facilities located east of Rabbit Creek are underlain by alluvium derived predominantly from Tertiary rhyolite. The average net neutralization potential of the Paleozoic carbonate derived alluvium is 270 tons of $CaCO_3$/kiloton, whereas the average net neutralization potential for the rhyolite derived alluvium is 59 tons of $CaCO_3$/kiloton (PTI and WESTEC 1996). The thickness of the alluvium generally thins toward the northwest corner of the project area. Paleozoic derived alluvium beneath storage facilities J, M, and the northwest one-half of storage area H generally ranges from 0 to greater than 100 feet. Bedrock exposed at the surface or beneath the alluvium in these areas consists of oxidized Paleozoic rocks that include limestone, chert, greenstone, tuff and other volcanic rocks. Average net neutralization potential for the column of rocks under these overburden and interburden storage areas ranges from approximately 56 to 539 tons of $CaCO_3$/kiloton (PTI and WESTEC 1996). The net neutralization data indicate that all of the storage areas would be underlain by materials that have the ability to neutralize acid; areas underlain by Paleozoic derived alluvium or limestone would have the greatest acid neutralization capacity.

Impacts. Excluding the storage areas proposed over tailings facilities, the design of the other overburden and interburden storage areas and the flotation grade ore stockpile is the same as the No Action alternative. Therefore, the potential impacts associated with the Proposed Action would be essentially the same as those previously discussed for the No Action alternative (see Section 3.2.2.2). In summary, based on the site conditions, low precipitation, depth to ground water, design of the facilities, and neutralization and attenuation capacity of the basal layer and material beneath the facility, potential surface or ground water degradation resulting from these overburden and interburden storage areas is not anticipated. The general depth to ground water in the postmining period would be an average of approximately 100 feet lower beneath most of the storage areas compared to the No Action alternative. The permanent increase in depth to ground water would tend to further reduce the risk of acid or mobilized constituents from these facilities reaching ground water.

A geotechnical design for the placement of overburden and interburden material over existing or proposed tailings facilities was not available for this analysis. The tailings waters have concentrations of several constituents, including arsenic, antimony, chromium, and lead, that exceed the Nevada maximum contaminant levels for drinking water. To prevent migration of water from the tailings facilities, the facilities are designed with a liner, subdrain, collection pond, and pump-back system. Significant migration from the base of the facilities would be prevented by the liner systems, provided that they remain functional following loading of the overburden and interburden material. In addition, the tailings are projected to be net acid-neutralizing and would be placed under alkaline pH conditions, such that storage of the overburden and interburden material is not anticipated to increase acid production (PTI and WESTEC 1996). However, if the coupled tailings/overburden and interburden facilities are not properly designed and constructed, there is a potential for impacts to the ground water system. Differential loading of the tailings impoundment with overburden and interburden material could potentially cause failure of the embankment,rupture of the liner, or damage of the subdrain system. Failure of the embankment, liner, or subdrain system could potentially result in a release of tailings solution into the unsaturated zone beneath the facility and eventual migration to ground water. Therefore, failure of the tailings facility design or a release of tailings solution caused by loading of the tailings with overburden and interburden material would potentially result in a significant impact. (Proposed mitigation for the coupled tailings/overburden facilities is presented in mitigation measure GM-3, Section 3.1.4, Geology and Minerals).

__Sulfide Ore Stockpile__

An additional 62 million tons of sulfide mill grade ore would be generated as part of the Proposed Action; the volume of sulfide material in the temporary stockpiles at any one time would vary depending on the mining and milling rates. The sulfide material would be continuously fed from the sulfide stockpiles to the milling facilities for processing. All ore to be stored would be assumed to be potentially acid-generating and would be handled accordingly. The general design and potential impacts associated with the stockpile facilities would be the same as for the No Action alternative.

__Heap Leach Facilities__

Operation. An additional 135 million tons of material would be added to the heap leach pads as part of the Proposed Action. Design of the heap leach facilities for the Proposed Action would be the same as the design described for the No Action alternative.

Reclamation. Reclamation of the heap leach facilities for the Proposed Action would be the same as the reclamation described for the No Action alternative.

Impacts. Potential impacts to water quality would generally be the same as stated for the No Action alternative. As described for the No Action alternative, there is minimal potential for impacts to water quality from the heap leach facilities.

__Mill and Tailings Facilities__

Operation and Reclamation. An additional 132 million tons of tailings would be generated as part of the Proposed Action. Operation and reclamation of the mill and tailings facilities for the Proposed Action would be the same as described for the No Action alternative.

Geochemical Characterization. Acid-generating and acid-neutralizing potential of tailings material were determined by static testing of eight samples. The composition of leachate was determined by the Meteoric Water Mobility Testing Procedure for the same eight samples. In addition, tailings slurry samples were filtered and the resulting filtrate was analyzed for metals and water quality parameters (SFPG 1995a).

Results of static acid-generating and acid-neutralizing potential indicate that the tailings are net acid-neutralizing. The autoclave process oxidizes virtually all of the sulfide sulfur to sulfate sulfur, which is stable and not acid-forming. The Meteoric Water Mobility Testing Procedure results indicate that several metal constituents, including arsenic, cadmium, chromium, mercury, and lead have the potential to leach from the tailings solids. Analysis of the tailings filtrate confirms the presence of these metals, as well as copper, selenium, silver, zinc, and chloride.

Impacts. Operation and closure of the mill and tailings facilities are not anticipated to have significant impact on water quality because the facilities are designed to operate at zero discharge (SFPG 1995a). If materials from the mill and tailings facilities were to leak, the potential for significant impact is considered minimal because of naturally occurring conditions at the site, including low annual precipitation, depth of ground water in excess of 175 feet, and the attenuation capacity of the underlying alluvial materials.

Treated Dewatering Water

As described under the No Action alternative, water from the South Pit dewatering operation is treated and then discharged into Rabbit Creek or the reinfiltration basins. The quality of the treated discharge and ground water in the vicinity of the reinfiltration basins is summarized in ***Tables A-3*** and ***A-4*** (Appendix A) and Section 3.2.1, Affected Environment.

Discharge of treated water to Rabbit Creek and the reinfiltration basins is expected to have limited impact on water quality. Baseline data for antimony concentrations in ground water beneath the reinfiltration basins are not available. However, as stated under the No Action alternative, one sample of treated discharge to the reinfiltration basin contained concentrations of antimony that exceed the state and federal maximum contaminant levels. Without background water quality data, it is not possible to determine if antimony concentrations in the discharge water exceed the background concentrations in the ground water system beneath the reinfiltration basins. If the antimony concentrations of the discharge exceed the background concentrations in the ground water, then continued infiltration of the treated water could impact the water quality of the ground water system beneath and downgradient of the reinfiltration basins.

Potential impacts associated with the disposal of sludge generated in the water treatment and filtration plants would generally be the same as those described for the No Action alternative (Section 3.2.2.2).

Bioremediation Site

Existing operations include bioremediation facilities to actively remediate hydrocarbon-contaminated soils and hydrocarbon-contaminated material from sumps (***Figure 2-2***). The Proposed Action includes continued operation of the bioremediation facilities.

As described for the No Action alternative, limited or no impact to water quality is expected to occur from the bioremediation facilities.

Watershed Yield, Erosion, and Sedimentation

Stormwater Control. Facilities would be constructed to contain (without release) the volume from a 25-year, 24-hour storm event plus operational volumes, and to withstand the peak flow from a 100-year, 24-hour storm event.

The proposed Rabbit Creek diversion has the potential to create significant impacts to channel stability in the project area. Such impacts could occur both during the operational phase of the project and over the long term after reclamation and closure. The potential for impacts is based on expected differences in channel gradients, watershed area, and drainage features between the existing conditions and the conditions following the reclamation phase of the Proposed Action. The proposed Rabbit Creek diversion has channel slopes ranging from approximately 16 feet per mile to 63 feet per mile, with approximately 26 feet per mile being typical (WESTEC 1995f). These are significantly flatter overall than the natural channels that would be replaced by the diversion. Bed material sediment in the braided reach of the Kelly Creek channel consists of a well-graded gravel with sand (WESTEC 1995f).

Storm flows entering the Rabbit Creek diversion are likely to be high-velocity flows with substantial sediment transport capacity. Flows in the diversion channel are likely to have comparatively lower velocities with substantially less sediment transport capacity. During operations, the channel would be maintained to minimize the potential for significant sediment aggradation. After operations, however, the channel would aggrade. For this reason, controlled breach weirs have been proposed to allow the diversion to breach under directed conditions after operations (WESTEC 1996c). The breach weirs would route overtopping storm flows into a sequence of protected retention areas and overflow spillways that would direct flows around project area features. Site features, such as the exposed flanks of the overburden and interburden storage areas, would be protected by compacted earth berms to reduce the potential for these facilities to erode while the drainage sequentially re-establishes itself. The potential for seepage of runoff from the retention areas into the overburden and interburden storage areas would also be minimized by placement of the compacted earth berms.

During the operational phase, flows exiting the Rabbit Creek diversion would be discharged into a branch of Kelly Creek. Near the outfall, Kelly Creek is a braided channel with several segments conveying flow. Limited storm flow capacities in the outfall branch would result in bank erosion, channel degradation, and possibly shifting of channel branches in the local area as the Kelly Creek system adjusts to the diversion. The extent of such adjustments is unknown, but would probably be limited to the reach near the outfall. These continued discharges could potentially create an impact from localized erosion and sedimentation along Kelly Creek.

After reclamation and closure, drainageways would be allowed to evolve in a directed manner over time. This would create localized erosion and sedimentation. The extent of such effects is not known, but would potentially create significant impacts to site stabilization within local areas along and immediately adjacent to channels.

Tailings area A would have a diversion along the northeast side to re-route runoff from existing Rabbit Creek tributaries around Cell 2 of the proposed expansion. Sloping fill would be placed along the junction of the east and west forks of the Cell 2 diversion to maintain a distance of 100 feet or more between the face of the tailings embankment and flow in the channel. The diversion channel is designed to convey a peak flow of 1,200 cubic feet per second resulting from the 100-year, 24-hour storm event on the upgradient watershed of approximately 4.24 square miles. (Knight Piésold 1994a). Long-term stability of the channel would probably be adequate to protect the tailings facility against storm flows.

Overburden and interburden storage area A would permanently block the Rabbit Creek drainageway along the south section line of Section 9. A storm water control feature, including an embankment, would be placed in the south-central part of Section 9 during the operational phase of the Proposed Action. This feature would remain in place for the long term during the postmining phase. Sedimentation is likely to occur in this area from runoff drainage. Assuming that the long-term flow capacity of the upper Rabbit Creek Diversion is maintained, the pond area is likely to remain dry throughout most years. During comparatively rare storm events, however, temporary pooling may occur as a result of runoff from approximately 2.8 square miles of contributing watershed area. The 10-year, 24-hour storm event would result in approximately 8.4 acre-feet of runoff volume. The 100-year, 24-hour storm event would result in approximately 42.5 acre-feet of runoff volume.

When the Rabbit Creek Diversion aggrades to the point of failure in the Section 9 locale, runoff from approximately 8.3 square miles would temporarily pool upgradient of the storage area. In most years, little if any pooling is likely to occur because of limited precipitation and runoff and the high evapotranspiration rates in the project area. However, if the diversion were unable to convey flow, approximately 25 acre-feet of water would collect in the area following a 10-year, 24-hour storm event. Similarly, approximately 127 acre-feet of water would collect behind the storage area following a 100-year, 24-hour storm event. Generalized calculations indicate that the latter pool would occupy a 20- to 25-acre area. Depending on the permeability of the substrate of the ponded area and actual size of the pond, complete drying of the ponded area after a 100-year, 24-hour storm event could take up to approximately 1-2 years. Sediment build-up in the pond area might eventually cause uncontrolled overflow in the vicinity.

The storm events described would be comparatively rare. For the Proposed Action, the watershed area withdrawn and the amount of pooled water would be significantly less than what would be expected with the No Action alternative. In general, since Rabbit Creek is an ephemeral or intermittent stream and Kelly Creek does not directly contribute to surface flows in the Humboldt River, potential impacts to surface flow quantities from losses of the contributing watershed area would not be significant. However, because of the potential impacts to postmining site stability from blocked drainage and overflow or seepage into project components, mitigation measures are recommended (see Section 3.2.4).

Flow quantities, durations, and sediment transport capacities are limited in the downstream reaches of Kelly Creek outside the project area. Because of the active channel system dynamics and geomorphic features in the region, potential impacts from any of the diversion systems are not anticipated to perpetuate noticeably beyond 1 to 2 miles outside the project area.

Surface Disturbance. Up to approximately 0.5 square miles of contributing watershed area within the Rabbit Creek drainage would be withdrawn under the Proposed Action. This would result primarily from expanding pits. The overall combined area (including withdrawals from the No Action alternative) would be up to approximately 16 square miles, depending on drainage area restoration from tailings facilities.

The area potentially withdrawn from contributing flow to Rabbit Creek is approximately 38 percent of its watershed at the confluence with Kelly Creek. The area withdrawn represents approximately 3.2 percent of the overall Kelly Creek drainage area, as opposed to 3.1 percent under the No Action alternative. Impacts to surface water quantities from the Proposed Action would be similar to those described for the No Action alternative. Reductions of surface water yields in the overall Kelly Creek watershed are expected to be minimal.

Under the Proposed Action, an additional 1.09 acres of jurisdictional waters of the United States would be affected by project development beyond the 2.24 acres affected under the No Action alternative. Regulations in effect would require impacts to this acreage to be mitigated. Under the Proposed Action, construction of the Rabbit Creek diversion would represent approximately 4.5 acres of mitigation to ephemeral waters of the United States (Resource Concepts, Inc. 1995b). The use of controlled breach weirs to re-direct flows out of the diversion into an evolving drainage system would reduce the area of mitigation within the diversion area itself, but would create additional mitigation acreage. Impacts to waters of the United States are anticipated to be adequately mitigated as a result of the Proposed Action.

As discussed in Section 3.1.2, ground subsidence is predicted to result from the drawdown of the regional water table. Subsidence effects on the diversion, postclosure drainage plans, and Kelly Creek would be minimal. Project subsidence from pit dewatering would lower the existing channel floor of Rabbit Creek by 2 to 3 feet in the area of Section 29, Township 39 North, Range 43 East. The remnant stream base level would be lowered, which would accelerate erosion and sedimentation in a small drainage area between the proposed Rabbit Creek Diversion and downstream project components.

Surface Discharge. Potential impacts to drainage-way erosion from pit dewatering would be the same as those described for the No Action alternative.

3.2.2.4 Other Project Alternatives

Partial Vista Pit Backfill

Effects on surface water flow from this alternative would be the same as those described for the Proposed Action.

Selective Handling of Overburden and Interburden

Selective handling of overburden and interburden would consist of the separate handling and storage of acid-neutralizing and acid-generating overburden and interburden (see Section 2.5.1.2). The general design for this alternative, as illustrated in Figure 2-10, would consist of constructing a 140-foot thick basal unit of acid-neutralizing material (carbonate alluvium). Up to 250 feet of potentially acid-generating material would then be placed on top of the basal layer. A statistical analysis of the overburden and interburden data incorporating selective handling was performed using the same methods of analysis as random emplacement of overburden and interburden (see Sections 3.1.2.2 and 3.1.2.3). Results for a simulation consisting of 250 feet of acid-generating material underlain by 150 feet of net acid-neutralizing material indicate that 95 percent of the selective handling storage area would have no acid-generating potential at the base. In addition, the analysis indicates that 99 percent of the acid generated would be neutralized in the uppermost 32 feet of in situ alluvium. Thus, selective handling with a 150-foot basal layer of alluvium would achieve similar protection of water resources as random emplacement of overburden and interburden with a 50-foot basal layer of acid-neutralizing material as discussed in the No Action and Proposed Action alternatives.

Overburden and Interburden Storage Area Alternatives

The impacts associated with the alternative overburden and interburden storage areas would be similar to the Proposed Action. Alternative 2 would disturb an additional 200 acres and could result in a slight, but probably not significant, increase in sedimentation to Rabbit Creek. As with the Proposed Action, a secondary diversion system would be constructed during closure. The purpose of the secondary diversion system would be to continue to protect the storage area from surface water runoff after the primary Rabbit Creek Diversion is no longer maintained. Under alternative 2, breach weirs, soil buffer dikes, and outlet spillways for the Proposed Action would be modified, as appropriate. Therefore, potential impacts to surface water resources and watershed stability during both operation and postclosure would be similar to those described for the Proposed Action. No significant additional water quality, or erosion and sedimentation impacts are expected.

3.2.3 Cumulative Impacts

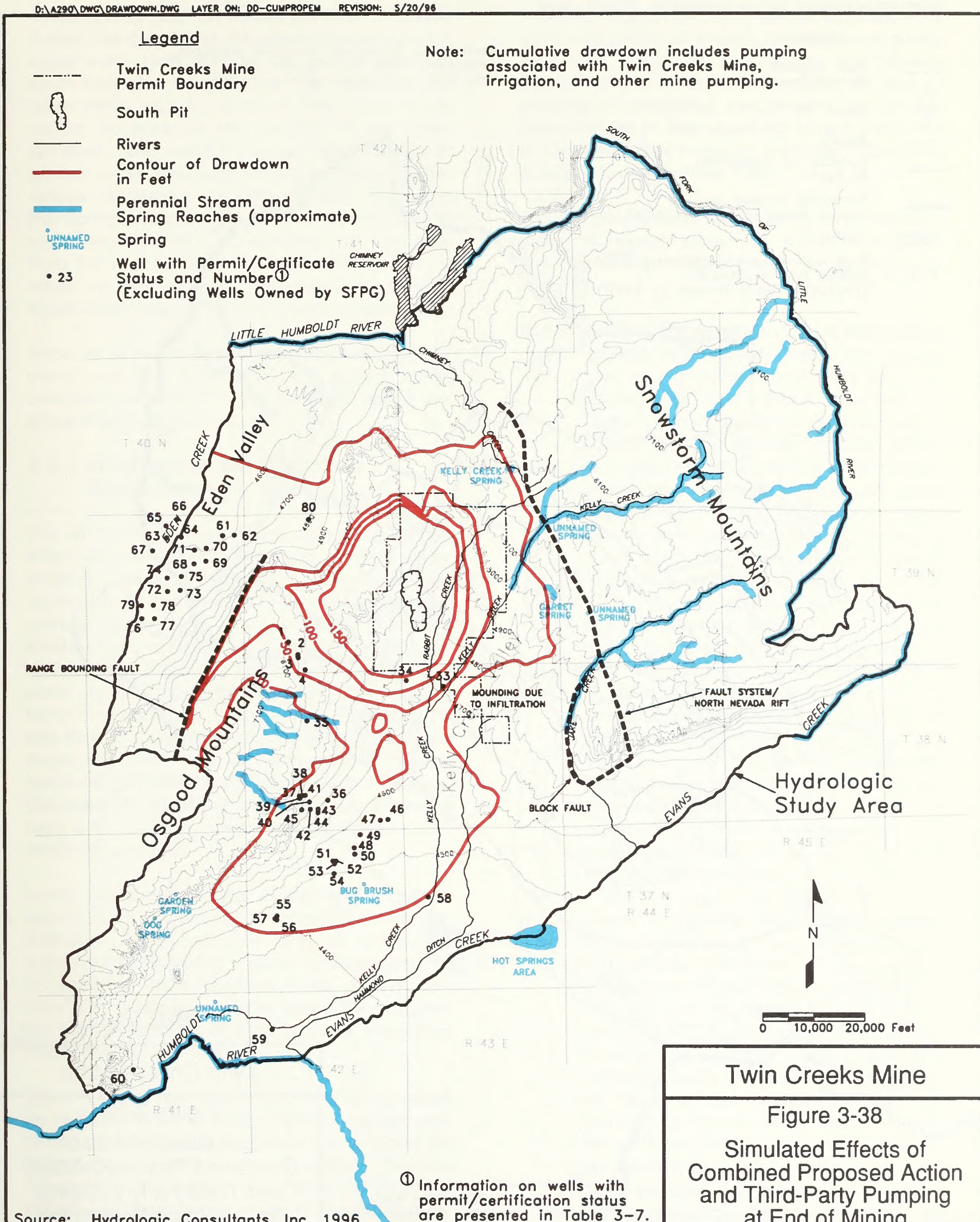
The hydrologic study area shown in ***Figure 3-11*** was evaluated for potential cumulative effects to water resources. This area includes the Kelly Creek basin and portions of the Little Humboldt River basin and Clovers basin. Most existing and reasonable foreseeable mines in the study area would potentially contribute to increased sedimentation to drainageways from disturbed areas. However, these impacts are expected to be limited and should not cause a significant cumulative impact.

Ground water is withdrawn from the area for mining and milling operations, for pit dewatering, and for agricultural purposes. Of the total active appropriations of 16,620 acre-feet per year, 60 percent (10,089 acre-feet per year) is used by the mining industry and 40 percent (6,531 acre-feet per year) is used for crop irrigation. Most of the pumped water is consumed; however some infiltrates and recharges the ground water system.

Information on existing ground water rights is presented in Section 3.2.1. In addition to SFPG, major ground water users in the area include (1) Getchell Mine (First Miss Gold, Inc.) located 4 miles southwest, (2) Pinson Mine located 8 miles south, (3) Nevada First Corporation's irrigation wells located in Eden Valley 6 miles west, (4) Adams Peak Properties irrigation wells located 8 miles south, and (5) Milchems irrigation wells located 13 miles south of the mine.

The potential hydrologic effects attributable to past, present, and future ground water withdrawal were simulated using the calibrated numerical flow model (HCI 1996). The simulation was designed to include pumping associated with all past and current water rights, historical pumping at the Twin Creeks Mine, estimated future pumping associated with the Proposed Action and future third-party pumping for non-SFPG mines and agricultural uses. Pumping from mines other than SFPG was assumed to be entirely consumptive and continue through the dates set forth in the mines' current plans of operations. To account for reinfiltration of irrigation water, agricultural pumping was simulated by assuming 70 percent of the reported water right (HCI 1996) would be consumed and 30 percent would reinfiltrate back to the ground water table. All existing agricultural water rights were modeled as if they would continue to extract ground water at the rates specified in the water right for the foreseeable future.

The effects of dewatering and pit lake development under the Proposed Action, combined with pumping from other existing mines and agricultural wells are presented in ***Figures 3-38 and 3-39***. The cumulative drawdown actually represents a series of overlapping cones of depression in the water table from each ground water withdrawal point.



Source: Hydrologic Consultants, Inc. 1996

① Information on wells with permit/certification status are presented in Table 3-7.

Twin Creeks Mine

Figure 3-38

Simulated Effects of Combined Proposed Action and Third-Party Pumping at End of Mining

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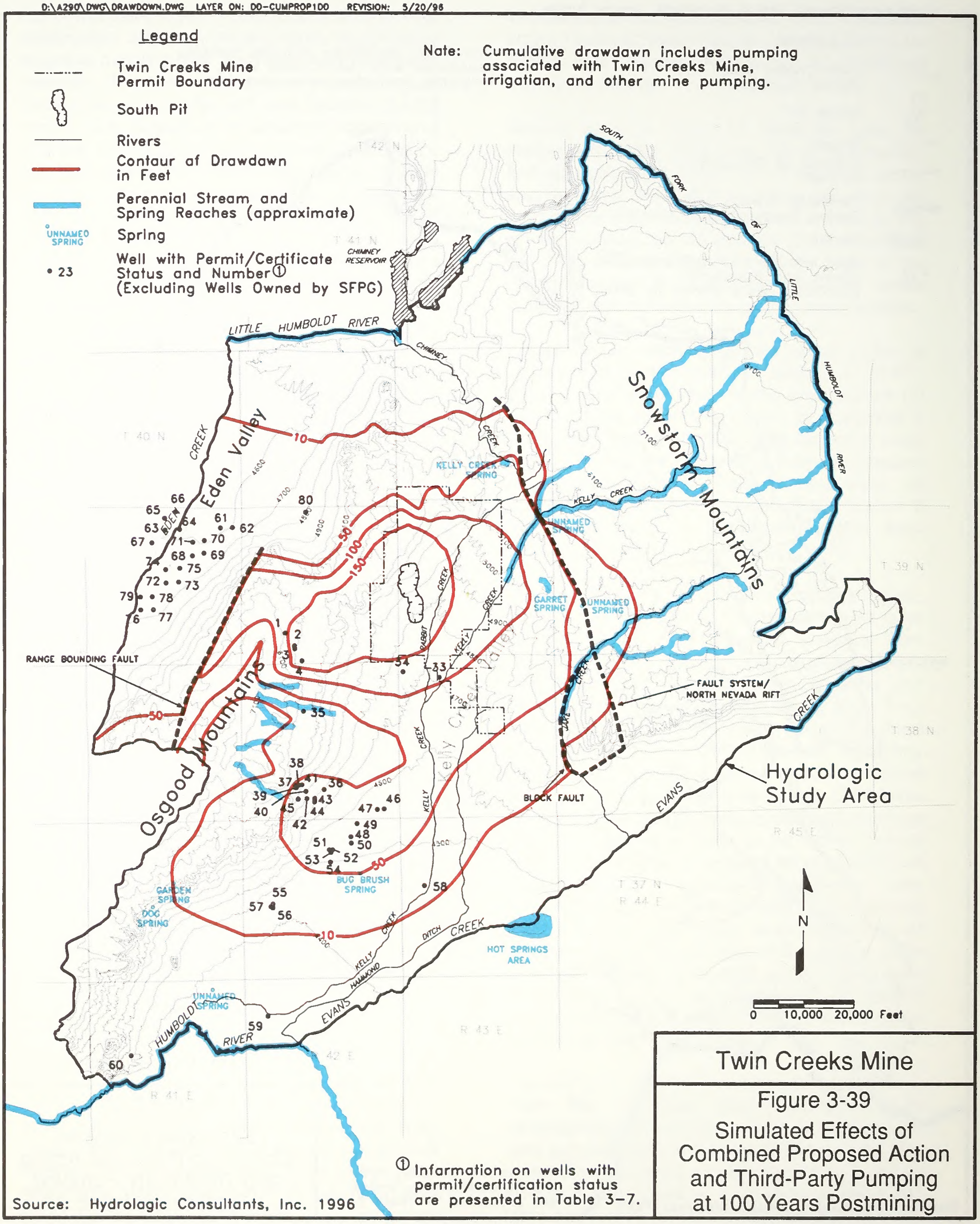

Source: Hydrologic Consultants, Inc. 1996

① Information on wells with permit/certification status are presented in Table 3-7.

Twin Creeks Mine

Figure 3-39
Simulated Effects of Combined Proposed Action and Third-Party Pumping at 100 Years Postmining

Compared to the drawdown for the Proposed Action, the cumulative drawdown encompasses a larger area, particularly in the Eden Valley and south Kelly Creek basin area. The expansion into Eden Valley and the southern Kelly Creek basin occurs because of the addition of the other identified water users in those areas. Continued ground water discharge could potentially further reduce discharge in the Little Humboldt River, the Hot Springs area, and any other perennial surface water sources that are dependent on discharge from the regional ground water system. Ground water quality is not anticipated to change significantly because of the cumulative drawdown.

Because of the proposed reclamation and closure plans, and the location of the project, other cumulative effects from the proposed action are anticipated to be minimal.

3.2.4 Monitoring and Mitigation Measures

The SFPG Twin Creeks Mine collects hydrologic information on a periodic basis as part of its ongoing monitoring program. The hydrologic monitoring is performed to maintain a seasonal surface water and ground water chemistry database and to report any changing conditions in surface water flow rates, ground water levels, and water quality. The locations of the existing monitoring wells are presented in ***Figures 3-19*** and ***3-20***. The current monitoring program includes monitoring wells located downgradient of the interburden and overburden storage areas, flotation grade ore stockpile, sulfide ore stockpile, heap leach facilities, mill and tailings facilities, and reinfiltration basins.

Under the current mine permit and proposed modifications to the mine permit resulting from the Proposed Action, samples from all designated water quality monitoring stations would continue to be collected on a quarterly basis. For all the monitoring stations, samples would be analyzed for Nevada Division of Environmental Protection Profile I constituent lists.

Under Nevada law, postclosure monitoring would be required to demonstrate that the existing and proposed facilities do not have the potential to degrade waters of the state. In addition, Nevada law prohibits the creation of pit lakes that have the potential to degrade the waters of the state or the potential to adversely affect human health or terrestrial and avian life (Nevada Administrative Code 445.2435). As a result, pit lake water quality monitoring would be required by the Nevada Division of Environmental Protection as part of postclosure monitoring requirements to demonstrate that the pit lake would not have the potential to adversely affect waters of the state or terrestrial or avian life (Zimmerman 1995).

The following proposed monitoring and mitigation measures would lessen or eliminate potential impacts to water resources from the Proposed Action.

WR-1: Numerical simulations indicate that several existing water supply wells, and stream and spring flows would potentially be affected by mine-induced drawdown of regional ground water levels. The existing ground water monitoring program would continue to monitor the rate of expansion, extent, and magnitude of drawdown of the regional water levels. The program would include continued quarterly monitoring of water levels in existing site and regional monitoring wells. New wells would be added to the program as needed to evaluate potential drawdown in the vicinity of sensitive water-dependent resources.

WR-2: SFPG would be responsible for monitoring ground water levels between the mine and water supply wells. Adverse impacts to wells would be mitigated by appropriate measures, such as lowering the pump, deepening an existing well, drilling a replacement well, or providing a replacement water supply of equivalent yield and general quality.

WR-3: Flows in streams and springs located within the area of drawdown that are hydraulically connected to the regional ground water system could potentially be reduced. The existing SFPG stream and spring monitoring program would continue. In addition, all springs located within the hydrologic study area that could potentially be impacted by drawdown would be inventoried. The baseline inventory should be conducted in the late summer to early fall low-flow period to establish baseflow and water quality conditions. The inventory would include site observations of hydrogeologic conditions; laboratory analyses of major ion, trace element, and isotope geochemistry; and interpretation to determine if individual springs represent discharge from perched or regional aquifers. Based on the results of the inventory, springs suspected of being controlled by discharge from the regional ground water system and located within the area that could potentially be affected by drawdown would be added to SFPG's regional surface water monitoring program. In addition, continuous stream gages would be established to monitor flows on (1) the Little Humboldt River above Eden Creek, (2) perennial reaches of Kelly Creek and Jake Creek within the potential area of drawdown, and (3) Hot Springs discharge area near Evans Creek. The combined surface and ground water monitoring results would be used to trigger the implementation of measures to mitigate impacts to surface water resources.

WR-4: Additional water level and water quality data would be collected and analyzed to further evaluate the connection between the lower perennial reach of Jake Creek and the regional ground water system. The lower perennial reach, as referred to in this mitigation measure, includes the 4- to 5-mile reach of the perennial stream that is located downstream from the confluence of the north and south forks of Jake Creek. For this data collection and analysis program it is anticipated that two to three nested monitoring well sets would need to be completed along this reach. (The actual location of the nested well sets would depend in part on access to land along Jake Creek, much of which is under private control.) Suggested locations for the nested monitoring wells include (1) between the confluence of the north and south forks of Jake Creek and the Hammond Ranch, (2) in Section 5, Township 38 North, Range 44 East, in the reach located downstream from Hammond Ranch, and (3) in Section 18, Township 38 North, Range 44 East, in the reach located near the Desmond Ranch. Each nested well set would consist of a shallow well completed in the alluvium aquifer associated with Jake Creek and a deep well completed in the regional bedrock aquifer system. The primary purpose of the nested well set would be to monitor the difference in hydraulic head and vertical gradients between the two aquifers. Water level data in the two wells would be monitored on a monthly basis for a minimum of 1 to 2 years to determine seasonal and annual variations in ground water elevations within the shallow and deeper aquifers. Water quality samples would be collected quarterly to evaluate the differences in major ion and trace element concentrations of chemical constituents between the two aquifers. If necessary, stable and unstable isotopes samples would be collected and analyzed to provide additional information to define the similarity or differences between the waters contained within the two aquifer systems. The water level and geochemistry data, coupled with instantaneous stream flow data from Jake Creek, would be evaluated to define the connection (or lack of connection) between the baseflow in Jake Creek and the regional aquifer. If the results of this study indicate that the flows in Jake Creek could potentially be reduced as a result of mine-induced drawdown, then the numerical model would be modified accordingly and rerun to predict the magnitude of change that could potentially occur during the postclosure period. Monitoring and mitigation measures for biological resources associated with Jake Creek are addressed in TW-4 and AB-1 (Section 3.5.4).

WR-5: Reductions in baseflow could occur both during project operation and for some extended period following cessation of mining. Stream and spring flow augmentation may be implemented if necessary to maintain functional riparian and aquatic habitat at pre-project levels. The source of water for flow augmentation could include water piped from another nearby source or water supplied by a new well drilled into an underlying aquifer near the affected spring or stream. Discharge from the well to the surface would be maintained by natural artesian flow or by using an electric, solar, or wind powered pump. Alternative mitigation for stream or spring impacts is to improve other identified stream reaches, wetlands, or riparian corridors, or artificially recharge the ground water system near sensitive resource areas. Impacts to individual surface water rights holders would be mitigated on a case by case basis in coordination with the State Engineer. The BLM and the State of Nevada would be responsible for determining site-specific monitoring and mitigation measures such as flow augmentation or habitat restoration.

WR-6: The evaluation of mine rock storage facilities (overburden and interburden storage facilities, and flotation grade ore stockpiles) was based on extrapolating data from the existing block model. The adequacy of the extrapolation would be verified by developing a rock sampling and characterization plan. The results of the characterization plan would be evaluated on a periodic basis to determine the adequacy of the materials handling plan. The revegetation methods for overburden and interburden and flotation grade ore storage areas would be tested in field plots. Lysimeters would be installed in test plots of overburden and interburden storage areas to test infiltration rates and to compare the results to the rates predicted by HELP modeling. The materials handling plan would be modified, if necessary, to prevent impacts to surface or ground waters.

WR-7: During and after operations, periodic inspection of the Rabbit Creek drainage-way would be made to identify any occurrence of accelerated channel and bank erosion or gullying from discharges or drainage modifications. A similar program would be implemented for the Kelly Creek drainage, where particular attention would focus on potential effects at the Rabbit Creek diversion outfall. The duration, frequency and specific scope of monitoring, and any adjustments to the program, would be determined in coordination with the BLM and Nevada Division of Environmental Protection. The results of the monitoring would be used to develop appropriate stabilization measures, as outlined below, if necessary.

WR-8: After operations, a stabilization program would be implemented if needed for drainage pathways evolving through the project area as the Rabbit Creek Diversion aggrades. Objectives of the program would be to establish and maintain the stability of reclaimed project components and a free-draining postmining topography over the long term. Modifications to the Rabbit Creek Diversion through Section 9 would be made as necessary to ensure long-term drainage of upgradient areas. Such measures may include channel lining, steepening, relocation, or other approaches developed in coordination with appropriate agencies. Earth work would be undertaken as necessary to encourage drainage in a southeasterly direction through Section 9 and to discourage drainage or seepage into other project components. Stabilization of any accelerated channel and bank erosion or gullying along the undisturbed Kelly Creek or Rabbit Creek drainages within or adjacent to the project area would also be undertaken. Stabilization techniques may include revegetation and recontouring, riprap with adequate filter layers, stone windrows at the toes of banks, low-drop grade control structures, or other approaches determined in coordination with the Nevada Division of Environmental Protection and BLM. Note: this mitigation measure applies to both the Proposed Action and Overburden and Interburden Storage Area Reclamation alternative 2.

3.2.5 Residual Adverse Effects

At the completion of mining and dewatering activities, ground water inflow is predicted to result in the development of a pit lake. The pit lake would lose water through evaporation at an estimated rate of 1,500 acre-feet per year for the No Action alternative and 3,100 acre-feet per year for the Proposed Action. Compared to the estimated total recharge for the hydrologic study area (***Table 3-6***), evaporation from the No Action and Proposed Action pit lakes would consume approximately 7 percent and 15 percent, respectively, of the total ground water recharge for the hydrologic study area. This change in the regional ground water balance is considered a residual adverse impact.

The continuous inflow of ground water into the lake to replace water lost through evaporation is predicted to maintain a cone of depression that extends 5 to 7 miles from the pit. Successful implementation of mitigation measures would eliminate most residual adverse effects to water resources. However, adequate mitigation for the possible permanent reduction in baseflows at some stream or spring locations may not be available. A permanent reduction in surface discharge would constitute a residual adverse impact.

The pit lake would not discharge to surface or ground water; therefore, residual adverse water quality impacts to other waters of the state are not anticipated. As the lake forms, it would become a water of the state; therefore, the applicable standards for the lake would depend on the identified beneficial uses. The only anticipated use of the lake would be as a source of water for wildlife. The potential residual adverse effects to wildlife are addressed in Section 3.5.

3.3 Soils

3.3.1 Affected Environment

3.3.1.1 Regional Overview

The project area and the surrounding regional area are located within the Great Basin section of the Basin and Range Physiographic Province (Peterson 1981). In the lower elevations (less than 4,200 feet) of the regional area, the average annual precipitation is 6 to 8 inches. In this arid climate, weathering of parent material is slow and leaching is incomplete. The plant cover is sparse and consists mainly of drought and salt-tolerant shrubs. Typically, the soils are low in organic matter and have thin, light colored A horizons. Soluble salts and calcium carbonate accumulate in the soil profile at a relatively shallow depth. Typic Torriorthents characterize these soils (Denny unpublished).

In the mid elevations (between approximately 4,200 and 7,500 feet) of the regional area, the average annual precipitation ranges from 8 to 12 inches. With increasing elevation and precipitation, there results a deeper leaching of salts and calcium carbonate, lower pH, a thicker and darker A horizon, and more pronounced soil horizonation. Lithic Xerollic Haplargids, Lithic Argixerolls, and Aridic Argixerolls are typical of these soils (Denny unpublished).

Precipitation ranges from 12 to 16 inches at the higher elevations (greater than 7,500 feet) of the regional area. The vegetation is mostly sagebrush with a greater amount and variation in the kinds of grasses. Leaching of salts and carbonates is more intensive, and the soils are neutral or slightly acidic. The A horizons are thicker and higher in organic matter due to increased vegetative production, combined with slower organic matter decomposition due to cooler temperatures. Argic Cryoborolls and Pachic Argixerolls are typical of these soils (Denny unpublished).

3.3.1.2 Project Area

The project area lies within the Humboldt Area Major Land Resource Area 024 (Soil Conservation Service] 1991a). Soils information for the project area is based on detailed soils mapping (Order 2), profile description, and soil sampling (Stoneman-Landers, Inc. 1994). Soils information for the regional and cumulative impacts area is based primarily on Natural Resources Conservation Service Order 3 soils mapping and description conducted in 1984 and 1985. The Natural Resources Conservation Service information is described in the Soil Survey for Humboldt County, East Part, Nevada (Denny unpublished).

Project Area Soil Descriptions

The detailed Order 2 soils map of the project area is presented in ***Figure 3-40***. The project area contains 40 soil map units based on 17 typifying soil profile descriptions and sampling sets. A disturbed land map unit (Map Unit 17) was included as one of the map units in the survey. ***Table 3-17*** lists the soil series and their taxonomic classifications for soils in the project area. All 17 dominant soils are established Natural Resources Conservation Service soil series except Rio King, which is a tentative series. ***Table 3-18*** summarizes the soil map unit characteristics and reclamation suitabilities for soils in the project area. This information includes map unit name, dominant soils and soil inclusions within each map unit, soil depth, parent material type, water and wind erosion hazard for surface horizons of named components of each map unit, range site, suitable topsoil salvage depth, and limiting factors.

Approximately 1,165 acres in the southwest corner of the project area contain soils which have a surface layer with high arsenic concentrations (Stoneman-Landers, Inc. 1994). As depicted on the soils map (***Figure 3-40***), the suffix "A" has been attached to map unit numbers in this area (map units 02A, 03A, 04A, 05A, 10A, 18A, 19A, 21A, 22A, and one delineation of map unit 17 [disturbed lands] in the north half of Section 31, Township 39 North, Range 43 East). The extent of the area with elevated arsenic levels is based on discussions with SFPG and photointerpretation of Landsat imagery (Stoneman-Landers, Inc. 1994). The arsenic apparently originated about 3 or 4 miles west of the project area in the vicinity of the Getchell Mine and was contained in dust that was wind blown from old tailings and deposited to the east in an area that is now part of the SFPG project area (Stoneman-Landers, Inc. 1994). The arsenic levels (greater than 15 parts per million) are high enough to preclude soil salvage (Stoneman-Landers, Inc. 1994).

TABLE 3-17
Soil Series and Classifications in Project Area

Series	Classification
Beoska	fine-loamy, mixed, mesic Duric Natrargids
Bliss	coarse-loamy, mixed, mesic Haploxerollic Durorthids
Boger	loamy-skeletal, mixed, mesic shallow Xerollic Durorthids
Chiara	loamy, mixed, mesic shallow Xerollic Durorthids
Connel	coarse-loamy over sandy or sandy-skeletal, mixed, mesic Durixerollic Camborthids
Dacker	fine-loamy, mixed, mesic Xerollic Durargids
Golconda	fine-loamy, mixed, mesic Haplic Nadurargids
Goosel	fine, montmorillonitic, mesic Xerollic Durargids
Hunnton	fine, montmorillonitic, mesic Xerollic Durargids
Orovada	coarse-loamy, mixed, mesic Durixerollic Camborthids
Panlee	loamy-skeletal, mixed, mesic Xerollic Camborthids
Puffer	loamy-skeletal, mixed (calcareous), mesic Lithic Xeric Torriorthents
Rebel	coarse-loamy, mixed, mesic Xerollic Camborthids
Rio King	coarse-loamy, mixed, mesic Aridic Haploxerolls
Soughe	loamy-skeletal, mixed, mesic Lithic Xerollic Haplargids
Trocken	loamy-skeletal, mixed (calcareous), mesic Typic Torriorthents
Truck	fine, montmorillonitic, mesic Xerollic Haplargids

Source: Stoneman-Landers, Inc. 1994.

There is no prime farmland within the project area (Denny 1993). In addition, none of the named soils of any map unit meet the criteria for hydric soils (Stoneman-Landers, Inc. 1994). Hydric soils are saturated, flooded, or ponded with water long enough during the growing season to develop anaerobic soil conditions (reduced oxygen levels). These soils develop characteristics that are indicative of wet and anaerobic conditions, and these characteristics generally occur within the upper part of the plant root zone. Hydric soils are one of three necessary criteria (the other two being hydrophytic vegetation and wetland hydrology) for wetland consideration.

The Natural Resources Conservation Service Order 3 soil survey (Denny unpublished) mapped hydric soils along Kelly Creek within the project area. Stoneman-Landers, Inc. described soil profiles at numerous locations on the terraces of Kelly Creek for this reason. Although mottling in the profile was observed, it was deeper, typically below 30 inches, and the drainage class was moderately well to well drained, not somewhat poorly to poorly drained as mapped by the Natural Resources Conservation Service. Because the detailed Stoneman-Landers, Inc. survey did not substantiate the presence of hydric soils along Kelly Creek, these areas do not meet the necessary soils criteria for wetlands.

Water and wind erosion hazard ratings are for bare surfaces of project area soils and are based on site-specific data contained in the Stoneman-Landers, Inc. soils report (1994). The water erosion hazard value is the product of multiplying the maximum slope percentage from each map unit range times the “K” soil erodibility factor for the surface horizon of the named soils in each map unit (Soil Conservation Service 1994). The “K” factor reflects the susceptibility of soil particles to erosion by rainfall. “K” factors were calculated using standard methodology (Soil and Water Conservation Society 1993).

Soils in 36 of the 40 map units have a low or moderate water erosion hazard (***Table 3-18***). Although most of the soils in these map units have very high "K" factors (from 0.40 to 0.55), the map units are on slopes of 15 percent or less, and the resulting water erosion hazard (***Table 3-18***) is low to moderate. Conversely, soils in the remaining four map units (Map Units 8, 27, 30, and 34) have a high water erosion hazard (Stoneman-Landers, Inc. 1994). This high rating is primarily a function of slopes greater than 15 percent, and these map units are located in the more steeply sloping bedrock-controlled hills area.

The water erosion hazard ratings are not soil loss rates. Soil loss rates are determined by the Revised

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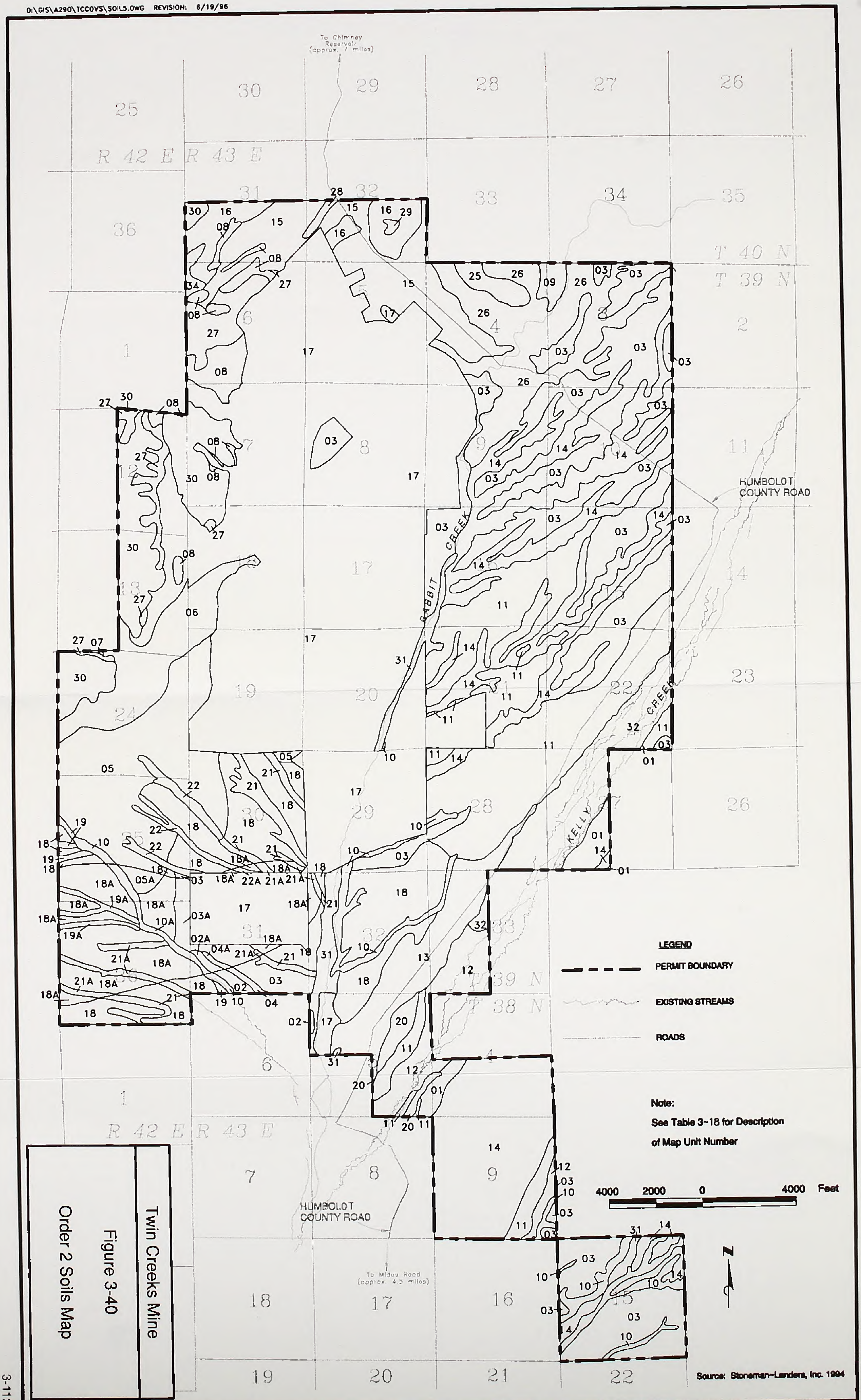


Twin Creeks Mine

Figure 3-40
Order 2 Soils Map

TABLE 3-18
Soil Map Unit Characteristics and Reclamation Suitabilities

Map Unit Number	Map Unit Name	Percent of Map Unit	Inclusions Within Map Unit	Soil Depth	Parent Material Type	Water Erosion	Wind Erosion	Range Site	Limiting Factors	Suitable Soil Depth[1]
1	Beoska silt loam , 0 -2% slopes	90	Connel 5% Trocken 5%	very deep	gravely alluvium from mixed rock sources	low	low	Droughty loam 8-10" precip	High SAR[2] below 16"	16"
2	Bliss silt loam, 0-4% slopes	85	Chiara 5% Connel 5% Orovada 5%	moderately deep	alluvium from mixed rock sources	low	low	Loamy 8-10" precip	Cemented duripan below 25"	25"
2A	Bliss silt loam, high As, 0-4% slopes	85	Chiara 5% Connel 5% Orovada 5%	moderately deep	alluvium from mixed rock sources	low	low	Loamy 8-10" precip	High Arsenic levels	0
3	Bliss-Chiara complex, 0-4% slopes	50 40	Connel 3% Golconda 2% Orovada 5%	moderately deep and shallow	alluvium and loess from mixed rock sources	low	low	Loamy 8-10" precip	Cemented duripan at 21"	21"
3A	Bliss-Chiara complex, high As, 0-4% slopes	50 40	Connel 3% Golconda 2% Orovada 5%	moderately deep and shallow	alluvium and loess from mixed rock sources	low	low	Loamy 8-10" precip	High Arsenic levels	0
4	Bliss-Chiara, complex, 8-15% slopes	50 40	Connel 5% Orovada 5%	moderately deep and shallow	alluvium and loess from mixed rock sources	moderate	low	Loamy 8-10" precip	Cemented duripan at 21"	21"
4A	Bliss-Chiara complex, high As, 8-15% slopes	50 40	Connel 5% Orovada 5%	moderately deep and shallow	alluvium and loess from mixed rock sources	moderate	low	Loamy 8-10" precip	High Arsenic levels	0
5	Bliss-Orovada complex, 0-4% slopes	40 40	Chiara 10% Connel 5% Golconda 5%	moderately deep and very deep	alluvium and colluvium from mixed rock sources (Orovada has a loess mantle)	low	low	Droughty loam 8-10" precip	High SAR and duripan below 24"	24"
5A	Bliss-Orovada complex, high As, 0-4% ,slopes	40 40	Chiara 10% Connel 5% Golconda 5%	moderately deep and very deep	alluvium and colluvium from mixed rock sources (Orovada has a loess mantle)	low	low	Droughty loam 8-10" precip	High Arsenic levels	0
6	Bliss-Orovada complex, 4-8% slopes	40 40	Chiara 10% Connel 5% 15-20% slopes 5%	moderately deep and very deep	alluvium and colluvium from mixed rock sources (Orovada has a loess mantle)	Bliss - low Orovada - moderate	low	Droughty loam 8-10" precip and Loamy 8-10" precip	High SAR and duripan below 24"	24"
7	Bliss-Orovada complex, 8-15% slopes	40 40	Chiara 10% Connel 5% 15-20% slopes 5%	moderately deep and very deep	alluvium and colluvium from mixed rock sources (Orovada has a loess mantle)	moderate	low	Loamy 8-10" precip	High SAR and duripan below 24"	24"

TABLE 3-18 (continued)
Soil Map Unit Characteristics and Reclamation Suitabilities

Map Unit Number	Map Unit Name	Percent of Map Unit	Inclusions Within Map Unit	Soil Depth	Parent Material Type	Water Erosion	Wind Erosion	Range Site	Limiting Factors	Suitable Soil Depth
8	Bliss-Puffer complex, 15-30% slopes	45 40	Chiara 5% Panlee 5% Rock Outcrop 5%	moderately deep, shallow and very shallow	alluvium from mixed rock sources	high	low	Loamy 8-10" precip	Hard bedrock at 15"	15"
9	Boger-Bliss complex, 4-8% slopes	45 40	Bliss 5% Hunnton 5% Rebel 5%	shallow and moderately deep	alluvium and colluvium from mixed but dominantly basalt rocks alluvium.	low	low	Loamy 8-10" precip	Cemented duripan below 20"	20"
10	Chiara-Orovada-Connel complex, 8-15% slopes	35 30 20	Bliss 5% Boger 5% Rebel 5%	shallow and very deep	loess and alluvium from mixed rock sources.	moderate	low	Droughty loam 8-10" precip and Loamy 8-10" precip	High SAR and duripan below 21"	21"
10A	Chiara-Orovada-Connel complex, high As, 8-15% slopes	35 30 20	Bliss 5% Boger 5% Rebel 5%	shallow and very deep	loess and alluvium from mixed rock sources.	moderate	low	Droughty loam 8-10" precip and Loamy 8-10" precip	High Arsenic levels	0
11	Connel loam, 0-2% slopes	90	Chiara 5% loamy skeletal Connel 5%	very deep	loess over alluvium from mixed rock sources	low	low	Droughty loam 8-10" precip	Duripan below 24"	24"
12	Connel loam - Connel silt loam complex , 0-2% slopes	40 40	Stream Channels 5% stratified 1st terrace 10% Rebel 5%	very deep	loess over alluvium from mixed rock sources	low	low	Dry Floodplain and Moist Floodplain	Duripan below 24"	24"
13	Connel-Golconda complex, 0-4% slopes	45 35	Chiara 5% loamy skeletal Connel 10% clayey Golconda 5%	very deep and moderately deep	loess over alluvium from mixed rock sources	low	low	Loamy 8-10" precip	High SAR and duripan below 19"	19"
14	Connel-Trocken complex, 4-15% slopes	50 45	Chiara 5%	very deep	loess (Connel) over alluvium from mixed rock sources	Connel-low Trocken-moderate	low	Droughty loam 8-10" precip	Duripan below 17"	17"
15	Dacker-Bliss complex, 4-8% slopes	50 35	Chiara 5% Trunk 5% 8-15% slopes 5%	moderately deep	alluvium from mixed rock sources	low	low	Loamy 8-10" precip	High SAR and duripan below 20"	20"
16	Dacker-Bliss complex, 8-15% slopes	50 35	Chiara 10% Trunk 5%	moderately deep	alluvium from mixed rock sources	moderate	low	Loamy 8-10" precip	High SAR and duripan below 20"	20"

TABLE 3-18 (continued)
Soil Map Unit Characteristics and Reclamation Suitabilities

Map Unit Number	Map Unit Name	Percent of Map Unit	Inclusions Within Map Unit	Soil Depth	Parent Material Type	Water Erosion	Wind Erosion	Range Site	Limiting Factors	Suitable Soil Depth
17	Disturbed Lands	95	native soil 5%	variable	variable	variable	variable	No estimate	No soil	0
18	Golconda silt loam, 0-4% slopes	85	Chiara 5% Connel 5% clayey Golconda 5%	moderately deep	loess over alluvium from mixed rock sources	low	low	Loamy 5-8" precip	High SAR and duripan below 14"	14"
18A	Golconda silt loam, high As, 0-4% slopes	85	Chiara 5% Connel 5% clayey Golconda 5%	moderately deep	loess over alluvium from mixed rock sources	low	low	Loamy 5-8" precip	High Arsenic levels	0
19	Golconda silt loam, 4-8% slopes	85	Chiara 5% Connel 5% clayey Golconda 5%	moderately deep	loess over alluvium from mixed rock sources	moderate	low	Loamy 5-8" precip	High SAR and duripan below 14"	14"
19A	Golconda silt loam, high As, 4-8% slopes	85	Chiara 5% Connel 5% clayey Golconda 5%	moderately deep	loess over alluvium from mixed rock sources	moderate	low	Loamy 5-8" precip	High Arsenic levels	0
20	Golconda-Chiara complex, 0-4% slopes	55 30	Connel 5% clayey Golconda 5% 4-8% slopes 5%	moderately deep and shallow	loess and alluvium from mixed rock sources	low	low	Loamy 5-8" precip and Loamy 8-10" precip	High SAR and duripan below 15"	15"
21	Golconda-Rebel complex, 2-8% slopes	55 30	Chiara 5% Connel % 8-15% slopes 5%	moderately deep and very deep	alluvium from mixed rock sources	Golconda -moderate Rebel-low	low	Loamy 5-8" precip and Gravely Fan	High SAR and duripan below 25"	25"
high 21A	Golconda-Rebel complex, high As, 2-8% slopes	55 30	Chiara 5% Connel % 8-15% slopes 5%	moderately deep and very deep	alluvium from mixed rock sources)	Golconda -moderate Rebel-low	low	Loamy 5-8" precip and Gravely Fan	High Arsenic levels	0
22	Golconda-Rebel-Orovada complex, 4-8% slopes	35 30 25	Connel 3% Bliss 2% 8-15% slopes 5%	moderately deep and very deep	alluvium from mixed rock sources (Orovada has a loess mantle)	moderate	low	Loamy 5-8" precip , Gravely Fan and Droughty Loam 8-10" precip	High SAR and duripan below 27"	27"
22A	Golconda-Rebel-Orovada complex, high As, 4-8% slopes	35 30 25	Connel 3% Bliss 2% 8-15% slopes 5%	moderately deep and very deep	colluvium or alluvium from mixed rock sources (Orovada has a loess mantle)	moderate	low	Loamy 5-8" precip , Gravely Fan and Droughty Loam 8-10" precip	High Arsenic levels	0

TABLE 3-18 (continued)
Soil Map Unit Characteristics and Reclamation Suitabilities

Map Unit Number	Map Unit Name	Percent of Map Unit	Inclusions Within Map Unit	Soil Depth	Parent Material Type	Water Erosion	Wind Erosion	Range Site	Limiting Factors	Suitable Soil Depth
25	Hunnton loam, 4-8% slopes	85	Bliss 10% Connel 5%	moderately deep	mantle of loess over alluvium from mixed rock sources	low	low	Loamy 8-10" precip	Cemented duripan below 23"	23"
26	Hunnton-Dacker complex, 8-15%	50 25	Boger 10% Rebel 10% Soughe 5%	moderately deep	mantle of loess (Hunnton) over alluvium from mixed rock sources	moderate	low	Loamy 8-10" precip	High SAR and duripan below 21"	21"
27	Orovada-Rebel complex, 15-30%	50 30	Puffer 5% Bliss 5% Rock outcrop 5% skeletal Rebel 5%	very deep	colluvium or alluvium from mixed rock sources (Orovada has a loess mantle)	high	low	Shallow Calcareous Loam 810: precip	High SAR below 31"	31"
28	Panlee very gravely loam, 8-15% slopes	85	Bliss 5% Dacker 5% shallow Panlee 5%	deep	alluvium and colluvium from mixed rock sources	low	low	Loamy 8-10" precip	High SAR and duripan below 18"	18"
29	Puffer very gravely loam, 4-8% slopes	85	Bliss 5% Dacker 5% Rock Outcrop 5%	shallow and very shallow	residuum from sedimentary rock	low	low	Shallow Calcareous Loam 810: precip	Hard bedrock at 9"	9"
30	Puffer-Rock outcrop complex, 35-60% slopes	70 15	Soughe 10% shallow Puffer 5%	shallow and very shallow	residuum from sedimentary rock	high	low	Shallow Calcareous Loam 810: precip	Rock outcrop, steep slopes	0
31	Rebel silt loam, 0-2% slopes	85	Connel 5% Orovada 5% stream channels 5%	very deep	mixed alluvium	low	low	Sodic Terrace 8-10" precip and Dry Flood plain	High SAR below 45"	18"
32	Rio King silt loam, 0-2% slopes	90	Connel 3% poorly drained Rio King 4% stream channels 3%	very deep	alluvium from mixed rocks, loess and volcanic ash	low	low	Loamy Bottom 8-14" precip and Moist Floodplain Loamy 8-10" precip	No limiting factors	60"
34	Trunk-Rebel complex, 8-15% slope	50 35	Bliss 5% Dacker 5 % Orovada 5%	moderately deep and very deep	residuum and colluvium from various rocks (Trunk) and mixed alluvium (Rebel)	high	low	Shallow Loam 10-14" precip	High SAR below 32"	32"

[1]Suitable soil is soil material that is rated good or fair.
[2]SAR-sodium absorption ratio.
Source: Stoneman-Landers, Inc. 1994.

Universal Soil Loss Equation (version 1.04). Version 1.04 is a model to predict the soil erosion rate (tons/acre/year) caused by water from rill and sheet erosion (Soil and Water Conservation Society 1993). It is accepted as the standard for calculating estimated soil loss related to water erosion in Nevada. Soil loss was calculated for the undisturbed soil map units in the project area. Soil loss rates ranged from 0.01 to 0.49 tons/acre/year and are well below the "T" factor significant erosion threshold level of 5 tons/acre/year for deep soils (Stoneman-Landers, Inc. 1994). "T" is the soil loss tolerance value assigned to soils having different rooting depths and is 5 tons/acre/year for deep soils. An annual soil loss greater than 5 tons/acre/year would exceed the "T" threshold value for deep soils and would be considered significant erosion (Soil Conservation Service 1993).

WESTEC performed an erosional stability analysis for SFPG as part of its *Revised Final BLM Plan of Operations* (plan of operations) *and NDEP Reclamation Plan and Permit Application* (reclamation plan), Volume II, Appendix D (SFPG 1995a), and generated Revised Universal Soil Loss Equation erosion rates for undisturbed project soils between 0.05 and 0.70 tons/acre/year for slopes of 30 percent and less, and 1.20 to 1.40 tons/acre/year for soils on slopes of 50 to 60 percent. These values are very similar to those obtained by Stoneman-Landers, Inc. and are well below the threshold level of 5 tons/acre/year for deep soils. Soil loss rates due to water erosion are low on project area soils because the soils are undisturbed and support native vegetation, rainfall ("R" factor value) is low, and most precipitation falls as snow and infiltrates the soil gradually or evaporates before running off.

Wind erosion hazard is the product of the "I" factor times the climatic "C" factor and is expressed as a low, moderate, or high hazard of the soil to erode through wind action. The "I" factor is the vulnerability of soil particles to wind erosion and is expressed as average annual soil loss (tons/acre/year) for surface soil texture groupings or wind erodibility groups. All of the native soils on the project site have a low wind erosion hazard (***Table 3-18***) (Stoneman-Landers, Inc. 1994).

<u>Project Area Soil Suitability</u>

Project area soils were evaluated to determine their suitability and depth for possible salvage and subsequent use as topsoil for reclamation purposes. The suitability evaluations were based on commonly accepted criteria for soil salvage for hard rock mining in Nevada. Although the Nevada Division of Environmental Protection regulations concerning reclamation of lands subject to mining operations discuss removing and stockpiling sufficient topsoil if practicable and necessary for the establishment of the postmining use of the land (regulation section 519A.325), there is no published Nevada Division of Environmental Protection guideline listing soil suitability criteria for use in soil salvage operations (Nevada Division of Environmental Protection 1992).

The BLM Solid Minerals Reclamation Handbook H-3042-1 (BLM 1992) contains a soil suitability table (Table XII-1, page XII-2) that was used to evaluate soils for this project. Soil materials exhibiting a poor or unsuitable rating were considered unsuitable for salvage and reclamation. ***Table 3-19*** lists the BLM Soil Suitability Criteria. The parameters include soil texture, rock fragment percent, pH, sodium absorption ratio, and electrical conductivity. In addition, a very hard to extremely hard dry soil consistency would limit soil salvage, and soils with a very hard to extremely hard layer are considered unsuitable for salvage at and below this layer. Many project area soils have at variable depths a cemented hardpan layer (duripan) that limits soil salvage once encountered. A duripan is a mineral soil horizon that is cemented primarily by silica, usually opal or microcrystalline forms of silica, or secondarily by iron oxide or calcium carbonate.

Water and wind erosion potential are not parameters on the BLM or Natural Resources Conservation Service soil suitability tables, but are discussed relative to growth media selection (topsoil or alluvium) in Section 3.3.2, Environmental Consequences.

The soil suitability evaluations were based on the field descriptions of each soil series and mapping unit, as well as physical and chemical laboratory data, presented in the Stoneman-Landers, Inc. soils report (1994). Salvage depths for a particular soil series were based on average depths of suitable material. Suitable soil salvage depths are listed by map unit in ***Table 3-18***. Constraints or limiting factors preventing deeper salvage are also listed in ***Table 3-18***.

Based on the soil suitability evaluations and planimetry of map unit distribution across the project area, a weighted-average of 16.6 inches of suitable topsoil (good and fair rated soil material as evaluated in the Stoneman-Landers, Inc. report)

TABLE 3-19
BLM Topsoil Suitability Criteria

Soil Property	Suitable			Unsuitable	Limiting Factor
	Good	Fair	Poor		
Texture	sandy loam loam silt loam	sandy clay loam silty clay loam clay loam	sandy clay loamy sand silty clay clay (less than 60 percent	clay (greater than 60 percent)	excessive clay
Rock Fragments (percent by volume)	0-10	10-20	20-40	greater than 40	excessive gravels, cobbles, or boulders
pH	6-8	5-6	4.5-5	less than 4.5	excessive acidity
		8-8.5	8.5-9	greater than 9	excessive alkalinity
Sodium Absorption Ratio (SAR)	4	4-8	8-16	greater than 16	excessive sodium
Electrical Conductivity (EC)	3	3-7	7-15	greater than 15	excessive salinity

Source: BLM 1992.

exists over the No Action alternative projected disturbance areas, and 17.4 inches over the Proposed Action disturbance areas. This equals approximately 6,436,634 cubic yards of topsoil material for the No Action alternative, and 10,231,952 cubic yards for the Proposed Action.

3.3.2 Environmental Consequences

Impacts to soil resources are directly related to the total acreage of disturbance. ***Table 2-1*** summarizes the acreages affected by the Existing, No Action alternative, and Proposed Action surface disturbances. Potential impacts to soil resources would include soil loss and/or change in productivity as a result of mining and reclamation activities. Reclamation effectiveness and erosion potential are primary issues considered in the significance criteria for potential impacts to soil resources.

Impacts to soils would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Major loss of suitable soils or other growth media (alluvium) during salvage, stockpiling, or reclamation activities that would limit reclamation success
- Erosion of disturbed or reclaimed sites preventing the effective use of sediment control structures, blocking natural drainages, or not supporting revegetation efforts

SFPG proposes to use pit alluvium, rather than topsoil, as the primary growth medium for reclamation of disturbed areas. The SFPG plan of operations and reclamation plan (SFPG 1995a) includes the following statement under the heading Growth Media: "Alluvium or other appropriate growth media will be placed either directly from the pit during operation or stockpiled and placed at the end of the operational life of the facility. If the necessary quantity of alluvium is not available, the alluvium stored in the overburden and interburden storage area in Section 29 will be used. A small stockpile may be established if necessary near the end of mining activities to provide an adequate supply of growth media for the final reclamation effort. This small stockpile will have signs to prevent disturbance and be seeded to reduce loss due to erosion" (Volume I, page 2-47) (SFPG 1995a).

The same document also states: "Reclaimed areas will be covered with 6 inches (nominal) of growth media, unless test plots on comparable materials substantiate that the required revegetation can be established and maintained without growth media or with a lesser amount" (Volume I, page 3-5). Although the terms "growth media" and "comparable materials" are not defined in this statement, SFPG initiated a long-term Reclamation Test Plot Program in 1994 to compare revegetation and erosion rates on topsoil, pit alluvium, and overburden and interburden. To implement the reclamation test plot program, SFPG set aside five areas at the Twin Creeks Mine that differ in terms of growth media, slope gradient, and aspect. Test plot A is a "silts/native topsoil area"; test plot B is constructed on an overburden and interburden storage area; and test plots C, D, and E consist of alluvium material. The test plots were constructed in October 1994. A "Year-One Monitoring Results" report was completed by Resource Concepts, Inc. in September 1995 (Resource Concepts, Inc. 1995c).

Based on a field evaluation of the test plots, it was the BLM's conclusion that the Twin Creeks Mine pit alluvium is suitable for growth medium and two to four times less erosive. The Resource Concepts, Inc. report states: "Test plot A (silts/topsoil) produced good cover with both seed mixes. This test plot had the least relief and the most erosion of all test plots. This material would not be suitable as topsoil due to its erosive nature. The alluvium material produced good cover this year. This material was used on test plots with 2:1 slopes (about 50 percent slopes) and showed no substantial signs of erosion. This would be a good medium to stockpile for topsoil uses on other reclamation areas" (Resource Concepts, Inc. 1995c).

The topsoil texture is described as a silt loam with high wind erosion hazard, slight water erosion hazard on slopes of less than 7 percent, moderate hazard on slopes of 7 to 15 percent, and severe hazard on slopes exceeding 15 percent. Salinity and sodicity are slight in the topsoil. The topsoil is also said to have lower infiltration rates, and saline and sodic materials underlying the thin layer of topsoil, which could be mixed in if topsoil is salvaged. Topsoil placement would create a lithologic discontinuity between topsoil and overburden which would restrict water movement and root growth development (BLM 1995a).

The texture of the alluvium is described as a gravelly sandy loam with slight salinity and sodicity. Wind erosion hazard of the alluvium is moderate. Water erosion hazard is slight on slopes of less than 16 percent, moderate on slopes of 16 to 33 percent, and severe on slopes exceeding 33 percent.

Both the topsoil and alluvium had good establishment of seeded species. The establishment of seeded species varied by application technique or fertilizer application rates. The main difference between the topsoil and the alluvium was the rate of erosion. The topsoil areas had signs of rill and gully erosion. No apparent signs of erosion occurred on the alluvium. The topsoil appeared to have more vigorous vegetation, but the vegetation was dominated by annual rye. The percent of perennial species appeared to be higher on the overburden (BLM 1995a).

The BLM concluded that the existing topsoil is a suitable plant growth medium for revegetation but is subject to severe water erosion on slopes greater than 15 percent and high wind erosion. The test plots proved that successful revegetation can be accomplished on the alluvium; therefore, the alluvium is suitable for growth medium. The goals of reclamation are to leave areas disturbed by mining in a stable non-eroding condition and establish a self-renewing perennial plant community. The use of the topsoil available at the site would not be able to accomplish a stable non-eroding condition on the steeper slopes. The alluvium material would accomplish these goals (BLM 1995a).

Although the results of the reclamation test plots will not be quantified until years 2 through 5, it appears that revegetation of pit alluvium will meet reclamation goals for cover percent and plant diversity in 3 to 5 years (Zielinski 1996).

In addition to the reclamation test plot program, Revised Universal Soil Loss Equation calculations were also performed to compare soil loss estimates on native topsoil and pit alluvium as growth media on reclaimed slopes. Stoneman-Landers, Inc. calculated soil loss rates of 2.9 tons/acre/year on a 5 percent reclaimed slope using respread topsoil, 12 tons on a 15 percent slope, 22 tons on a 25 percent slope, 32 tons on a 35 percent slope, 43 tons on a 50 percent slope, and 50 tons on a 65 percent slope (Stoneman-Landers, Inc. 1994). These soil loss estimates are for a bare regraded surface and, as vegetation is established over time, "C" factor values will drop along with a corresponding drop in the soil loss rate. Based on this analysis, using native topsoil would cause significant erosion (5 tons/acre/year or greater) on slopes somewhere between 5 and 15 percent, and on all slopes greater than 15 percent, until vegetation is well established after several years, at a minimum.

WESTEC calculated Revised Universal Soil Loss Equation soil loss rates for alluvium as growth media on reclaimed slopes. The projected erosion rates for areas reclaimed with alluvium varied from: 0.04 tons/acre/year for a bare overburden and interburden storage area top on a 2 percent slope to 0.02 tons after 5 years of reclamation on the same top; from 0.50 tons/acre/year for a bare, 40 percent slope, overburden and interburden storage area sideslope to 0.26 tons after 5 years of reclamation on the same sideslope; from 0.04 tons/acre/year for a bare, 2 percent slope, tailings impoundment pond area to 0.02 tons after 5 years of reclamation on the same pond area; from 1.3 tons/acre/year for a bare, 40 percent slope, tailings impoundment sideslope to 0.66 tons after 5 years of reclamation on the same sideslope (SFPG 1995a, Volume II, Appendix D). None of these values exceed the significant threshold "T" factor value of 5 tons/acre/year for deep soils or other comparable growth media.

Based on the results of the Revised Universal Soil Loss Equation analysis, the projected rates of soil loss for areas using reclaimed soil and revegetated for 5 years were roughly 2 to 4 times higher than the values of undisturbed areas of native soils with similar slopes. The projected rates of soil loss for areas reclaimed with alluvium and revegetated for 5 years were substantially less than those for salvaged topsoil and also less than the rate of loss for undisturbed areas on similar slopes. In addition, the ongoing reclamation test plots, using various types of growth media, will be used to calibrate and verify or revise soil loss rates projected by the Revised Universal Soil Loss Equation model. These results will be used to identify any potential conditions that may require additional mechanical or chemical treatments that may aid in reducing growth media erosion.

3.3.2.1 No Action Alternative

The No Action alternative would include continued development and disturbance of existing soil resources within the existing mine permit area. Approximately 3,136 acres of planned disturbance would be distributed across project area soils. Based on results to date from the reclamation test plot program, successful reclamation can be achieved with alluvium growth media, and no significant impacts to soil resources are anticipated under the No Action alternative.

3.3.2.2 Proposed Action

The construction and operation of the Proposed Action would result in the disturbance of approximately 5,217 acres. Approximately 17.4 inches (weight-average depth across the proposed disturbance acres) of good and fair rated topsoil is available for use in reclamation. Because SFPG proposes to use pit alluvium rather than native topsoil as the primary source of growth media, the existing nonsalvaged soils resource at the proposed disturbance areas would be largely buried during construction of the proposed facilities. Some of the lower soil materials may be used as liner material for tailings impoundment ponds or heap leach pads.

However, based on the conclusions that (1) respread native topsoil has high erosion potential and would not provide a stable, non-eroding condition on steep reclaimed slopes, and (2) the pit alluvium can provide successful growth media for reclamation from both a revegetation and erosion control standpoint, a significant decrease in soil productivity from native conditions would not result from implementation of the Proposed Action. Therefore, no significant impacts to soil resources are anticipated under the Proposed Action.

3.3.2.3 Other Project Alternatives

Partial Vista Pit Backfill Alternative

Assuming that successful reclamation can be achieved with alluvium growth media on the partial backfill area, there would be no significant impacts to soil resources from this alternative.

Selective Handling of Overburden and Interburden Alternative

The overburden and interburden storage areas would be reclaimed at the surface in a similar manner to that for the Proposed Action through the use of sufficient alluvium growth media. Assuming successful reclamation, impacts to soil resources would be similar to the Proposed Action and would not be significant.

Overburden and Interburden Storage Area Reclamation Alternatives

Alternative 1 would have the same footprint as the Proposed Action with no additional surface disturbance. The overall slope percent of the storage area sideslopes would remain the same. Some additional growth media (alluvium) would be necessary to cover the additional sideslope areas. As with the Proposed Action, there would be no significant impacts to soil resources with this alternative configuration assuming successful reclamation.

Alternative 2 would involve additional rounding of the corners at the base of the storage areas but without a height increase. Compared to the Proposed Action, this alternative would disturb an additional 200 acres to accommodate the expanded footprint. This additional surface disturbance would be minimal compared to the total project area, and there would be no significant impacts to soil resources assuming successful reclamation.

3.3.3 Cumulative Impacts

The cumulative impacts area for soils includes disturbance areas associated with existing and future mining activities involving the Twin Creeks, Getchell, Pinson, and Preble Mines. Existing mining activities within the cumulative impacts area have disturbed approximately 8,039 acres of soil resources (***Table 2-9***). An additional 14,683 acres of reasonably foreseeable future actions could be disturbed by the year 2011 (***Table 2-10***), including 3,136 acres of currently permitted activities at the Twin Creeks Mine (the No Action alternative) and 5,217 acres from the Proposed Action. Presently, there are no proposed reasonably foreseeable future actions for the other three mines (Getchell, Pinson, and Preble) in the soils cumulative impacts area. Both the existing and the future disturbance acreages constitute only a small percent of the overall cumulative impacts area and are not considered significant impacts to the soils resource. Furthermore, with the exception of open pits, lands disturbed by mining activities would be reclaimed. Reclamation would minimize soil losses and re-establish soil productivity where soils or other appropriate growth media are salvaged and redistributed. Past and present grazing practices within the cumulative impacts area also contribute to soil erosion and reduction in soil productivity.

3.3.4 Monitoring and Mitigation Measures

Potential impacts to soil resources would be substantially mitigated by reclamation practices included as part of the Proposed Action. Proposed monitoring and mitigation measures generally follow those identified for soils in the Solid Minerals Reclamation Handbook (BLM 1992) as appropriate. Additional monitoring and mitigation measures recommended to improve reclamation effectiveness include the following:

S-1: Continuation of the reclamation test plot program through the life of the mine in order to incorporate successful practices into ongoing reclamation activities.

S-2: Development of a procedure for periodic evaluation of alluvium suitability for use as growth media. Some alluvial strata, exposed as the pit is vertically and laterally expanded, may be poor or unsuitable based on physical or chemical parameters used in soil suitability evaluations. Identification and non-salvage, or treatment of such strata, if present, would ensure good quality materials are used in root zones.

S-3: Inspection of final growth media root zone materials prior to redistribution to ensure their suitability to support vegetation.

S-4: Implementation of shallow ripping or other surface treatment to create roughness on the tailings embankment faces prior to the placement of growth media. This would improve the stability of replaced growth media with regard to the embankment materials.

S-5: Application of contour ripping and scarifying techniques during reclamation to minimize compaction and erosion.

S-6: Monitoring of reclaimed areas by visually inspecting flow channels, fencing, drainage and erosion controls, and slope stability until reclamation has final approval. Maintenance and/or corrective measures should be taken, as necessary, during the monitoring period.

3.3.5 Residual Adverse Effects

The Proposed Action would result in the loss of native soils and their development on disturbed areas. However, reclamation would promote development of soils on disturbed areas with growth media application and revegetation. Reductions in soil productivity and other soil impacts could be reversed within 5 to 15 years assuming successful reclamation. If reclamation is not successful, the Proposed Action could result in a long-term reduction in soil productivity.

3.4 Vegetation

3.4.1 Affected Environment

3.4.1.1 Regional Ecosystem Description

The project area is within the general Great Basin sagebrush-grass ecosystem, which is common throughout northern Nevada. Locally, this ecosystem is dominated by six plant communities or vegetation types, including: Wyoming big sagebrush-grass, mixed shrub, saltbush, meadow, low sagebrush, and basin big sagebrush. Additional communities occurring within the ecosystem, but several miles from the Twin Creeks Mine, include wet meadows and marshes around springs and seeps, greasewood, and winterfat. More montane communities such as aspen, juniper, and mountain mahogany occur in the Snowstorm Mountains east of the project site.

3.4.1.2 Project Area Plant Communities

The distribution of plant communities occurring in the immediate vicinity of the proposed project is shown in ***Figure 3-41***. These communities have been differentiated through field observation and measurements of species composition and cover. The general characteristics of each plant community are described below, and a listing of specific plant species observed in the project area is presented in ***Table 3-20***.

Wyoming Sagebrush-Grass

This community is characterized by the strong dominance of Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) occurring in combination with a variety of grass species including bluebunch wheatgrass (*Agropyron spicatum*), squirreltail (*Sitanion hystrix*), Idaho fescue (*Festuca idahoensis*), Thurber's needlegrass (*Stipa thurberiana*), Indian ricegrass (*Oryzopsis hymenoides*), Sandberg's bluegrass (*Poa secunda*), pine bluegrass (*P. scabrella*), and Great Basin wild-rye (*Elymus cinereus*). Lesser quantities of other shrub species and various perennial and annual forbs also may occur within the community. Local measurements within this community showed total vegetation cover of approximately 31 percent with Wyoming sagebrush contributing approximately 65 to 78 percent of the composition, while grasses (primarily squirreltail, bluebunch wheatgrass, and Idaho fescue) comprised approximately 21 to 34 percent of the perennial composition. Other common species observed on the transects included cheatgrass (*Bromus tectorum*), Indian ricegrass, Hood's phlox (*Phlox hoodii*), and peppergrass (*Lepidium perfoliatum*). Total perennial vegetation canopy or foliar cover within this community averaged 28.3 and 33.8 percent on six transects measured in this community in 1993 and 1994, respectively (WESTEC 1993c, 1994e, 1995i).

Mixed Shrub

Wyoming sagebrush is also a dominant species in this plant community, but occurs in combination with a variety of other abundant shrub species including spiny hopsage (*Grayia spinosa*), budsage (*Artemisia spinescens*), horsebrush (*Tetradymia glabrata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), and shadscale (*Atriplex confertifolia*). Relative abundance of these codominant shrub species is highly variable from site to site within this community. Perennial grasses are typically sparse in the understory, which is commonly dominated by the annual cheatgrass. Total perennial vegetation cover within this community averaged 21.2 and 21.9 percent in eight transects measured in this community in 1993 and 1994, respectively (WESTEC 1993c, 1994e, 1995i).

Shadscale

Saline tolerant shrub species such as shadscale and spiny hopsage dominate in this community, which occurs on the lower, more saline slopes in the southwest portion of the project area. Cheatgrass is the primary grass occurring in the understory. None of the vegetation transects measured in 1993 or 1994 were located within this vegetation community, but total perennial vegetation cover for this community is estimated to be very similar to the mixed shrub community discussed above.

Meadow

This community occurs at scattered sites along the Kelly Creek drainage where grasses and grass-like species dominate, often to the exclusion of sagebrush and other shrubs. The most common grass and grass-like species occurring in this community include Baltic rush (*Juncus balticus*), bluegrass (*Poa pratensis*), creeping wildrye (*Elymus triticoides*), and crested wheat-grass

TABLE 3-20
Plant Species Observed On or Near the Twin Creeks Mine Project Area

Scientific Name	Common Name
Apiaceae	
Lomatium grayii	Gray's lomatium
Peridiridia gairdneri	Yampah
Asteraceae	
Agoseris glauca var. laciniata	Pale agoseris
Antennaria dimorpha	Pussytoes
Antennaria rosea	Rose pussytoes
Artemisia arbuscula	Low sagebrush
Artemisia spinescens	Bud sagebrush
Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush
Artemisia tridentata ssp. tridentata	Basin big sagebrush
Aster sp.	Aster
Aster scopulorum	Crag aster
Balsamorhiza hookeri	Hooker balsamroot
Blepharipappus scaber	Blepharipappus
Chaenactis douglasii	Douglas' duskymaiden
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Lanceleaf rabbitbrush
Cirsium utahense	Utah thistle
Crepis acuminata	Hawksbeard
Crepis modocensis	Modoc hawksbeard
Crepis occidentalis ssp. costata	Gray hawksbeard
Erigeron aphanactis	Rayless fleabane daisy
Erigeron linearis	Linearleaf fleabane daisy
Erigeron scopulorum	Fleabane daisy
Iva axillaris ssp. robustior	Povertyweed
Lactuca serriola	Prickly lettuce
Layia glandulosa	Tidytips
Lygodesmia spinosa	Skeletonweed
Psoralea lanceolata var. solidagensis	Lemon scurfpea
Tetradymia glabrata	Horsebrush
Tetradymia spinosa	Spiny horsebrush
Boraginaceae	
Amsinkia tessellata	Fiddleneck
Cryptantha gracilis	Slender cryptantha
Lappula redowskii var. redowskii	Redowski's stickseed
Pectocarya spp.	Combseed
Plagiobothrys sp.	Popcornflower
Brassicaceae	
Arabis holboellii var. pinetorum	Holboell rockcress
Cardaria draba	White top
Cardaria pubescens	White top
Caulanthus crassicaulis	Thickstem wildcabbage
Descurainia pinnata	Tansymustard
Lepidium perfoliatum	Pepperweed

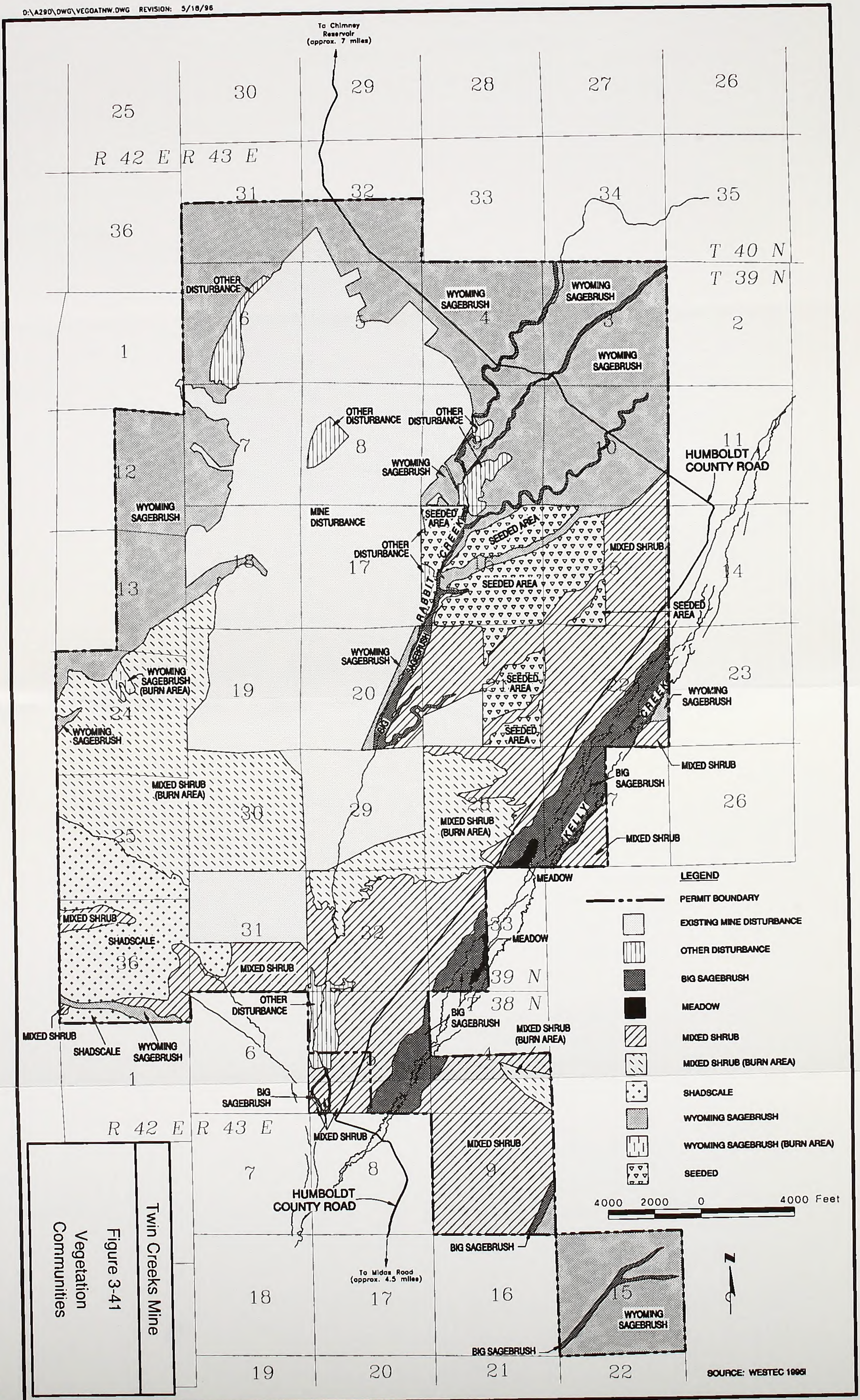
TABLE 3-20 (continued)
Plant Species Observed On or Near the Twin Creeks Mine Project Area

Scientific Name	Common Name
Brassicaceae (continued)	
Phoenicaulis cheiranthoides	Wallflower phoenicaulis
Sisymbrium altissimum	Tumble mustard
Caryophyllaceaea	
Arenaria sp.	Sandwort
Chenopodiaceae	
Atriplex confertifolia	Shadscale
Chenopodium leptophyllum	Narrowleaf lambsquarters
Grayia spinosa	Spiny hopsage
Halogeton glomeratus	Halogeton
Salsola iberica	Russian thistle
Sarcobatus vermiculatus	Greasewood
Fabaceae	
Astragalus curvicarpus	Curved pod milkvetch
Astragalus eremicus	Hermit milkvetch
Astragalus lentiginosus	Specklepod milkvetch
Astragalus pterocarpus	Winged milkvetch
Astragalus purshii	Pursh's milkvetch
Lupinus arbustus	Spurred lupine
Lupinus caudatus	Tailcup lupine
Geraniaceae	
Erodium cicutarium	Cutleaf filaree
Iridacea	
Sisyrinchium idahoense	Idaho blue-eyed grass
Juncaceae	
Juncus balticus	Baltic rush
Lamiaceae	
Salvia dorrii	Purple sage
Liliaceae	
Allium acuminatum	Hooker onion
Calochortus bruneaunis	Mariposa lily
Fritillaria pudica	Yellow bell
Fritillaria atropurpurea	Leopard lily
Zigadenus paniculatus	Panicled camas
Loasaceae	
Mentzelia albicaulis	White-stem blazing star
Malvaceae	
Sphaeralcea ambigua	Desert mallow
Onagraceae	
Camassonia claviformis	Clavate fruit primrose
Clarkia sp.	Clarkia
Oenothera caespitosa	Caespitose evening primrose
Orobanchaceae	
Orobanche corymbosa	Rydberge broomrape
Poaceae	
Agropyron cristatum	Crested wheatgrass

TABLE 3-20 (continued)
Plant Species Observed On or Near the Twin Creeks Mine Project Area

Scientific Name	Common Name
Poaceae (continued)	
Agropyron dasystachyum	Thickspike wheatgrass
Agropyron spicatum	Bluebunch wheatgrass
Bromus tectorum	Cheatgrass
Elymus cinereus	Great Basin wildrye
Elymus triticoides	Creeping wildrye
Festuca idahoensis	Idaho fescue
Muhlenbergia richardsonis	Richardson's muhly
Oryzopsis hymenoides	Indian ricegrass
Poa pratensis	Kentucky bluegrass
Poa secunda ssp. secunda	One-sided bluegrass
Sitanion hystrix	Squirreltail grass
Stipa thurberiana	Thurber's needlegrass
Sporobolus airoides	Dropseed
Vulpia sp.	Small fescue
Polemoniaceae	
Collomia grandiflora	Large-flowered collomia
Collomia linearis	Narrow leaf collomia
Eriastrum sparsiflorum	Few flowered woody star
Gilia triodon	Gilia
Leptodactylon pungens	Granite phlox
Phlox hoodii	Hood's phlox
Phlox longifolia var. longifolia	Longleaf phlox
Polygonaceae	
Eriogonum caespitosum	Mat buckwheat
Eriogonum microthecum (microtheca?)	Great Basin buckwheat
Eriogonum ovalifolium var. nevadense	Cushion buckwheat
Eriogonum ovalifolium var. ovalifolium	Cushion buckwheat
Eriogonum vimineum	Wicker buckwheat
Eriogonum umbellatum	Sulphur flower buckwheat
Portulacaceae	
Lewisia rediviva	Bitterroot
Ranunculaceae	
Delphinium nuttallianum	Nuttal's Larkspur
Ranunculus testiculatus	Nutty Buttercup
Scrophulariaceae	
Castillega chromosa	Desert paintbrush
Penstemon rydbergii	Rydberg's penstemon
Penstemon kingii	King's penstemon
Penstemon sp.	Penstemon

Source: WESTEC 1994e.



Twin Creeks Mine

Figure 3-41
Vegetation Communities

(*Agropyron cristatum*). These grasses and grass-like species are often accompanied by pyrrocoma (*Pyrrocoma lanceolata*) and poverty weed (*Iva axillaris*). Total vegetation cover in this community averages almost 100 percent (WESTEC 1993c, 1994e).

Low Sagebrush

Occurring almost entirely as small, isolated pockets occupying thin, rocky soils on or near the tops of hills in the Dry Hills and western end of the Snowstorm Mountains, this vegetation type exhibits very limited distribution within the project vicinity. Even though this plant community does not occur in the immediate project area (i.e., within SFPG's permit boundary), it is described here because it has been identified as important wildlife habitat in the project region (see Section 3.5.1.1, Terrestrial Wildlife). The community is characterized by the dominance of low sagebrush (*Artemisia arbuscula*). This species is commonly accompanied by Idaho fescue, squirreltail, bluegrass, spurred lupine (*Lupinus caudatus*), long-leaf phlox (*Phlox longifolia*), lava aster (*Aster scopulorum*), hermit milkvetch (*Astragalus eremiticus*), and hawksbeard (*Crepis acuminata*). Total perennial vegetation cover measured on two transects in this community averaged 29.3 and 40.0 percent for 1993 and 1994, respectively (WESTEC 1993c, 1994e).

Basin Big Sagebrush

As the name implies, this plant community, which occurs primarily in deeper, more mesic soils along the larger ephemeral drainages and dry washes, is characterized by the dominance of basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*). Other common species within the community include rubber rabbitbrush (*Chrysothamnus nauseosus*), squirreltail, thick spike wheatgrass (*Agropyron dasystachyum*), Great Basin wildrye, bluegrass, cheatgrass, lupine, and peppergrass. Total perennial vegetation cover measured on three transects within this community averaged 34.8 and 31.9 percent in 1993 and 1994, respectively (WESTEC 1993c, 1994e, 1995i).

Table 3-21 shows the correlation of the above vegetation communities with Natural Resource Conservation Service (formerly Soil Conservation Service) range site designations and soil mapping units for the area.

Burned and Brush-Cleared Areas

A sizable acreage across the southern portion of the project area was burned during range fires in 1985 and 1988. The existing species composition of these burned areas varies according to the type of vegetation on the area prior to the burn and the length of recovery period following the burn. Within the Wyoming sagebrush-grass vegetation type, the burned areas are composed primarily of Wyoming sagebrush, squirreltail, cheatgrass, Russian thistle, and peppergrass. Burned areas formerly occupied by mixed shrub vegetation are currently dominated by rubber rabbitbrush, shadscale, squirreltail, cheatgrass, and Russian thistle. Total perennial vegetation cover measured on five transects in the burned areas averaged 9.7 and 9.0 percent in 1993 and 1994, respectively (WESTEC 1995i).

In addition to the burned areas, a significant acreage within the Bullhead Seeding pasture was cleared of sagebrush and other shrubs in 1966 prior to being reseeded. These areas currently exhibit a lower cover by shrubs and a higher cover by perennial grasses in comparison to surrounding vegetation communities. Total perennial vegetation cover measured on two transects in these areas averaged 22.6 and 20.5 percent in 1993 and 1994, respectively (WESTEC 1995i).

Wetlands, Riparian, and Phreatophytic

No sites meeting the U.S. Army Corps of Engineers criteria for jurisdictional wetlands have been identified within the area of projected surface disturbance for the mine expansion. Riparian vegetation communities associated with the mine water discharge channel and with springs and seeps (Kelly Creek Spring, Garret Spring, and unnamed springs) along the western flank of the Snowstorm Mountains include various facultative and obligate wetland vegetation species, but these areas were not found to meet all of the criteria as jurisdictional wetlands under the Clean Water Act (WESTEC 1994e; RCI 1995b).

The wetland vegetation communities associated with the springs and seeps range in size from about 0.1 acre at some of the seeps to about 2.4 acres at Garret Spring. Vegetation communities around the springs and seeps, and along perennial reaches of Kelly Creek, Jake Creek, Evans Creek, and the Little Humboldt River were not quantitatively sampled during baseline surveys due

TABLE 3-21
Vegetation Communities, Range Sites, and Soil Mapping Units

Vegetation Community	Principal Range Sites	Principal Soil Mapping Units	Dominant Plant Species	Potential Forage Production (pounds/acre)	Seral Stage
Wyoming Sagebrush	Loamy 8-10" (24XY005)	Bliss-Chiara Complex Hunton-Dacker Complex Dacker-Bliss Complex Hunton Loam	Wyoming sagebrush, bluebunch wheatgrass, Thurber's needlegrass, Sandberg's bluegrass, squirreltail, Indian ricegrass, Hood's phlox	400-800	mid-late
	Loamy 8-10" (25XY019)	Bliss-Orovada Complex Bliss-Puffer Complex	Wyoming sagebrush, bluebunch wheatgrass, Thurber's needlegrass, Sandberg's bluegrass, squirreltail, Indian ricegrass, Hood's phlox	400-800	mid
	Loamy 8-10" (24XY005)	Bliss- Chiara Complex Connel-Trocken Complex	Wyoming sagebrush, bluebunch wheatgrass, Thurber's needlegrass, Sandberg's bluegrass, squirreltail, Indian ricegrass, Hood's phlox	400-800	mid-late
	Shallow Calcareous Loam 8-10" (24XY030)	Orovada-Rebel Complex Puffer-Rock Outcrop	Wyoming sagebrush, bluebunch wheatgrass, Thurber's needlegrass, Sandberg's bluegrass, squirreltail, Indian ricegrass, Hood's phlox	250-500	mid
Mixed Shrub	Loamy 8-10" (24XY005)	Connel Loam Connel-Golconda Complex	Wyoming sagebrush, spiny hopsage, bud sagebrush, squirreltail, cheatgrass	400-800	late
	Loamy 8-10" (24XY020)	Bliss-Chiara Complex	Wyoming sagebrush, spiny hopsage, bud sagebrush, squirreltail, cheatgrass	400-800	late
	Droughty Loam 8-10" (24XY020)	Connel Loam	Wyoming sagebrush, spiny hopsage, bud sagebrush, squirreltail, cheatgrass	300-700	late
Shadscale	Loamy 5-8" (24XY002)	Golconda Silt Loam Golconda-Rebel Complex	shadscale, Wyoming sagebrush, spiny hopsage, bud sagebrush, squirreltail, cheatgrass	300-750	late
	Droughty Loam 8-10" (24XY020)	Bliss-Orovada Complex	shadscale, Wyoming sagebrush, spiny hopsage, squirreltail, cheatgrass	300-700	late
Basin Big Sagebrush	Dry Floodplain (24XY006)	Chiara-Orovada Complex Rebel	basin big sagebrush, rubber rabbitbrush, green rabbitbrush, basin wildrye, squirreltail,	600-1,500	mid

Sources: WESTEC 1993c; Stoneman-Landers, Inc. 1994; Soil Conservation Service 1991a and 1992.

to their distance from the proposed mine operations. In general, these spring and seep areas, and the narrow riparian area along the mine water discharge channel are dominated by sedges (*Carex* spp.), cattail (*Typha* sp.), spikerush (*Eleocharis palustris*), Baltic rush, rubber rabbitbrush, and Basin big sagebrush. Additional species common to the spring and seep areas include buttercup (*Ranunculus cymbalaria*), blueflag iris (*Iris missouriensis*), and curly dock (*Rumex crispus*). Wetland vegetation communities with similar species, plus cottonwoods and willows, are also likely to occur along the perennial reaches of streams in the project vicinity including the Little Humboldt River, Evans Creek, and selected reaches of Kelly Creek and Jake Creek.

Phreatophytic species occur in several plant communities south and east of the project area. These include grass and grass-like species in the moist meadow areas along the Kelly Creek and Jake Creek drainages, cottonwoods and willows in limited areas of these same drainages, and extensive greasewood-dominated communities in the alkaline flats along the lower reaches of the Kelly Creek drainage, several miles south of the Twin Creeks Mine (***Figure 3-42***). Most of these phreatophytic communities were not studied nor mapped during baseline investigations due to their distance from the mine. Phreatophytic vegetation shown in ***Figure 3-42*** was mapped from the distribution of soil map units characterized by the domination of black greasewood (HCI 1996; Natural Resources Conservation Service unpublished data) coupled with interpretation of orthophotos and color aerial imagery.

3.4.1.3 Special Status Species

A search of the Nevada Natural Heritage Program database (Cooper 1994) and a request to the U.S. Fish and Wildlife Service pursuant to Section 7C of the Endangered Species Act of 1973 did not identify the known occurrence of any threatened or endangered plant species in the vicinity of the project site. The database search indicated that three BLM Sensitive Species (formerly Category 2 candidate species) have been recorded in the vicinity. These are windloving buckwheat (*Eriogonum anemophilum*), Osgood Mountain milkvetch (*Astragalus yoder-williamsii*), and Nevada oryctes (*Oryctes nevadensis*).

The U.S. Fish and Wildlife Service revised the federal candidate species lists, omitting the category 2 listing and developing a "candidate" list only. This Notice of Review was published in the Federal Register on February 28, 1996. The BLM subsequently developed interim guidelines on March 20, 1996, for the protection and conservation of these C1 and C2 species that have historically been protected as BLM Special Status Species. Therefore, all former Nevada C1 and C2 species that are not included in the U.S. Fish and Wildlife Service's new candidate list are currently incorporated into the Nevada BLM Sensitive Species List.

BLM Sensitive Species are species of limited distribution and abundance for which a proposed listing as threatened or endangered may be appropriate, but for which conclusive data on biological vulnerability and threat are not currently available to support a proposed listing. BLM's management objectives relative to sensitive species are to carry out management, consistent with the principles of multiple use, for the conservation of sensitive species and their habitats, and to ensure that actions authorized, funded, or carried out by the federal government do not contribute to the need to list any of these species as threatened or endangered.

Windloving buckwheat is described as a low, clumped perennial plant in the Polygonaceae family (WESTEC 1993c). Kartesz (1988) reports the status of the species as "rare and restricted to the West Humboldt Mts., Pershing Co.; to the Reese River Valley, Lander Co.; to the Jackson Mts. and Sonoma Range, Humboldt Co." Kartesz indicates that this species, which is endemic to Nevada, occurs primarily on exposed, windswept ridges and slopes, on loose gravel of limestone or volcanic outcrops with *Artemisia, Haplopappus, Pteryxi*a and *Chrysothamnus*. BLM (1981a) confirms that this species has been located in the Osgood Mountains southwest of the project site.

According to Kartesz (1988), Osgood Mountain milkvetch has an even more limited distribution, being known in Nevada only in the Osgood Mountains southwest of the project site, with the nearest known location about 6 miles away. At this location, its habitat includes decomposed granite and gravel flats with *Artemisia arbuscula* and *Chrysothamnus nauseosus*. It apparently occurs in similar habitats in the Owyhee Mountains of southwestern Idaho.

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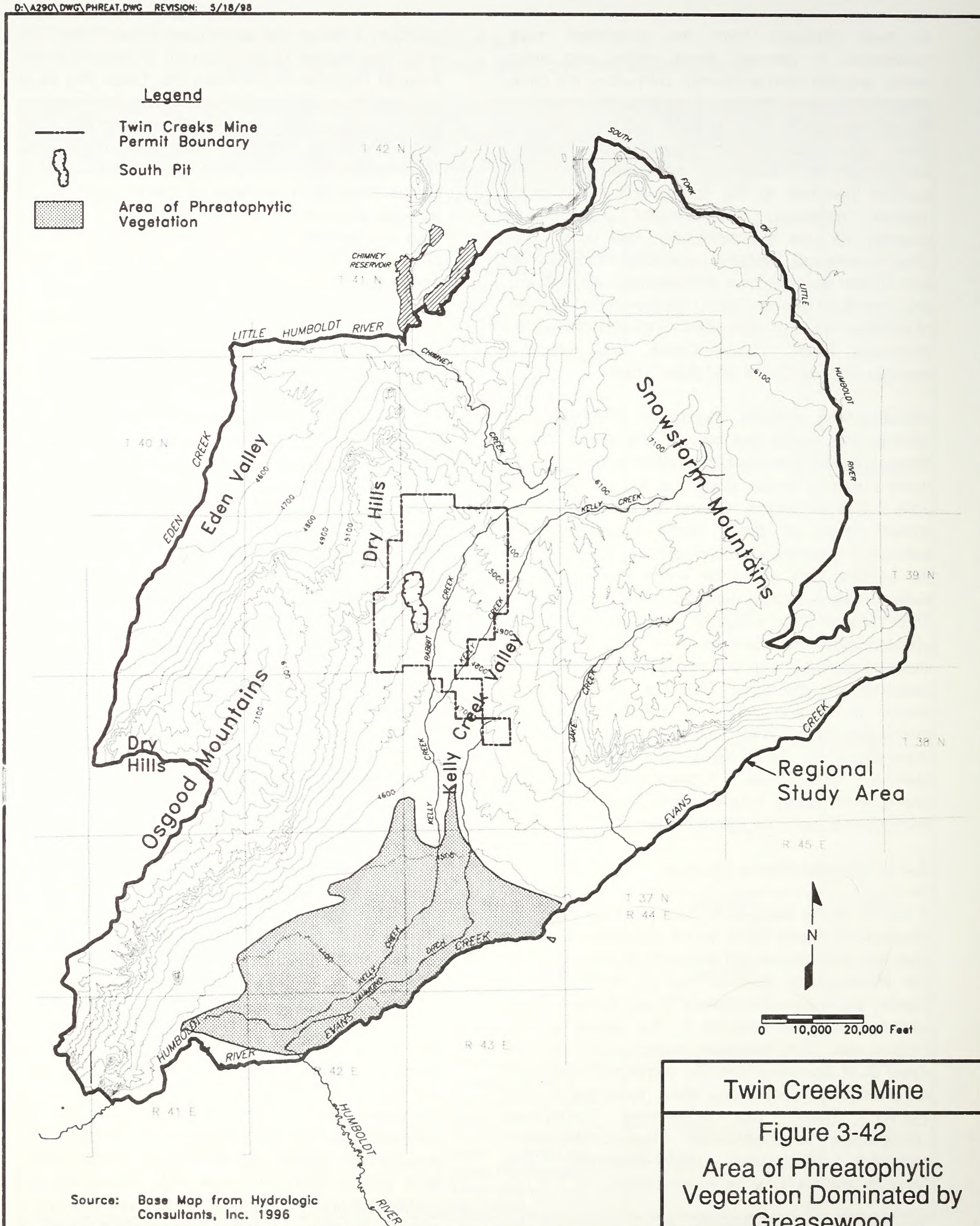


Twin Creeks Mine

Figure 3-42
Area of Phreatophytic Vegetation Dominated by Greasewood

Kartesz (1988) describes the distribution of Nevada oryctes as being known only from "Desert Valley, 12 miles northeast of Jumbo [sic], Humboldt Co.; to north of the West Humboldt Range, 11 miles south of Lovelock, Pershing Co.; to 5 miles north of Fallon, to near Wadsworth, Washoe Co.; extending south to Mineral and Esmeralda Cos." The habitat listed for this species includes sandy flats, slopes and low hills with *Atriplex*, *Tetradymia*, *Grayia*, *Sarcobatus*, *Psorothamnus*, and *Chrysothamnus*.

Appropriate potential habitats in the vicinity of the project area were examined during June 1993 and May 1994 to identify any populations of the first two of these candidate species. No occurrences of either species were found during the field surveys. (WESTEC 1994e). At the time of these field surveys, the third species, Nevada oryctes, was not identified as a candidate species potentially occurring in the project area and was not specifically included in the survey efforts. However, this species was not recorded as being observed during the vegetation surveys conducted in appropriate habitat areas.

3.4.2 Environmental Consequences

Impacts to vegetation would be significant if the Proposed Action, No Action alternative, or other project alternatives result in one or more of the following:

- Impacts to special status species, including direct or indirect disturbance of federally threatened or endangered plant species or their critical habitat, or disturbance of federal candidate species in a manner and a degree that would contribute to their being listed as either threatened or endangered

- Removal or loss of unique vegetation communities such as natural wetlands

- Establishment of noxious weeds on the reclaimed disturbance areas

- Failure of reclamation efforts to achieve a stable, perennial vegetation cover that protects disturbed soil surfaces against erosion

- Establishment of vegetation communities on the reclaimed areas that fail to meet the reclamation objectives of providing suitable forage for livestock and wildlife

3.4.2.1 No Action Alternative

Impacts to Special Status Species or Loss of Unique Vegetation Resources

No listed or candidate species were found in the project area during field investigations of potential habitat, and no unique vegetation resources were observed in the proposed disturbance area. Therefore, it is expected that the No Action alternative would have no direct impacts to special status or unique vegetation resources.

Ground water drawdown associated with the mine dewatering program could result in effects extending several miles beyond the mine boundary (see Section 3.2, Water Quantity and Quality). Field observations and the limited data available indicate that the closest springs and seeps, such as Garret Spring and Kelly Creek Spring, are likely fed by perched water sources and, therefore, are not expected to be impacted by the regional drawdown. Ground water drawdown from the No Action alternative is not expected to affect the volume of surface flows in the closest perennial reaches of Kelly Creek, but may affect flow in some reaches of Jake Creek. If perennial flow persists in these reaches despite changes in flow quantity, these changes are not expected to result in significant impacts to riparian or phreatophytic communities along these drainages. Ground water drawdown effects associated with the No Action alternative are not expected to extend far enough to affect phreatophytic vegetation communities growing in the lower reaches of the Kelly Creek drainage.

Potential for Noxious Weed Establishment

As evidenced by the widespread occurrence of cheatgrass, Russian thistle, and halogeton throughout northern Nevada on areas disturbed by construction activities, overgrazing, or fire, there is a high potential for weedy species to invade almost any freshly barren area unless more desirable species are promptly established to provide competition for the available moisture and nutrients.

Although not designated by the state as "noxious weeds," the three species mentioned above are among the most aggressive invaders of barren soil areas and can quickly establish stands that are difficult to remove or replace with more desirable species. Because of its potential health impacts to sheep, halogeton is designated by the state as an "injurious weed" within Nevada. None of the species observed in the project area during field investigations (WESTEC 1993c, 1994e) are among those currently designated as noxious weeds by the Nevada Administrative Code or cited by Antognini et al. (1995) as being species on the federal list that would be likely to occur in rangeland environments. Therefore, the potential for noxious weed establishment is considered low due to the absence of such populations in the vicinity (i.e., lack of a seed base). The potential for establishment of other nuisance species such as cheatgrass and halogeton is moderate, but this would not be a significant impact.

Potential for Reclamation Success

Reclamation procedures proposed by SFPG are appropriate for the site and are expected to result in establishment of a perennial vegetation cover that stabilizes the surface growth medium and protects against erosion. Therefore, no significant impacts associated with reclamation are expected.

Changes in Community Composition and Distribution Resulting from Reclamation

The No Action alternative would include continued mine development and disturbance of existing vegetation communities within the existing mine permit boundary. The additional acreage of planned disturbance within various vegetation communities on public lands is shown in ***Table 3-22***. The majority of the projected 850 acres of additional disturbance on public lands would occur within the mixed shrub (burned) and Wyoming sagebrush communities (579 acres [68 percent] and 141 acres [17 percent], respectively).

Vegetation communities on private lands affected by the No Action alternative are tabulated in ***Table 3-23***. The primary vegetation communities occurring on the projected 2,286 acres of private lands to be disturbed under this alternative include mixed shrub – 692 acres (30 percent), mixed shrub (burned) – 632 acres (28 percent), shadscale – 314 acres (14 percent), and Wyoming sagebrush – 327 acres (14 percent).

Reclamation of the disturbed areas would proceed according to the existing permit conditions and approved reclamation plans which focus on reestablishing a diverse grass, shrub, and forb community comparable in cover and production to that which existed prior to mining. It is expected that the reclaimed plant community would be initially less diverse in species composition and more uniform in density, growth form, and appearance than the original native plant communities being replaced. These visual and compositional differences may persist for several decades. Eventually, natural reinvasion of native species from surrounding areas and natural succession on the reclaimed areas would result in a more heterogeneous, "natural appearing" array of plant communities. Individual communities would develop in response to the variations in microhabitats and growth media within the reclaimed areas. It is expected that the reclaimed plant communities would remain noticeably different from the surrounding undisturbed areas for at least 30 to 50 years following initial reclamation.

Approximately 1,213 acres, or 39 percent of the total area to be disturbed under the No Action alternative have been subject to fires in recent years and are not occupied by the original native vegetation. These burned areas are dominated by cheatgrass with scattered remnants of the natural shrub communities. Therefore, the planned reclamation following mining is likely to accelerate the establishment of more productive and diverse plant communities than currently occupy these areas.

Discharge of excess mine water to a number of reinfiltration basins in Sections 5, 9, and 15, Township 38 North, Range 43 East would encourage the natural invasion and establishment of riparian vegetation around these facilities through the life of the operation. Maintenance of the reinfiltration basins would include periodic vegetation clearing to prevent establishment and growth of such riparian communities. Following mine closure, the individual basins would be reclaimed with similar species to those used on the other disturbed areas.

In summary, the proposed reclamation program is expected to result in establishment of perennial vegetation communities comparable to or exceeding the average cover and productivity values of the existing communities on the areas disturbed by the No Action alternative.

TABLE 3-22
Vegetation Types on Public Lands Affected by the No Action Alternative

Project Component	Location	Affected Acreage by Vegetation Community								
		WS[1]	WS Burn[1]	MS[1]	MS Burn[1]	BBS[1]	SS[1]	Seeded	Exist Disturb[2]	Totals
Open Pits										
Vista Pit	Sec. 6 & 7, T39N, R43E								51	51
South Pit	Sec. 18 & 30, T39N, R43E	26			91					117
Overburden/Interburden Storage Areas										
H	Sec. 24, T39N, R42E		2		369					371
Limestone Stockpile	Sec. 5 & 6, T39N, R43E	64								64
Process Facilities	Sec. 5, T39N, R43E								21	21
Tailings Storage Areas										
A	Sec. 4 & 9, T39N, R43E								52	52
Leach Pads										0
Drainage Diversion Channels										0
Ponds										0
Ancillary Facilities										0
Exploration Activities	(100 acres total)[3]	26			75					100
Well Pads/Pipelines	(40 acres total)[3]	12			24	4				40
Access/Haul Roads	(34 acres total)[3]	14			20					34
TOTALS		**141**	**2**	**0**	**579**	**4**	**0**	**0**	**124**	**850**

[1]WS - Wyoming sagebrush
WS Burn - Wyoming sagebrush (burned)
MS - mixed shrub
MS Burn - mixed shrub (burned)
BBS - basin big sagebrush
SS - shadscale
[2]Existing disturbance category refers to generally small areas of native or partially disturbed vegetation within the overall *Figure 3-41*.
[3]Acreage distribution by vegetation type for these components is based on SFPG's estimated location of the activities rather than map measurement.

TABLE 3-23
Vegetation Types on Private Lands Affected by the No Action Alternative

Project Component	Location	Affected Acreage by Vegetation Community								
		WS[1]	WS Burn[1]	MS[1]	MS Burn[1]	BBS[1]	SS[1]	Seeded	Exist Disturb[2]	Totals
Open Pits										
South Pit	Sec. 19, T39N, R43E				40				290	330
South Pit	Sec. 13, T39N, R42E	25			5					30
Overburden/Interburden Storage Areas										
B	Sec. 20, T39N, R43E			280		17				297
F	Sec. 25, T39N, R42E				376		257			633
M	Sec.13, T39N, R42E	159			38					197
Limestone Stockpile	Sec. 5 & 6, T39N, R43E									0
Process Facilities	Sec. 5, T39N, R43E									0
Tailings Storage Areas										
C	Sec.29, T39N, R43E				93					93
Infiltration Basin System	Sec. 5, 9, & 15, T38N, R43E	118		188		12				318
Leach Pads										
B	Sec. 31, T39N, R43E			99			55			154
Drainage Diversion Channels										0
Ponds										0
Ancillary Facilities										0
Exploration Activities	(100 acres total)[3]	25			75					100
Well Pads/Pipelines										0
Access/Haul Roads	(11 acres total)[3]			2	5		2		2	11
Bioremediation Site	Sec. 31, T39N, R43E			123						123
TOTALS		327	0	692	632	29	314	0	292	2,286

[1]WS - Wyoming sagebrush
WS Burn - Wyoming sagebrush (burned)
MS - mixed shrub
MS Burn - mixed shrub (burned)
BBS - basin big sagebrush
SS - shadscale

[2]Existing disturbance category refers to generally small areas of native or partially disturbed vegetation within the overall permit boundary of the existing mine operations. These areas, primarily Wyoming sagebrush and burned mixed shrub communities, are too small to be individually distinguished on aerial photographs and mapped accurately on ***Figure 3-41***.

[3]Acreage distribution by vegetation type for these components is based on SFPG's estimated location of the activities rather than map measurement.

3.4.2.2 Proposed Action

Impacts to Special Status Species or Loss of Unique Vegetation Resources

No listed or candidate species were found in the project area during field investigations of potential habitat, and no unique vegetation resources were observed in the proposed disturbance area. Therefore, it is anticipated that the Proposed Action would have no direct impact to special status species or unique vegetation resources.

Ground water drawdown associated with the mine dewatering program could result in effects extending several miles beyond the mine boundary (see Section 3.2, Water Quantity and Quality). Field observations and the limited data available indicate that the closest springs and seeps, such as Garret Spring and Kelly Creek Spring, are likely fed by perched water sources and, therefore, are not expected to be impacted by the regional drawdown. Ground water drawdown from the Proposed Action is not expected to affect the volume of surface flows in the closest perennial reaches of Kelly Creek, but may affect flow in some reaches of Jake Creek. If perennial flow persists in these reaches despite changes in flow quantity, such changes are not expected to result in significant impacts to riparian or phreatophytic communities along these drainages.

Ground water drawdown effects associated with the Proposed Action are projected to extend southward into the north edge of Township 37 North at 100 years following the end of mining (***Figure 3-32)***. Therefore, the drawdown associated with the Proposed Action may affect phreatophytic vegetation communities growing in this portion of the Kelly Creek drainage. If such effects occur, they would be expected to result in a gradual reduction in density of some greasewood stands, with corresponding invasion by more xeric saline/alkaline-tolerant species such as shadscale and other saltbush species from adjacent communities. The extent and nature of this substitution would depend largely on the subsequent water table depths following this drawdown. The resulting shift in boundaries between greasewood and shadscale/saltbush communities would not be a significant vegetation impact.

Potential for Noxious Weed Establishment

The same issues of weed control and management would apply to the Proposed Action as described for the No Action alternative. The potential for noxious weed establishment is considered low due to the absence of such populations in the vicinity (i.e., lack of a seed base), however, the establishment of cheatgrass, Russian thistle, and halogeton would hinder achieving reclamation objectives in a timely fashion. Therefore, initial establishment of desirable reclamation species on disturbed areas is important in combating the invasion of these aggressive weedy species.

Potential for Reclamation Success

Reclamation procedures proposed by SFPG are considered to be appropriate for the site and are expected to result in establishment of a perennial vegetation cover that stabilizes the surface growth medium and protects against erosion. Therefore, no significant impacts associated with reclamation are expected.

Changes in Community Composition and Distribution Resulting from Reclamation

The Proposed Action would result in the disturbance or removal of existing plant communities and establishment of reclaimed plant communities during the reclamation process. The expected additional acreage of disturbance in each vegetation community from the Proposed Action is shown in ***Tables 3-24*** and ***3-25*** for public and private lands, respectively. The primary affected plant communities on the 4,866 acres of public lands to be disturbed by the Proposed Action include mixed shrub (burned) – 1,349 acres (28 percent), Wyoming sagebrush – 1,074 acres (22 percent), mixed shrub – 924 acres (19 percent), shadscale – 391 acres (8 percent), and basin big sagebrush – 193 acres (4 percent). An additional 712 acres have been cleared of shrub species and seeded on the Bullhead Seeding. The 351 acres of private lands to be disturbed under the Proposed Action, includes the plant communities of mixed shrub – 117 acres (33 percent), mixed shrub (burned) – 119 acres (34 percent), Wyoming sagebrush – 110 acres (31 percent), and shadscale - 5 acres (2 percent).

TABLE 3-24
Vegetation Types on Public Lands Affected by the Proposed Action

Project Component	Location	Affected Acreage by Vegetation Community								
		WS[1]	WS Burn[1]	MS[1]	MS Burn[1]	BBS[1]	SS[1]	Seeded	Exist Disturb[2]	Totals
Open Pits										
South Pit	Sec. 18 & 30, T39N, R43E				614					614
South Pit	Sec. 12, T39N, R42E	10								10
South Pit	Sec. 17 & 20, T39N, R43E								5	5
Overburden/Interburden Storage Areas										
D	Sec. 16, T39N, R43E	82		6		39		475	22	624
B	Sec. 20, T39N, R43E	33		63		90				186
G	Sec. 21, T39N, R43E			110				211		321
D	Sec. 28, T39N, R43E			177	349					626
G	Sec 30, T39N, R43E				52					52
H	Sec. 24, T39N, R42E	73	20		142					235
K	Sec. 32, T39N, R43E			462	125				18	605
J	Sec. 31 & 32, T40N, R43E and Sec. 5 & 6, T39N, R43E	7								7
K	Sec. 8, T39N, R43E								50	50
Limestone Stockpile	Sec. 5 & 6, T39N, R43E									0
Process Facilities	Sec. 8, T39N, R43E									0
Tailings Storage Areas										
D	Sec. 4 & 9, T39N, R43E	175				26			56	297
B	Sec 10, T39N, R43E	588				39				626
Leach Pads										
D	Sec. 36, T39N, R42E[3]	23		100			380			503
G	Sec 30, T39N, R43E				53					53
D	Sec. 5, T39N, R43E	43							18	55
Drainage Diversion Channels	Rabbit Creek, West Side, and Far West[4]	40		6	14		11	26		97
Ponds										0
Ancillary Facilities										0
Exploration Activities										0
Well Pads/Pipelines										0
Access/Haul Roads										0
TOTALS		1,074	20	924	1,349	193	391	712	203	4,866

[1]WS - Wyoming sagebrush
WS Burn - Wyoming sagebrush (burned)
MS - mixed shrub
MS Burn - mixed shrub (burned)
BBS - basin big sagebrush
SS - shadscale

[2]Existing disturbance category refers to generally small areas of native or partially disturbed vegetation within the overall permit boundary of the existing mine operations. These areas, primarily Wyoming sagebrush and burned mixed shrub communities, are too small to be individually distinguished on aerial photographs and mapped accurately on ***Figure 3-41***.

[3]Includes 405 acres of disturbance (298 acres shadscale, 84 acres mixed shrub, and 23 acres Wyoming sagebrush) in the Osgood grazing allotment in Sections 25 and 36, Township 39 North, Range 42 East.

[4]Includes 13 acres of disturbance (2 acres mixed shrub and 11 acres shadscale) in the Osgood grazing allotment in Sections 25 and 36, Township 39 North, Range 42 East.

TABLE 3-25
Vegetation Types on Private Lands Affected by the Proposed Action

Project Component	Location	Affected Acreage by Vegetation Community								
		WS[1]	WS Burn[1]	MS[1]	MS Burn[1]	BBS[1]	SS[1]	Seeded	Exist Disturb[2]	Totals
Open Pits										
South Pit	Sec. 19, T39N, R43E				44					44
South Pit	Sec. 13, T39N, R42E	103			50					153
Overburden/Interburden Storage Areas										
E	Sec. 33, T39N, R43E			97	22					119
Limestone Stockpile	Sec. 5 & 6, T39N, R43E									0
Process Facilities	Sec. 5, T39N, R43E									0
Tailings Storage Areas										0
Leach Pads										0
Drainage Diversion Channels	Rabbit Creek, West Side, and Far West[3]	7		20	3		5			35
Ponds										0
Ancillary Facilities										0
Exploration Activities										0
Well Pads/Pipelines										0
Access/Haul Roads										0
TOTALS		110	0	117	119	0	5	0	0	351

[1]WS - Wyoming sagebrush
WS Burn - Wyoming sagebrush (burned)
MS - mixed shrub
MS Burn - mixed shrub (burned)
BBS - basin big sagebrush
SS - shadscale

[2]Existing disturbance category refers to generally small areas of native or partially disturbed vegetation within the overall permit boundary of the existing mine operations. These areas, primarily Wyoming sagebrush and burned mixed shrub communities, are too small to be individually distinguished on aerial photographs and mapped accurately on ***Figure 3-41***.

[3]Includes 5 acres of disturbance (shadscale) in the Osgood grazing allotment in Section 25, Township 39 North, Range 42 East.

The areas disturbed under the Proposed Action would be reclaimed in a similar manner to areas being disturbed under the existing mining operations. While the reclaimed plant communities are designed to generally replace the values associated with grazing forage and wildlife habitat, they would be quite different from the existing communities. Reclaimed plant communities are typically less diverse in species composition and more uniform in density, growth form, and appearance than the communities they replace. Over a period of several decades, reestablished communities tend to be invaded by volunteer species from surrounding areas, develop a more heterogeneous appearance, and provide more specialized habitat niches for individual wildlife species. This "natural" succession of reclaimed plant communities is hastened by establishment of a reasonably diverse vegetation cover on the reclaimed areas, by careful management to discourage invasion of weedy species, and by the spread of volunteer species from nearby native communities.

It is expected that the reclaimed plant communities would remain noticeably different from the surrounding undisturbed areas for at least 30 to 50 years following initial reclamation.

Approximately 1,488 acres, or 29 percent of the total area to be disturbed by the Proposed Action has been burned in recent years and is currently dominated by large stands of cheatgrass with few perennial species present. This area is likely to exhibit a substantial improvement in species diversity and production following reclamation.

Wyoming sagebrush and seeded areas represent the most productive major communities to be affected by the Proposed Action. These communities occupy approximately 1,184 acres (23 percent) and 712 acres (14 percent), respectively, of the total area to be disturbed by the Proposed Action.

In summary, the proposed reclamation program is expected to result in establishment of perennial vegetation communities comparable to or exceeding, the average cover and productivity values of the existing communities on the areas disturbed by the Proposed Action.

3.4.2.3 Other Project Alternatives

Partial Vista Pit Backfill Alternative

Although this alternative would involve disposal of overburden and interburden in the Vista Pit as opposed to an overburden and interburden storage area, it is not expected to result in a change in the overall acreages or distribution of surface disturbance. Therefore, vegetation impacts anticipated from this alternative are expected to be similar to the Proposed Action and would not be significant.

Selective Handling of Overburden and Interburden Alternative

This alternative involves the separate handling and placement of acid-generating material and would not result in any changes to the extent and distribution of disturbance of natural vegetation communities. Since the No Action alternative and the Proposed Action both involve application of at least 5 feet of alluvium prior to revegetation, it is unlikely that this alternative would result in any difference in reclamation success from the other alternatives.

Overburden and Interburden Storage Area Reclamation Alternatives

Storage area alternative 1 would not change the extent or distribution of surface disturbance from the Proposed Action and, therefore, would have similar impacts on vegetation. Storage area alternative 2, however, would result in an additional surface disturbance of approximately 200 acres in Sections 15, 22, and 27, Township 39 North, Range 43 East to accommodate the desired reconfiguration of the storage facility. This additional disturbance area is currently occupied by the mixed shrub community in Sections 22 and 27, which is private land, and by a combination of mixed shrub and seeded area in Section 15, which is public land. Approximately 174 acres of the potentially affected area is occupied by mixed shrub community and approximately 26 acres is in the seeded area of the Bullhead Seeding. These differences in disturbance from the Proposed Action are not significant and, therefore, the anticipated vegetation impacts associated with this storage area configuration are not significant.

3.4.3 Cumulative Impacts

3.4.3.1 Impacts to Special Status Species or Loss of Unique Vegetation Resources

Because no listed or candidate species were found in the project area, the proposed project would not contribute to cumulative impacts to special status species.

As discussed under the Proposed Action, ground water drawdown associated with the mine dewatering program could result in vegetation effects several miles beyond the mine boundary.

Ground water drawdown effects associated with the Proposed Action in combination with drawdown from other reasonably foreseeable future actions are projected to extend southward to encompass the majority of Township 37 North, Range 42 East, and a large portion of Township 37 North, Range 43 East at 100 years following the end of mining (***Figure 3-39)***. This cumulative impact is likely to affect phreatophytic vegetation communities growing in the lower portion of the Kelly Creek drainage. Such effects, if they occur, would be expected to result in a gradual reduction in density of greasewood stands with a corresponding invasion by more xeric saline/alkaline-tolerant species such as shadscale and other saltbush species from adjacent communities. The extent and nature of this substitution would depend largely on the drawdown. The resulting shift in boundaries between greasewood and shadscale/ saltbush communities is not expected to constitute a significant regional vegetation impact, even though it may affect vegetation over several hundred acres.

3.4.3.2 Potential for Noxious Weed Establishment

The proposed project is not expected to increase the potential for noxious weed establishment in the project vicinity, therefore, it would not contribute to cumulative impacts.

3.4.3.3 Changes in Community Composition and Distribution Resulting from Reclamation

The majority of the mining activity in the Osgood Mountains/Kelly Creek Valley area has occurred in the Wyoming sagebrush zone of the Great Basin sagebrush-grass ecosystem. Therefore, the affected areas commonly involve diverse, productive vegetation communities. The affected area for this project is less productive than is typical of these communities because of the burn history of the area. Therefore, the incremental contribution of this project to the cumulative loss of vegetation productivity and diversity within the Wyoming sagebrush zone is not considered significant.

3.4.4 Monitoring and Mitigation Measures

Potential measures to minimize vegetation impacts relate primarily to prompt and effective reclamation of disturbed surfaces once mining activities are completed in a given area. The proposed reclamation plan is described in Section 2.4.12, Reclamation.

V-1: All seeds for reclamation would be tested for noxious weeds for the State of Nevada. Only noxious weed-free seeds would be used.

3.4.5 Residual Adverse Effects

The residual adverse vegetation effects of the Proposed Action would be determined by the approaches and ultimate success of the reclamation program. Prompt reclamation, resulting in the establishment of stable, productive forage species compatible with the surrounding natural plant communities would minimize residual adverse vegetation effects. Any failure in the reclamation efforts that results in the widespread establishment of weedy annual species such as cheatgrass, Russian thistle, or halogeton could seriously hamper further attempts at establishment of desirable perennial plant species on these areas and lead to long-term adverse impacts.

3.5 Wildlife and Fisheries Resources

3.5.1 Affected Environment

3.5.1.1 Terrestrial Wildlife

Wildlife Habitat

The vegetation communities within the project region support a variety of wildlife species. Appendix B provides a list of representative wildlife species for the lower sagebrush/grassland steppe of northeastern Nevada, and for riparian habitat similar to that occurring along the Little Humboldt and Humboldt Rivers and along the smaller perennial creeks within the region. Dominant plant communities, described in Section 3.4, Vegetation, include Wyoming sagebrush-grass, mixed shrub, shadscale, meadow, low sagebrush, and basin big sagebrush. Important plant communities to area wildlife include those containing big sagebrush, mixed shrub, greasewood, wet meadows, riparian, seeps and springs, mountain mahogany, juniper, and aspen. Many of these important communities are located along the western slope of the Snowstorm Mountains.

The structural and compositional diversity of vegetation communities typically determines the numbers and diversity of animal species. Species diversity and biological diversity are often confused. Biological diversity, or "biodiversity," has recently become a focus of land management agencies throughout the western United States. The loss of biodiversity is currently recognized as an important issue that may have ecological and economic consequences. In an effort to clarify complex biodiversity goals and objectives, the Council on Environmental Quality (1993) published a guide to incorporating biodiversity considerations into environmental impact analyses.

Biodiversity is often confused with increasing the number of species or the "species richness" within a specific habitat. This measurement, how ever, does not consider the issues of ecosystems and landscapes, generally treating all species alike, whether native or introduced, common or rare. Biodiversity focuses on native species or communities that are rare or under-represented, emphasizing the genetic, structural, compositional, and functional diversity.

The overall range condition in the project area is not optimal (BLM 1981a and 1987b). Wildfire has contributed to increasing levels of cheatgrass and the poor regeneration of native grasses, forbs, and shrubs. This decreased plant regeneration is particularly apparent in areas of low precipitation, such as around the mine site.

Available water for wildlife consumption and riparian vegetation for cover and forage are the limiting wildlife factors in the project region. Therefore, riparian habitats, particularly those with multistoried canopies and free water, support a greater diversity and population density of wildlife species than any other habitat type.

The higher elevations along the western slope of the Snowstorm Mountains support different plant and animal communities than those associated with the immediate mine area. The majority of the upland habitat is the low sagebrush community (discussed in Section 3.4.1.2, Project Area Plant Communities) surrounding the riparian corridors and deciduous stringers along the western flank of the mountains. These riparian systems are primarily composed of small, narrow drainages with scattered patches of riparian vegetation, and small isolated springs. A few drainages, such as Kelly Creek and Jake Creek, maintain excellent water distribution, escape cover, and foraging areas for wildlife resources along portions of their perennial flow (BLM 1985a). Kelly Creek supports riparian habitat and dense aspen stands. Riparian areas, such as Jake Creek canyon, maintain a wide diversity of plant growth and topographical relief, resulting in a high value and productive ecosystem for wildlife resources. Other prominent riparian communities identified for the project region include the Little Humboldt River on the northern boundary of the project region and the Humboldt River, which is crossed by the primary transportation corridor.

The majority of seeps and springs in the valley near the mine are characterized by moist soils and minimal riparian vegetation. Existing conditions at the lower elevation spring sites near the mine generally reflect overuse of the mesic (transitional) vegetation, resulting in minimal resource value for area wildlife. These seeps and springs can fluctuate annually between wet and dry, depending upon seasonal precipitation and temperatures. Two prominent springs include Alkali Spring and Hot Springs Ranch Spring. Both of these springs are higher quality warm water marshes that support a wide variety of birds and mammals (WESTEC 1994b).

The outflow from mine dewatering into Rabbit Creek has established emergent vegetation and a series of small pools along the drainage. The riparian plant species associated with this artificially created riparian zone include sedges, cattail, and spikerush, with rubber rabbitbrush and basin big sagebrush adjacent to the channel. The existing vegetation structure along Rabbit Creek and within the artificial riparian area provides some cover and forage for both resident and migratory species. This discharge provides limited nesting and brood rearing habitat for migratory birds.

Wildlife Species

The following species descriptions focus on both resident and migratory wildlife that may occur in and near the project area. Because some species are wide ranging, regional characterizations may be appropriate.

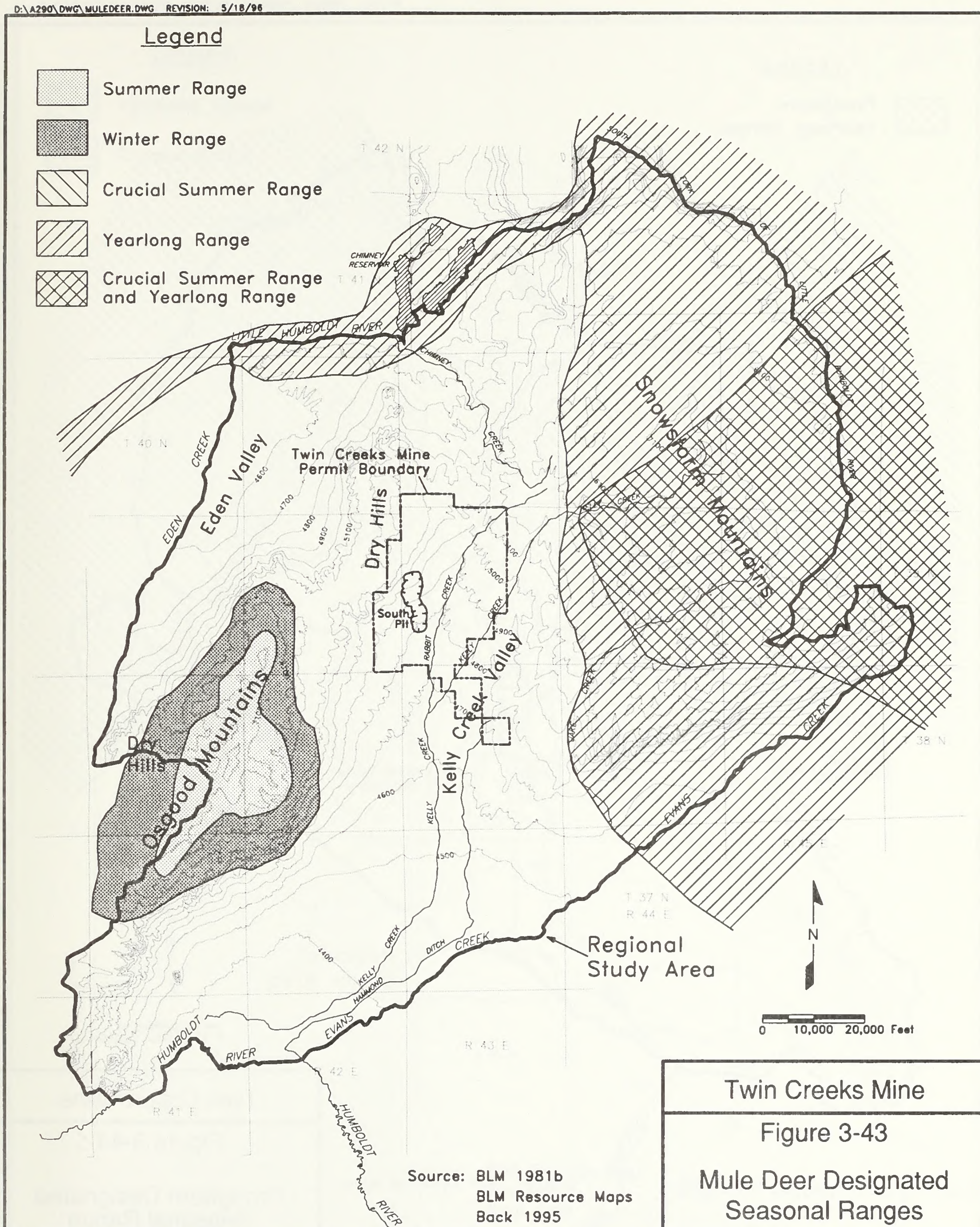
Mule deer are the principal big game species in the region. The use of the immediate project area by mule deer has been limited (BLM 1993), with mule deer occurring yearlong in low numbers. Movements occur between seasonal ranges (***Figure 3-43***), typically defined by available forage and water. Deer predominantly use the Dry Hills area near the mine during the winter and spring seasons (Nevada Division of Wildlife 1993). The closest designated seasonal range, located in the Osgood Mountains to the west, encompasses both mule deer winter and summer ranges. Crucial summer range for mule deer occurs along the western slope of the Snowstorm Mountains, extending along the perennial portions of Tall Corral, Kelly, and Jake creeks down to Garrett Spring and The Knolls (Back 1995). Designated yearlong range for mule deer extends along the Little Humboldt River to the north and along the foothills of the Snowstorm Mountains to the east of the project area. The naturally occurring seeps and springs along these foothills are particularly important to mule deer during the winter season, as the animals use the lower elevations for winter range (Lamp 1995). No prominent migratory or movement corridors exist in the project area (BLM 1994c; SFPG 1995b).

Low numbers of scattered pronghorn occur in the project area (Nevada Division of Wildlife 1993; BLM 1993). However, the population levels are currently expanding because of increased water availability within the BLM's Paradise-Denio Resource Area and increased fawn survival (BLM 1981b and 1994c; Nevada Division of Wildlife 1993). Designated pronghorn yearlong range occurs north and east of the project area (***Figure 3-44***).

Crucial range has been designated for California bighorn sheep from the Snowstorm Mountains down into the foothills region east of the project area (***Figure 3-45***) (Back 1995). The BLM and Nevada Division of Wildlife have been involved with a reintroduction program for California bighorn sheep in the Snowstorm Mountains in accordance with an Interagency Cooperative Agreement (BLM 1985a). Water availability throughout these mountains is considered excellent. Important water sources include Jake, Kelly, and Tall Corral creeks. The Jake Creek drainage provides excellent foraging areas, available water, escape cover, and lambing areas for area bighorn. Although adequate habitat occurs along both Kelly and Tall Corral creeks, the dense aspen stands occurring at the higher elevations of Kelly Creek limit bighorn use in this area (BLM 1985a). It is estimated that approximately 65 to 70 bighorn sheep currently occupy the Jake Creek area and the Owyhee Bluffs. The Nevada Division of Wildlife released 15 sheep into the Jake Creek drainage in March 1995 (Nevada Division of Wildlife 1995a) and is planning to release an additional 20 bighorns into the Kelly Creek drainage in 1996 (Gray 1995). In addition to the bighorn use in the Snowstorm Mountains, reports indicate that one bighorn ram from the Osgood Mountains to the west of the project area has been observed repeatedly visiting the Twin Creeks Mine (Gebhardt 1995).

Mountain lion also occur along the west side of the Snowstorm Mountains, preying primarily on mule deer. This area is considered to be excellent habitat for mountain lion (Gray 1995).

Upland game birds are not abundant but could occur within the appropriate habitat types found in and near the project area. Species characteristic of the arid upland habitats and the higher elevations along the foothills of the Snowstorm Mountains include sage grouse, chukar, mourning dove, California quail, and mountain quail. All of these upland game birds depend on the perennial water sources found in the foothills of the Snowstorm Mountains during the brooding period;



Twin Creeks Mine

Figure 3-43

Mule Deer Designated Seasonal Ranges

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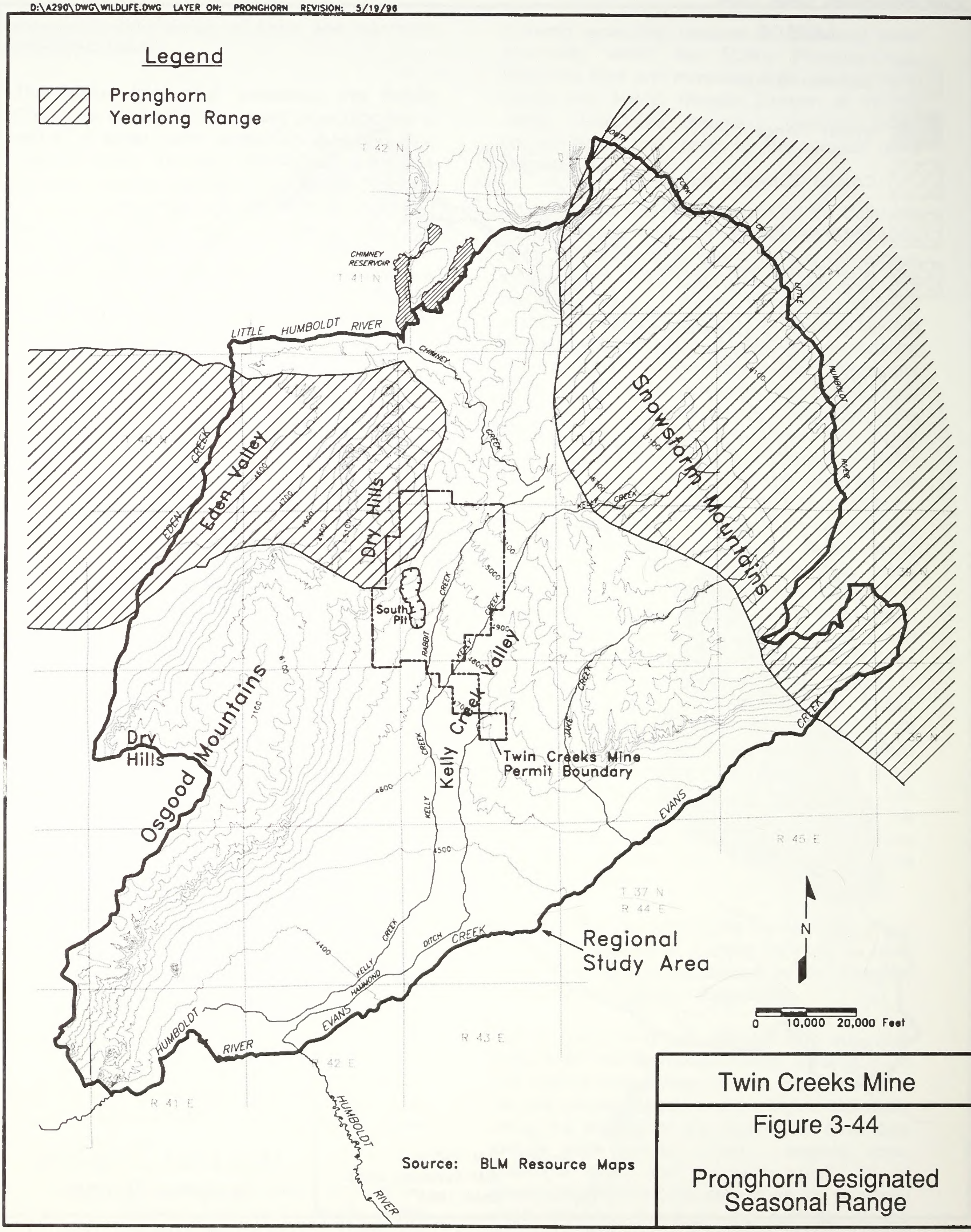

Twin Creeks Mine

Figure 3-44

Pronghorn Designated Seasonal Range

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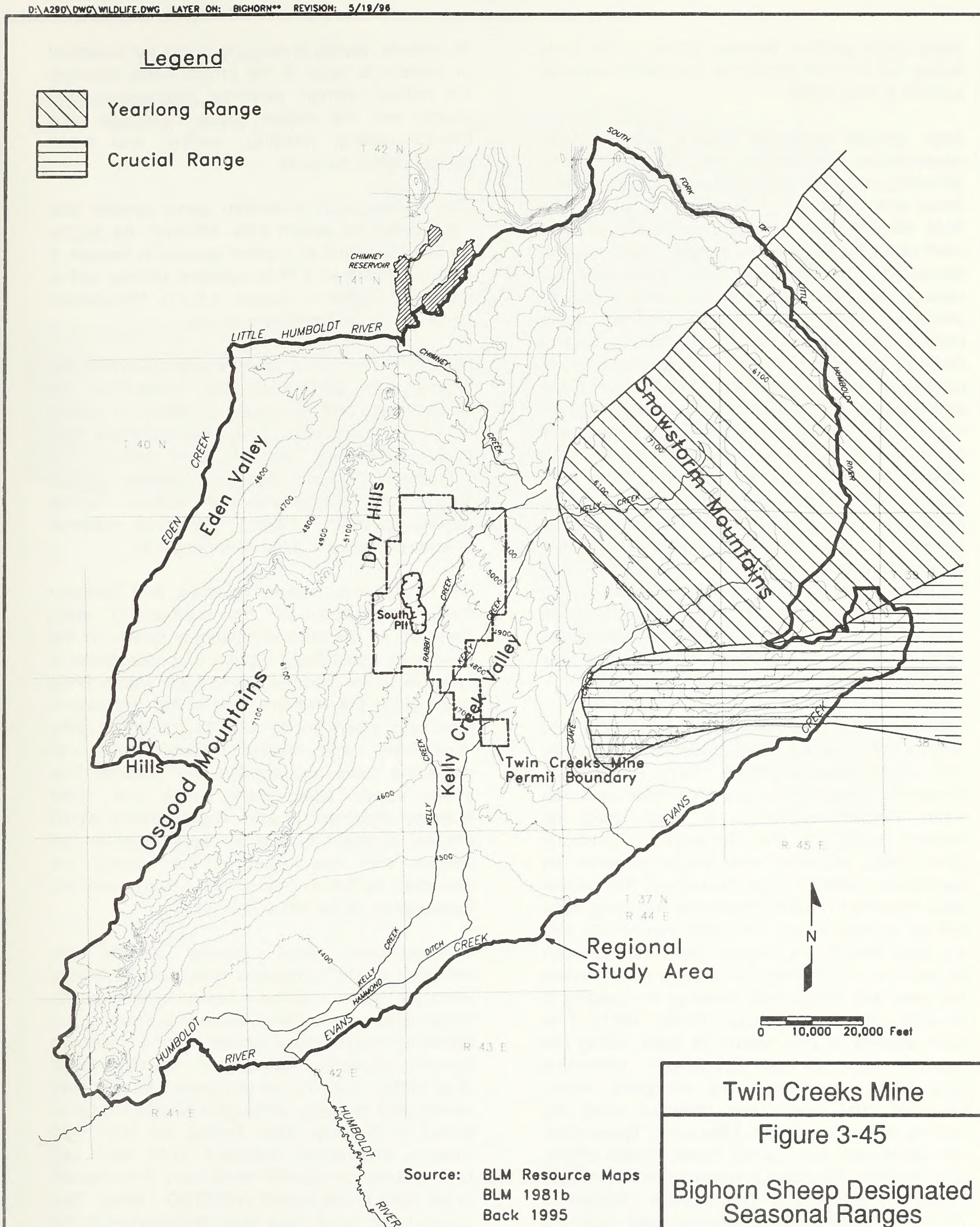

Source: BLM Resource Maps
BLM 1981b
Back 1995

Twin Creeks Mine

Figure 3-45

Bighorn Sheep Designated Seasonal Ranges these water sources become critical to the birds during the summer period, as intermittent sources subside (Lamp 1995).

Sage grouse generally occupy upland shrub communities, breeding on open leks (or strutting grounds), and often nesting and brooding in upland areas and meadows in proximity to water. The BLM identified an area approximately 10 miles north of the project area as a sage grouse general distribution area (SFPG 1995b) (***Figure 3-46***). No sage grouse leks, nest sites, brooding areas, or winter use areas have been documented in the project area (BLM 1993 and 1994c; Nevada Division of Wildlife 1995a). Baseline surveys conducted April through July of 1994 in the project area focused on identifying potential sage grouse habitat. No formal sage grouse surveys were conducted at that time. No breeding activity or optimal habitat were recorded; only one sage grouse was observed in the project area during this field program (WESTEC 1994a). Informal BLM observations have documented sage grouse near the project area in April 1996, and birds could use the project area, depending on habitat availability. It is likely that sage grouse are present along the western slope of the Snowstorm Mountains (Back 1995). This area may provide adequate winter use areas and riparian habitat for brooding.

Chukar occur in dry sagebrush, grasslands, and deserts, often along rocky slopes, mesic areas, and rugged canyons (Terres 1991). This species forages in grassy and weedy areas near perennial water. Chukar are known to occur along the western slope of the Snowstorm Mountains (Gray 1995). Mourning dove are found within the appropriate habitat types throughout the project area. Important habitat features for mourning dove include riparian zones with trees and shrubs that are large enough for nesting. California quail can be found in dry foothills and valleys that maintain low trees and shrubs with openings for foraging in proximity to water sources (Terres 1991). This quail species is also known to occur along the western slope of the Snowstorm Mountains (Gray 1995) and along the Humboldt River. Mountain quail have been released along the foothills of the Snowstorm Mountains. These birds are associated with dense brush, forest edges, and mountain meadows in proximity to water (U.S. Forest Service 1991). The Nevada Division of Wildlife released 30 to 50 mountain quail along the Kelly Creek drainage during the summer of 1995 to augment earlier releases (Back 1995; Gray 1995).

No historic nesting or foraging areas for waterfowl or shorebirds occur in the project area, although the natural springs, perennial drainages, stock ponds, and the Rabbit Creek discharge area provide resting, foraging, nesting, and brood rearing habitat for birds.

The pygmy rabbit is another game species that may inhabit the project area. Although the pygmy rabbit is classified as a game species in Nevada, it is also considered a BLM sensitive species and is discussed further in Section 3.5.1.3, Threatened, Endangered, or Sensitive Species.

Many of the nongame species associated with the project area, particularly small mammals, are widely distributed, occupying a variety of habitat types. Representative nongame mammals that occur within the project area include the Townsend's ground squirrel, Belding ground squirrel, least chipmunk, and western harvest mouse (WESTEC 1994a). Additional mammal species present are listed in Appendix B.

Bat hibernacula, nursery colonies, and bachelor roosts may occur in the surrounding area; however, no structural components located in the mine area would likely support a concentration of bats. Resident and migratory bats would likely occur along the western slope of the Snowstorm Mountains where rocky outcrops, canyons, cliffs, open water, and riparian corridors with both deciduous trees and conifers are present. The aspen stands along Kelly Creek and rocky outcrops prominent in Jake Creek canyon would provide excellent habitat for bats. Specific bat species that may occur in this vicinity are discussed further in Section 3.5.1.3, Threatened, Endangered, or Sensitive Species.

Representative raptor species include the red-tailed hawk, ferruginous hawk, prairie falcon, American kestrel, northern harrier, golden eagle, turkey vulture, short-eared owl, and burrowing owl. Wintering rough-legged hawks occur in northern Nevada (Nevada Division of Wildlife 1993; BLM 1995a). Raptors use the project area for both nesting and foraging, although available habitat is limited in the mine area. During the 1994 field surveys, one active red-tailed hawk nest and several American kestrel nests were documented at the Kelly Creek Ranch (WESTEC 1994a). Two golden eagle nests have been documented in the vicinity of the project. One nest site occurs approximately 18 miles south of the Twin Creeks

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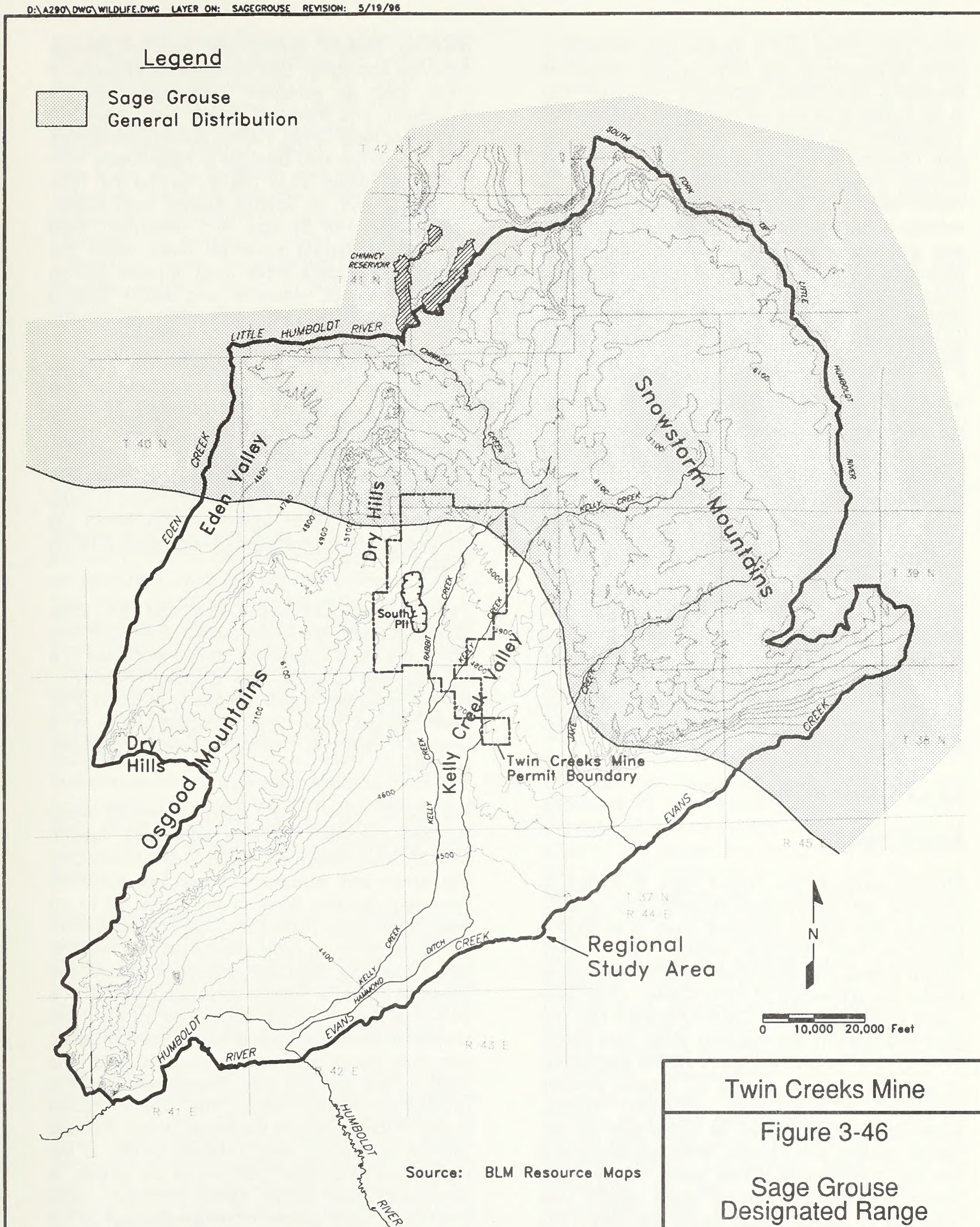


Twin Creeks Mine

Figure 3-46

Sage Grouse Designated Range

Mine; the second nest is located approximately 6 miles southeast of the mine in the Snowstorm Mountains (Niel 1995). Burrowing owls likely nest in the project area and are discussed further under Threatened, Endangered, or Sensitive Species (see Section 3.5.1.3). Raptor use along the western slope of the Snowstorm Mountains is higher than that found in the mine area. The mosaic of upland vegetation, riparian corridors, and topography within the foothills, and higher elevations provides a variety of nesting sites and foraging areas for both resident and migratory species. In addition, available prey species are more abundant and varied than those found in the Rabbit Creek drainage and surrounding areas.

Passerines or songbirds are numerous and occupy the entire range of habitats that occur in the project area. Nongame birds include a diversity of neotropical migrants; birds that breed in North America and winter in the Neotropical Region of South America. These birds are important nongame species as they often act as environmental indicators.

Reptiles and amphibians characteristic of the area include the Great Basin gopher snake, western whiptail lizard, desert spiny lizard, Pacific treefrog, and Great Basin spadefoot (WESTEC 1994a). A number of these nongame species depend on the limited riparian habitat associated with area streams and springs.

3.5.1.2 Aquatic Biology

Aquatic Habitat

Surface water in the project area is limited to perennial and intermittent streams and springs. Streams that exhibit perennial flows in at least a portion of their drainage include Kelly, Rabbit, Kenny, Evans, and Jake creeks. Rabbit and Kenny creeks are tributaries of Kelly Creek, while Jake Creek drains into Evans Creek (***Figure 3-14***). The perennial streams are relatively small, with widths ranging from approximately 5 to 10 feet and depths of less than 1 foot. Based on aquatic surveys conducted in May 1994 (WESTEC 1994b), substrate in Kelly Creek is composed of silt, gravel, cobble, and boulder, while silt and gravel are the dominant substrate sizes in the other streams. Dense filamentous algae growth was observed in Rabbit Creek during the May 1994 habitat survey. Aquatic habitat in Jake, Kelly, Evans, and Rabbit creeks is limited by the relatively shallow depths and lack of diverse substrate and cover. Low to moderate amounts of cover, such as substrate, overhanging riparian vegetation, and instream debris, are present in portions of Kelly Creek. Habitat surveys conducted by the BLM reported damage to Kelly Creek from cattle and horses (BLM 1987a). During the 1994 aquatic surveys, six springs (Garret, Kelly Creek, Jake, Alkali, Hot Springs, and unnamed) were identified as having perennial flows within the project area (***Figure 3-14***). Most of these springs contained aquatic vegetation and depths ranging from approximately 0.1 to 1 foot (WESTEC 1994b).

In a typical year, little or no surface flow from the project area reaches the main course of the Humboldt River, located approximately 19 miles south of the South Pit. In the hydrologic study area, the Humboldt River is approximately 10 to 20 feet wide, with average depths ranging from less than 1 to 6 feet. Turbidity and fluctuations in flows appear to limit warm water fisheries within the Humboldt River downstream of the project (French 1994a).

Two streams, Chimney Creek and the Little Humboldt River, are in the project area. Chimney Creek is a small intermittent stream that flows in a northwesterly direction into Chimney Reservoir. Flow is restricted mainly to periods of runoff after storm events. The Little Humboldt River is a braided perennial stream below Chimney Reservoir.

The South Fork of the Little Humboldt River supports Lahontan cutthroat trout (see Section 3.5.1.3). This stream originates in the Snowstorm Mountains and eventually flows into Chimney Reservoir. Surface flows in the upper 15 to 20 miles of the South Fork of the Little Humboldt River are perennial; flows in the lower portion of the river vary depending upon the amount of annual and seasonal moisture. Habitat surveys conducted in a 11.5-mile section of the South Fork of the Little Humboldt River from Rodear Flat to the confluence with Pole Creek reported an average width and depth of 8.4 and 0.3 feet, respectively (Nevada Division of Wildlife 1988). The overall habitat quality in this section of the stream is fair (Nevada Division of Wildlife 1988). Habitat quality in the headwaters and upper portions of the stream is considered good (Coffin 1995). However, cattle and horses have caused moderate damage to the stream (Nevada Division of Wildlife 1988). Chimney Reservoir is located at the confluence of the North and South Forks of the Little Humboldt River. The reservoir is separated into two arms at the vertical gorge-channel of the South Fork. Upstream of this gorge, the South Fork arm is flooded meadow and sagebrush flats with relatively shallow depths (French 1994b). The South Fork arm is dry at the minimum pool volume of 3,500 acre-feet. The North Fork arm exhibits a mixture of canyon and sagebrush flat terrain. The shoreline characteristics consist of vertical rock walls, talus rock-rubble slopes, and earth and rock banks. The average depths at maximum and minimum pools are approximately 16.3 and 11.7 feet, respectively (French 1994b).

Fish

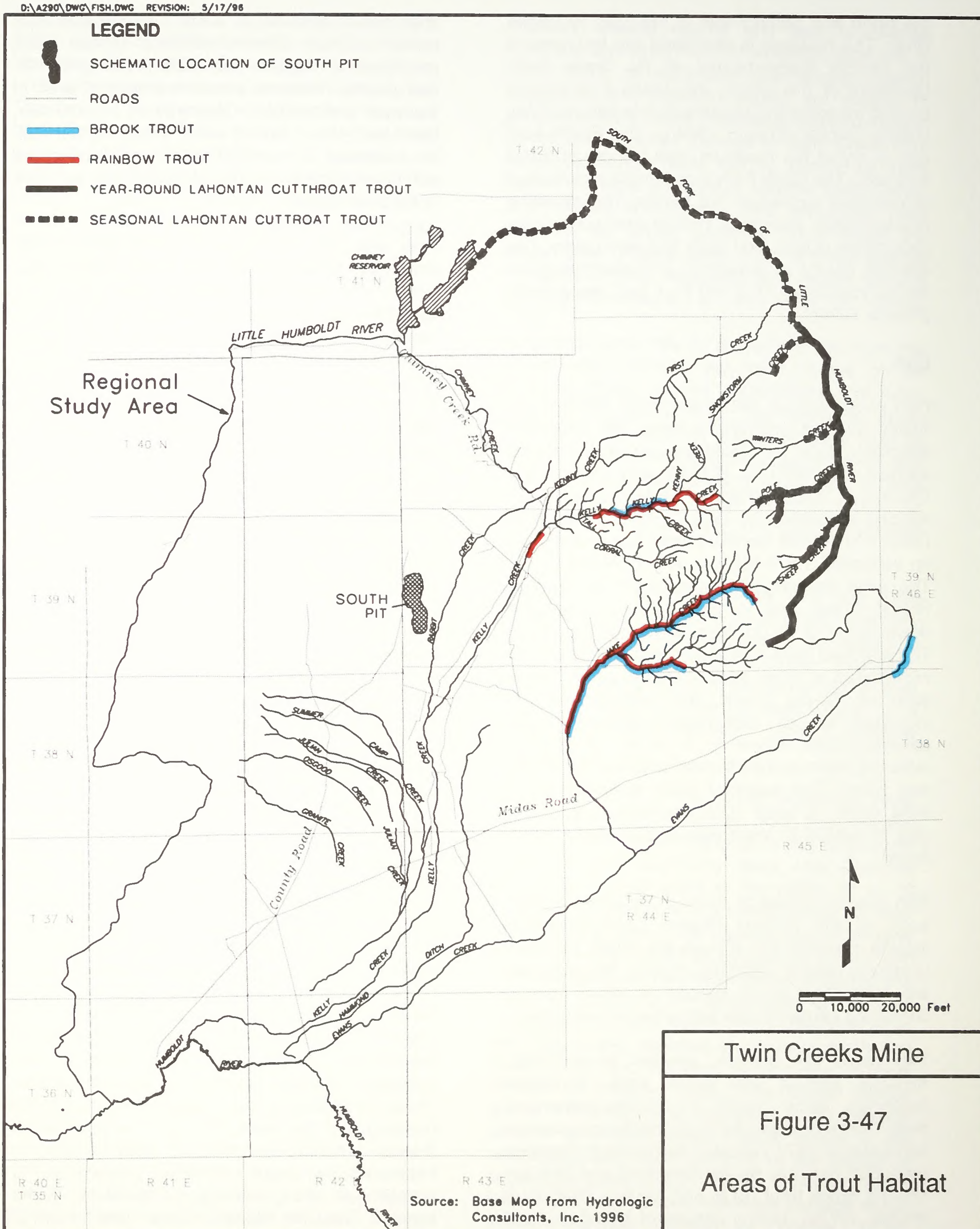
Fish populations in the project area streams are limited to one resident species, the Lahontan speckled dace (*Rhinichthys osculus*). Recent surveys by WESTEC (1994b) and the Nevada Division of Wildlife (French 1994a) collected this species in Rabbit and Kelly creeks. The Nevada Division of Wildlife identified three age classes and an estimated 1,870 fish per mile in Rabbit Creek. The mine discharge provides water for dace in Rabbit Creek and in Kelly Creek immediately downstream of its confluence with Rabbit Creek. The speckled dace is expected to be common and widespread in other streams in the project area, such as Kenny, Evans, and Jake creeks. As indicated by its widespread distribution, the speckled dace occurs in a variety of habitats, including warm and cold water streams, reservoirs, and lakes. The speckled dace is tolerant of a wide range of water quality conditions, and it is able to survive in areas with limited surface water flows.

Fish species known to occur in perennial springs such as Hot Springs (Evans Creek drainage) include mosquito fish (*Gambusia affinis*) and carp (*Cyprinus carpio*) (WESTEC 1994b). Mosquito fish are suspected to be present in other springs containing perennial flow within the project area.

Two game fish species, rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*), occur mainly in the headwaters of Kelly Creek (***Figure 3-47***). Electrofishing surveys conducted in 1977 indicated that average densities were 838 per mile for rainbow trout and 264 per mile for brook trout (BLM and Nevada Division of Wildlife 1977a). During periods of high flow, trout occasionally are washed or move downstream into intermittent portions of Kelly Creek below the perennial reach (French 1994c). These trout usually are confined to pool habitats during the low flow period; however, these trout cannot exist in the lower portions of the drainage on a permanent basis because of lack of water during dry periods. No spawning or rearing habitat for juvenile trout are found within the portion of Kelly Creek adjacent to the project area.

Trout also occur in the perennial sections of Jake and Evans creeks. In Evans Creek, brook trout occur in the headwater areas (***Figure 3-47***) (BLM and Nevada Division of Wildlife 1980). Trout distribution in the portion of Evans Creek downstream of the headwaters is limited by a predominance of intermittent flow during most of the year. Rainbow and brook trout have been collected in the perennial sections of Jake Creek from the headwaters in the North and South Forks downstream to approximately 3 miles above Midas Road (***Figure 3-47***) (BLM 1988a,b; BLM and Nevada Division of Wildlife 1977b,c). As with Kelly Creek, trout may be washed or move downstream into sections of stream located below the perennial reach during periods of high flow.

Fish species in the South Fork of the Little Humboldt River include speckled dace, Lahontan redside shiner (*Richardsonius egregius*), mountain sucker (*Catostomus platyrhynchus*), and Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) (Nevada Division of Wildlife 1988). An average of 113 Lahontan cutthroat trout per mile was estimated for a 3.75-mile section of the stream (Nevada Division of Wildlife 1988). The upper 16 miles of this stream are designated as occupied and potential habitat for Lahontan cutthroat trout, which is classified as a federally threatened species (Coffin and Cowan 1995) (see Section 3.5.1.3, Threatened, Endangered, or Sensitive Species). Game fish species found in Chimney Reservoir include Lahontan cutthroat trout, rainbow trout, largemouth bass, rainbow/cutthroat hybrids, channel catfish, walleye, and white crappie. Because of limitations in water level and fluctuations, temperature, and presence of nongame species, such as carp, the Nevada Division of Wildlife has proposed to convert the fishery from cold water to warm water species (French 1994b). Largemouth bass would be introduced as part of this conversion to supplement other existing warm water game species. The Little Humboldt River downstream of Chimney Reservoir supports game species,


D:\A290\DWG\FISH.DWG REVISION: 5/17/96
LEGEND
SCHEMATIC LOCATION OF SOUTH PIT
ROADS
BROOK TROUT
RAINBOW TROUT
YEAR-ROUND LAHONTAN CUTTHROAT TROUT
SEASONAL LAHONTAN CUTTROAT TROUT
Regional Study Area
LITTLE HUMBOLDT RIVER
SOUTH FORK OF LITTLE HUMBOLDT RIVER
CHIMNEY RESERVOIR
Chimney Creek Rd.
SOUTH PIT
Midas Road
County Road
N
0 10,000 20,000 Feet
Source: Base Map from Hydrologic Consultants, Inc. 1996
Twin Creeks Mine
Figure 3-47
Areas of Trout Habitat

including channel catfish, white crappie, largemouth bass, and walleye.

Fisheries in the Humboldt River downstream of the Kelly Creek confluence are composed of warm water species that can tolerate turbid conditions. Game fish species include bullhead, channel catfish, white catfish, smallmouth bass, white crappie, bluegill, white bass, and walleye (French 1994a). Bullhead and catfish were initially established in the river in the late 1890s; the other species were introduced in the 1950s. Nevada Division of Wildlife surveys conducted during the late 1970s and early 1980s identified active spawning sites for walleye in the Humboldt River between Ryepatch Reservoir and Winnemucca. The walleye spawning run usually is limited to March and April during average and wet years. Historically, Lahontan cutthroat trout occurred in the Humboldt River, but this species has not been collected since the 1930s (French 1994a).

Benthic Macroinvertebrates

A benthic macroinvertebrate survey was conducted at one station on Kenny, Kelly, Jake, and Rabbit creeks in July 1994 (Mangum 1994; WESTEC 1994b). The results showed differences in the composition, diversity, and abundance of macroinvertebrates at these four stream locations (***Table 3-26***). In general, diverse and moderate numbers of macroinvertebrates were present in Kenny and Jake creek stations. The Diversity Index rating was good in both streams (mean number of taxa ranged from 11 to 17). The total number of taxa was 29 at the Kenny Creek station and 21 at the Jake Creek station. The most abundant taxa in these streams included midges and caddisflies in Kenny Creek and midges, blackflies, and snails in Jake Creek. The Biotic Condition Index, which is a measure of organisms' tolerance to pollution, indicated generally good macroinvertebrate habitat in Kenny Creek and poor habitat in Jake Creek at the survey points. The EPT Index (percent composition of Ephemeroptera, Plecoptera, and Trichoptera) habitat presence of these three groups of macroinvertebrates indicates relatively good conditions in Kenny Creek.

Benthic macroinvertebrate communities in Kelly and Rabbit creeks exhibited low diversity, low number of taxa, and low densities (***Table 3-26***). The most abundant taxa in these two streams included elmid beetles, mayflies, and midges in Kelly Creek, and midges and caddisflies in Rabbit Creek. The ratings for the Diversity Index and Biotic Condition Index indicated poor conditions. Even though mean densities were low in both streams, the standing crop in Kelly Creek was rated as good (i.e., mean dry weight biomass ranging from about 1.6 to 4.0 grams/square meter). The standing crop in Rabbit Creek was rated as poor (less than 0.5 grams/square meter of dry weight biomass).

Springsnails, a group of invertebrates that are found in perennial springs and seeps, are considered important aquatic organisms due to their occurrence in restricted habitats and the fact that they are native species in Nevada. WESTEC (1994b) conducted springsnail surveys in six springs (Garret, Kelly Creek, Jake, Alkali, Hot Springs, and unnamed) in 1994; no springsnails were observed in any of these springs. Potential habitat may exist in other springs in the project area that have not been surveyed. Characteristics of springs inhabited by springsnails include relatively high discharges (great than 30 gallons per minute), well defined channels, riparian vegetation, and dense aquatic vegetation (McGuire 1992).

3.5.1.3 Threatened, Endangered, or Sensitive Species

A number of sensitive terrestrial and aquatic species occur within northern Nevada; however, few species have been documented for the project area. ***Table 3-27*** includes the federally listed threatened and endangered species, federal candidate species, and BLM sensitive species analyzed for this project. These species were identified by the U.S. Fish and Wildlife Service (1993 and 1995a), BLM (1993), and the Nevada Natural Heritage Program (Cooper 1996). Under the Endangered Species Act of 1973, as amended, the lead agency (BLM) in consultation with the U.S. Fish and Wildlife Service must ensure that any action that it authorizes, funds, or carries out will not adversely affect a federally listed threatened or endangered species. The U.S. Fish and Wildlife Service revised the federal candidate species lists, omitting the category 2 listing and developing a "candidate" list only. This Notice of Review was published in the Federal Register on February 28, 1996. The BLM subsequently developed interim guidelines on March 20, 1996, for the protection and conservation of these C1 and C2 species that have historically been

TABLE 3-26
Summary of Macroinvertebrate Survey Conducted in July 1994

Type of Information	Sampling Locations			
	Kenny Creek	Kelly Creek	Jake Creek	Rabbit Creek
Number of Taxa	29	13	21	9
Diversity Index[1]	15.6 (Good)	5.4 (Poor)	11.2 (Good)	3.6 (Poor)
EPT Index[2]	44%	26%	12%	32%
Standing Crop (grams/square meter)[1]	2.3 (Good)	2.2 (Good)	1.3 (Fair)	0.1 (Poor)
Biotic Condition Index[1]	77 (Good)	68 (Poor)	61 (Poor)	61 (Poor)
Mean Density (number/square meter)	1,600	305	3,488	111
Dominant Taxa[3]	• Orthocladiinae (Midges) [28.9%] • *Baetis* (Caddisflies) [18.8%]	• *Optioservus* (Elmid beetles) [32.8%] • Elmidae (Elmid beetles) [12.8%] • *Rithrogena* (Mayflies) [11.8%] • Orthocladiinae (Midges) [11.8%] • *Heptagenia* (Mayflies) [10.5%]	• Chironomini (Midges) [43.8%] • Simuliidae (Blackflies) [16.7%] • *Physa* (Snails) [14.5%]	• Chironomini (Midges) [42.3%] • *Hydroptila* (Caddisflies) [26.1%]

[1]Relative rating for macroinvertebrate community is provided in parentheses.
[2]EPT Index = Percent of total macroinvertebrate density composed of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (mayflies).
[3]Dominant Taxa = Comprised 10 percent or more of the total macroinvertebrate density.
Source: Mangum 1994.

protected as BLM Special Status Species. Therefore, all former Nevada C1 and C2 species that are not included in the U.S. Fish and Wildlife Service's new candidate list are currently incorporated into the Nevada BLM Sensitive Species List.

Birds

The American peregrine falcon is currently listed as endangered, but has been proposed to be federally delisted (i.e., removed from the federal list) (Craig 1995). The arctic peregrine falcon was delisted in 1994; however, migrants are still protected under the similarity of appearance provision of the Endangered Species Act and the Migratory Bird Treaty Act. Nesting peregrine falcons prefer cliffs in proximity to water and typically forage in riparian zones where avian prey species (e.g., passerines, shorebirds) are abundant (U.S. Fish and Wildlife Service 1984). No occupied territories or active areas are known to

TABLE 3-27
Threatened, Endangered, and Sensitive Species
Identified for the Twin Creeks Mine EIS

Common Name	Scientific Name	Federal Status	Occurrence in the Study Area
BIRDS			
American peregrine falcon	*Falco peregrinus anatum*	E[1]	M
Bald eagle	*Haliaeetus leucocephalus*	T	M,W
Northern goshawk	*Accipiter gentilis*	SS	U
Ferruginous hawk	*Buteo regalis*	SS	R, M
Western burrowing owl	*Athene cunicularia hypugea*	SS	R, M
Loggerhead shrike	*Lanius ludovicianus*	SS	R, M
White-faced ibis	*Plegadis chihi*	SS	M
Black tern	*Chlidonias niger*	SS	M
Western least bittern	*Ixobrychus exilis hesperis*	SS	M
MAMMALS			
Small-footed myotis	*Myotis ciliolabrum*	SS	U
Long-eared myotis	*Myotis evotis*	SS	U
Fringed myotis	*Myotis thysanodes*	SS	U
Long-legged myotis	*Myotis volans*	SS	U
Pacific Townsend's big-eared bat	*Plecotus townsendii townsendii*	SS	U
Pale Townsend's big-eared bat[2]	*Plecotus townsendii pallescens*	SS	U
Spotted bat	*Euderma maculatum*	SS	U
Preble's shrew	*Sorex preblei*	SS	U
Pygmy rabbit	*Brachylagus idahoensis*	SS	R
AMPHIBIANS			
Spotted frog	*Rana pretiosa*	C	U
INVERTEBRATES			
Nevada viceroy	*Limenitus archippus lahontani*		U
California floater	*Anodonta californiensis*		R
FISH			
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*	T	R

[1]Currently proposed to be delisted; final decision is pending.
[2]Taxa known to occur in Nevada, but omitted in error from the historical range listed in the U.S. Fish and Wildlife Service's 1994 Animal Notice of Review.

E = Endangered: A species in danger of extinction throughout all or a significant portion of its range.
T = Threatened: A species likely to become endangered within the foreseeable future through all or a significant portion of its range.
C = Candidate. Previously federal candidate - category 1.
SS = BLM Sensitive Species. Previously federal candidate - category 2.
R = Resident within the vicinity of the project.
M = Migrates through the project area.
W = Winters in the vicinity of the project area.
U = Currently unknown whether this species occurs in the study area; however, appropriate habitat is present.

occur in the portion of the Snowstorm Mountains in the study area. Both the American and arctic subspecies would migrate through and possibly use the riparian habitat along the perennial creeks and wetland areas for foraging (Back 1995).

The U.S. Fish and Wildlife Service recently downlisted the bald eagle to federally threatened from endangered status (U.S. Fish and Wildlife Service 1995b). No successful bald eagle nesting has been recorded in Nevada within the last century; however, migrating bald eagles do move through the state, and wintering birds occupy appropriate winter habitats from December through March. The project area is located in the Great Basin Management Zone for the recovery of the bald eagle (U.S. Fish and Wildlife Service 1986). Wintering eagles may use both riparian and upland habitats in the project area for foraging during migration and during the winter period (Back 1995). However, it is expected that use of the project area would be infrequent, based on available habitat.

The northern goshawk is an uncommon forest species that is a year-round resident in Nevada, breeding in the mountains and wintering in the lower foothills and valleys (Herron et al. 1985). This species is typically associated with mature, old-growth coniferous forests, but goshawks occupy different forest types depending on seasonal requirements and forest availability (Hoover and Wills 1987). In Nevada, this species often nests in aspen stands near perennial water (Herron et al. 1985; Back 1995) and is intolerant of disturbance during nesting (Hoover and Wills 1987). This species may occur in the higher elevations of the study area in the Snowstorm Mountains (Back 1995). Perennial portions of Kelly Creek support aspen, which could provide habitat for the goshawk.

The ferruginous hawk is a common breeder in much of Nevada. This species typically nests on trees, promontory points, rocky outcrops, cut banks, or on the ground (Terres 1991). Its preferred breeding habitat is scattered juniper trees at the interface between piñon-juniper and desert shrub communities that overlook broad valleys. The ferruginous hawk has been documented in the project area (WESTEC 1994a); the Kelly Creek basin would provide moderate to good foraging habitat for these birds. Potential nesting habitat would be limited to the foothills of the Snowstorm Mountains, although this would be marginal habitat based on vegetation association. BLM nest surveys were conducted in May of 1994 and 1995; no nesting was recorded within the project area (Back 1995).

The western burrowing owl is an uncommon summer migrant that breeds in portions of northern Nevada. It is dependent on mammal burrows for nesting, typically foraging in open grasslands and sagebrush habitats (Terres 1991). It may also be found near areas of livestock concentration (Back 1995). One burrowing owl den has been documented along the eastern edge of the project area north of Kelly Creek Spring (BLM 1994c), and burrowing owl pellets were collected near Rabbit Creek (WESTEC 1994a). It is likely that additional nests occur in the project area (Back 1995; Niel 1995).

The loggerhead shrike is typically found in open grasslands and shrublands, with some birds occurring in piñon-juniper woodlands. Nesting birds often use isolated trees or large shrubs and may also use vegetative stringers or greasewood for breeding and nesting (Andrews and Righter 1992). The loggerhead shrike has been recorded in the project area and would likely nest in the appropriate habitat types. During the 1994 field surveys, the greatest number of shrikes was observed along the Rabbit Creek drainage (WESTEC 1994a).

Intermittent and perennial wetlands provide habitat for resident or migrant shorebirds. Within the arid areas of northern Nevada, potential nesting habitat fluctuates annually with available water. The white-faced ibis, black tern, and western least bittern typically prefer wetlands and low, marshy areas for nesting and foraging (Terres 1991). Potential habitat for these three water birds would be limited to the Humboldt River crossed by the primary transportation corridor to the mine and the Little Humboldt River along the northern boundary of the project area. The black tern and white-faced ibis have been observed along the Humboldt River (Alcorn 1988). A few limiting factors associated with the dewatering discharge into the Rabbit Creek drainage, including the rapid water flow, channel substrate, and restricted species' distribution, would limit use along this drainage by the white-faced ibis, black tern, or western least bittern.

Mammals

A number of sensitive bat species may occur in the vicinity of the proposed project. Hibernacula, nursery colonies, and bachelor roosts may be present in the appropriate habitat; however, few data on bat occurrences exist for the region. The primary areas of potential habitat are located along the western slope of the Snowstorm Mountains, particularly near perennial water sources, rocky outcrops, and deciduous vegetation. Jake Creek canyon may support area bat species based on available habitat. In the immediate mine area, perennial and intermittent drainages, area seeps and springs, and upland habitats could also provide habitat, depending on the individual species' foraging and roosting requirements. No bat evidence was observed during the 1994 field surveys conducted near the mine area (WESTEC 1994a). However, applicable federal and state agencies identified the following bat species as possibly being present. This information was summarized, based on *Bats of Nevada* (no date), *General Life History of Nevada Bats* (no date), and assorted agency publications.

Based on habitat associations, distribution, and behavior (Colorado Division of Wildlife 1984; Fitzgerald et al. 1994; Back 1995), the small-footed myotis and long-legged myotis could occur in the project region (Back 1995), with likely habitat along the western slope of the Snowstorm Mountains. The long-eared myotis is fairly common in northeastern Nevada (Back 1995); it would only be expected to occur within the small woodland stringers along the drainages in the Snowstorm Mountains. Because of the rare distribution and basic habitat association for the fringed myotis, it is not likely that this species occurs in the project area (Back 1995). The Townsend's big-eared bat could occur in the project area (Back 1995). However, the availability of hibernacula that maintain stable temperatures is currently unknown. The spotted bat may occur within the valley areas of the BLM's Winnemucca District (BLM 1973). In the project area, suitable habitat for the spotted bat would be limited to the rocky outcrops and cliffs located in Jake Creek canyon (Back 1995). The rock crevices and riparian corridor could provide roost sites and foraging areas for this rare species (Wai-Ping and Fenton 1989).

Other sensitive mammals include the Preble's shrew and pygmy rabbit. Very little is known about the Preble's shrew throughout its range, although it is known to occur in the northern Great Basin. Habitats where the Preble's shrew has been recorded encompass sagebrush, grasslands, openings in subalpine forest, and alpine tundra (Fitzgerald et al. 1994). The Preble's shrew is also thought to occupy wetland or marshy areas with adequate emergent and woody vegetation (Back 1995). Currently, it is unknown whether this species could occur in the project area.

The pygmy rabbit is distributed throughout sagebrush habitat in the northern Great Basin. Habitat requirements for these small, burrowing rabbits include dense stands of big sagebrush or bitterbrush for both food and cover (Green and Flinders 1980) and deep, friable soils for their burrows (Wilde 1978). The species has an irregular distribution, limited to suitable stands of sagebrush and rabbitbrush (Dobler and Dixon 1990), often along riparian areas. In Nevada, the pygmy rabbit is considered a game species. Although the appropriate habitat occurs within the project area, no sign of pygmy rabbit presence was recorded during 1994 field surveys (WESTEC 1994a). This species is known to occur in adjacent Eden Valley. It is currently unknown whether the pygmy rabbit occurs in the project area.

Amphibians

Since the spotted frog is a federal candidate species, federal listing is anticipated. This species typically occupies open perennial water, breeding in the surrounding ephemeral pools, and is also dependent on perennial springs for hibernation (Ports 1995). In Nevada, spotted frog populations have significantly declined; these declines are primarily attributed to habitat loss and degradation from land conversions, dewatering for irrigation, and intensive livestock grazing.

The spotted frog has been documented in the Tuscarora Mountains in northern Nevada, east of the project region (Ports 1996). It is currently unknown whether this species occurs within the project area, including the Snowstorm Mountains. Based on available habitat, it is possible that this amphibian could occupy perennial pools, particularly along the Humboldt River, Little Humboldt River, the temporary outflow of Rabbit Creek, and the Snowstorm Mountains. The 1994 field surveys also indicated that potential spotted frog habitat exists at the Kelly Creek Ranch diversion and the upstream Kelly Creek Spring (WESTEC 1994a).

Invertebrates

The Nevada viceroy is found only in Elko County and may occur along the Humboldt River. The larval stage of this species is associated with willow habitat, which would be restricted to areas along the Humboldt River crossed by the primary transportation corridor to the mine (Austin 1993) and along Kelly Creek (BLM 1994c).

Potential habitat for California floater, a freshwater mussel, may exist in the project area, although no previous surveys have been conducted. Historically, this species has occurred in the Humboldt River. Recent surveys in Nevada have indicated that California floater occurs primarily in small, permanent streams with pool habitats, depths ranging from approximately 1.5 to 3 feet, and silt, sand, and small gravel substrates (McGuire 1996).

Fish

The Lahontan cutthroat trout was initially listed as an endangered species, but its status was changed to threatened in 1975 to legalize angling and facilitate management (Behnke 1992). This species occurs in the upper 15 to 20 miles of the South Fork of the Little Humboldt River (***Figure 3-47***). This section of the South Fork of the Little Humboldt River exhibits perennial flows, which is important for the establishment of permanent populations. Populations also are found in tributaries to the South Fork of the Little Humboldt River, such as Secret, Sheep, and Pole creeks (Coffin and Cowan 1995). During high water periods, fish occasionally move into the lower section of the stream and enter Chimney Reservoir. The best habitat occurs in the tributaries and mainstream section of the South Fork of the Little Humboldt River from the headwaters downstream to the confluence with Pole Creek. However, cattle grazing and recent dry water years have reduced the quality of available habitat even in the upper portions of the drainage. No Lahontan cutthroat trout populations have been found in the streams located downgradient from the South Pit.

3.5.2 Environmental Consequences

Terrestrial Wildlife

Impacts to terrestrial wildlife resources would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Impacts to riparian habitat if riparian vegetation or available water were adversely affected, lost, or made unavailable, resulting in habitat degradation for wildlife resources
- Impacts to vegetation resulted in changing trends of wildlife populations, due to reduced forage or cover availability
- Impacts to big game if vehicle mortalities resulted in declining population numbers below the Nevada Division of Wildlife's management goals
- Impacts to wildlife resources if habitat fragmentation within the cumulative impact area prevented viable reproduction of resident populations
- Impacts to game and nongame birds (including raptors and neotropical migrants) dependent on riparian habitat for nesting if declining ground water levels resulted in a loss of woody plant species (i.e., shrubs and trees) that comprise the understory and overstory components of the system
- Impacts to resident and migratory wildlife if the project were to result in either acute or chronic toxicity (e.g., increased mortality, impaired reproduction, reduced growth or fitness)
- Impacts to important wildlife species from a hazardous materials spill into a sensitive resource (e.g., stream or river channel) along the primary transportation route to the mine, resulting in increased mortalities, reproductive loss, or habitat loss

Aquatic Biology

Impacts to aquatic resources would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Important spawning habitat (expressed in linear stream miles) for game fish and/or threatened or endangered species were affected by increased sedimentation on a long-term basis (greater than approximately 6 months during spawning)

- Important habitat (expressed in linear stream miles and square-feet) for game fish and/or threatened or endangered species were removed due to the stream diversion
- Important habitat (expressed in linear stream miles) for game fish and/or threatened or endangered species were affected by flow reductions from dewatering such that the streams no longer support a viable population, i.e., not able to reproduce and sustain numbers at premining conditions
- Habitat for springsnails were affected by water level reductions such that the spring no longer supports a viable population

Threatened, Endangered, or Sensitive Species

Impacts to threatened, endangered, or sensitive species would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Impacts to species federally listed as threatened or endangered if the project were to cause a "take" of the species, in accordance with the Endangered Species Act, including loss of designated critical habitat
- Impacts to federal candidate species if the project were to contribute to the need to list the species as federally threatened or endangered
- Impacts to BLM sensitive species, if the project were to result in adverse impacts to individuals or populations, contributing to the need to list the species as a candidate for federal listing
- Impacts to concentrations of sensitive bat species in and near the project area, resulting in increased mortalities or the loss or abandonment of a communal roost site (e.g., hibernacula, maternity roosts, bachelor roosts)
- Important game fish species and/or threatened or endangered species were affected by water quality changes resulting in direct toxicity or habitat degradation

3.5.2.1 No Action Alternative

Terrestrial Wildlife

The primary direct impacts to terrestrial wildlife from the No Action alternative would include habitat loss, increased habitat fragmentation, increased animal mortalities, and animal displacement. Indirect impacts would encompass increased noise, possible decreased water availability, and potential loss of riparian habitat.

Three factors limit the potential impacts to wildlife resources from the No Action alternative: (1) habitat in and adjacent to the immediate mine area is not considered unique to area wildlife, relative to available habitats outside of the project area; (2) range degradation has reduced associated carrying capacities for wildlife; and (3) the ongoing mining operations have restricted wildlife use of the project area to its present level. Primary concerns for this project are the potential long-term impacts to available water and riparian habitat and to the species dependent on these resources.

The No Action alternative would result in the direct loss of 726 acres and 1,994 acres of native habitat on public and private lands, respectively (see Section 3.4.). Of the 2,720 acres of native habitat affected, 1,413 acres have burned (2 acres of Wyoming big sagebrush and 1,411 acres of mixed shrub), which resulted in a lower habitat value for area wildlife. Of the dominant plant communities that would be impacted, the most important to wildlife resources would be the 141 acres of Wyoming big sagebrush, 622 acres of mixed shrub, and 21 acres of basin big sagebrush that would be lost under the No Action alternative. Of the 3,136 total acres disturbed under this alternative, 2,608 acres would be reclaimed following mine closure, leaving 528 acres (i.e., the open pits) not reclaimed for postmining use. The disturbance of the 2,608 acres would be considered a short-term habitat loss during the life of the project, until final site reclamation is completed. The loss of the 528 acres would be a long-term impact to terrestrial wildlife.

As part of SFPG's reclamation plan, the company has committed to enhance and protect wildlife habitat by implementing certain reclamation measures. These measures are discussed in Section 2.4.11 and would include: (1) creating nesting areas in the pit high walls, depending on final pit water quality; (2) placing large rocks and boulders on reclaimed slopes for improved microhabitats and raptor foraging perches; (3) incorporating irregularities in reclaimed slopes to create different microclimates for increased species diversity, (4) installing supplemental water devices following mine closure; and (5) installing and maintaining a perimeter fence to exclude livestock and wild horses. These measures would enhance the reclaimed habitat for area wildlife and minimize the long-term impacts to the local populations. In addition, the primary plant communities that would be affected by the No Action alternative (i.e., Wyoming big sagebrush-grass, mixed shrub, and basin big sagebrush) are prominent in the areas surrounding the Twin Creeks Mine. Therefore, the No Action alternative would not result in a significant change in wildlife use trends or forage availability in the project area.

Habitat loss would remove forage, escape and thermal cover, and breeding areas for certain terrestrial wildlife species. Mine development and expansion would displace animals from the project area into adjacent habitats, which are assumed to be at or near their carrying capacities. Therefore, it is assumed that displaced animals would be lost from the population. The species primarily impacted by displacement would be those dependent on the upland sagebrush-grass and mixed shrub communities, including small and medium-sized mammals, reptiles, ground-nesting birds, foraging raptors, and scattered big game (i.e., mule deer).

Direct mortalities would occur with the less mobile or burrowing species (e.g., bird nestlings, reptiles, small mammals) on the site. More mobile species (medium-sized mammals, adult birds, and big game animals) would be displaced from the disturbance area, increasing the competition in adjacent habitats and effectively eliminating the animals from the population, as discussed above. This loss would occur for the life of the project until reclamation is achieved. Habitat fragmentation also would occur for the life of the project, resulting in decreased values for surrounding areas. This issue is addressed in greater detail in Section 3.5.3, Cumulative Impacts.

Mine operations would reduce the hunting or foraging territories of raptors and mammalian predators (e.g., red-tailed hawk, American kestrel, prairie falcon, coyote, badger). However, the majority of the predators that occupy the project area are wide-ranging, and it is not likely that the loss of hunting range and associated prey base of this low magnitude would result in significant impacts. These impacts would be short-term during mine operation.

The potential direct impacts to big game species from the No Action alternative would be minimal. No designated big game ranges are intersected by the project area. Use of the mine area by mule deer, pronghorn, and bighorn sheep is limited, due to relative habitat quality. No migratory or movement corridors would be affected. The potential increase in vehicle mortalities would be negligible, due to SFPG's ongoing mass transit program, posted speed limits or restrictions along the mine access road, and no anticipated increase in mine personnel. Although the mine records indicate that vehicle-related mortalities have occurred along the access route, these have not been numerous and have primarily involved small mammals and reptiles. Therefore, based on the lack of designated big game ranges in the project area and the minimal increase in mine traffic, no significant direct impacts to big game species would be anticipated. Potential indirect impacts are discussed below for water quantity.

No additional indirect impacts to wildlife from increased human use and presence would be expected under this alternative, since the size of the work force would be the same as the existing operations.

Potential impacts to nesting birds from mine development would be limited to ground-nesting species. No raptor nests would be directly disturbed by the No Action alternative. Possible impacts to nesting birds associated with the riparian zones along the foothills of the Snowstorm Mountains are discussed below for water quantity impacts, and the cumulative impacts to breeding birds, including neotropical migrants, are discussed further in Section 3.5.3, Cumulative Impacts.

Potential direct impacts to upland game birds from mine development are expected to be low. The lack of water sources and riparian habitat in the mine area limits bird use. As previously discussed, range conditions in and near the project area have deteriorated, which has resulted in declining habitat values for sage grouse. No active sage grouse leks have been reported in the project area; however, breeding birds may be present. If sage grouse leks were in the project area, development activities from mine expansion within 0.5 mile of an established and viable sage grouse lek from March 1 to May 15 (2 hours before dawn until 10 a.m.) may impact sage grouse productivity. In addition, nesting birds and brooding habitat may be lost, if project activities disturbed suitable habitat near an active lek. Although female sage grouse may establish nest sites and occupy brooding habitat up to 5 miles from a lek, the BLM commonly considers suitable habitat within 2 miles of an active lek as being important to breeding birds. Potential indirect impacts to upland game bird species from project operations are addressed below in the water quantity analysis.

From previous mine records, it appears that electrocution may have been a factor in a low number of bird mortalities at the mine. There is a potential for electrocution of raptors associated with operation of the additional electrical spur lines.

Noise generated during project development would result in minor impacts to area wildlife, typically displacing animals beyond the current operations. Noise level increases above the existing background levels are expected to be minimal (see Section 3.14, Noise). Generally, animal responses to increased noise are either avoidance or accommodation. Abrupt and intermittent noises (e.g., blasting, sirens) are less likely to be accommodated than the more steady and continuous noises (e.g., traffic, equipment).

Although historical mining occurred throughout the region, no shafts, adits, or other underground workings associated with past mining activities occur in the project area, limiting the potential occurrence of bat populations. Therefore, no direct impacts to bats would occur from the No Action alternative. Potential indirect effects are discussed further for the water quantity analysis.

If animals were to access water containing lethal levels of sodium cyanide, direct mortalities from ingestion would result. Previous mine records indicate that cyanide-related mortalities have been reported for the Piñon and Juniper heap leach pads. To prevent future wildlife mortalities, in accordance with the BLM's cyanide management policy and the Nevada Division of Wildlife's Artificial Industrial Pond Permit, SFPG has committed to physically excluding wildlife from potentially lethal facilities or maintaining free cyanide below lethal levels (see Sections 2.3.6 and 2.3.7). Pooling of the cyanide solution on the heap leach pads has resulted in previous wildlife mortalities. SFPG is currently working with the BLM, Nevada Division of Wildlife, and the U.S. Fish and Wildlife Service to prevent further mortalities.

Water Quality Impacts to Terrestrial Wildlife. As discussed in Appendix C, screening-level and baseline ecological risk assessments were conducted to identify chemicals of potential concern that may affect receptor organisms and to estimate the potential impact. The screening-level risk assessment identified the need for further examination of specific chemicals in a baseline risk assessment in order to fully assess potential ecological risks and management options.

The evolution of pit lake morphology and ecology is difficult to predict. PTI and RCI (1996) recorded variable vegetation succession associated with other pit lakes in Nevada. These surveys were able to ascertain that vegetation establishment, composition, and structural diversity typically depended on water depth, extent of slope failures, sediment accumulation, protection from wind and wave action, seed sources, chemical constituents, and nutrient availability. Seeps and springs along the side walls of the pit were found to support both herbaceous and woody vegetation, which can provide adequate to good habitat for wildlife resources. In addition to this riparian vegetation that was established in and near the pit lake, the pit wall benches exhibited primary and secondary succession of upland plant species. Weedy annuals generally colonized the substrate on the pit benches, followed by secondary herbaceous and woody species, as soil depth and organic levels increased.

The PTI and RCI (1996) surveys documented invertebrate and vertebrate presence and use of the pit lake water and associated vegetation. Zooplankton (copepods, cladocerans, and rotifers) were frequently found in plankton samples in the pits studied. Important terrestrial vertebrate species observed included the spotted sandpiper, horned and eared grebe, rock wren, bank swallow, bat species, and lizard species. These animals are representative of the wildlife groups that would likely be associated with the eventual pit lake development for the Twin Creeks Mine.

It is anticipated that the overall depth of the future pit lake and rapid fill rate would limit animal use to primarily resting or loafing areas for migratory birds during the first 27 years. However, some forage would begin to establish, as the lake filling rate begins to decrease. Adult chironomid midges would likely be available for consumption by shorebirds, bats, and some waterfowl (both dabblers and divers). As the fill rate continues to decrease at 127 years for the No Action alternative, some shoreline vegetation would become established in and adjacent to the littoral zone in wind-protected areas. The ecological risk assessment (Parametrix 1996a) indicates that "classic" riparian vegetation would eventually become established in limited areas, as the lake reaches equilibrium. As the lake fill rate decreases to 2 feet/year, it is estimated that riparian vegetation would establish and expand upslope from the lake margin (approximately 40 to 60 years after mine closure) (Parametrix 1996). The maximum anticipated riparian development in these restricted areas would include some shrubs and emergents; no trees would likely occur, due to the limited seed sources near the mine area (Parametrix 1996a). Plant species, such as coyote willow, tamarisk, and macrophytes (e.g., *Typha)* could persist, as long as the hydrologic conditions remained unchanged (RCI 1996).

As presented in Appendix C, the screening-level ecological risk assessment examined the pit lakes associated with both the No Action alternative and the Proposed Action. Anticipated short- and long-term effects are similar for both alternatives; however, the pit lake for the No Action alternative would develop at a faster rate than for the Proposed Action, due to the reduced pit size under the No Action alternative. The No Action alternative pit lake may have a greater potential to develop and support riparian communities and wet meadows than the Proposed Action, based on the final pit lake level (RCI 1996).

As the lake approaches equilibrium, the limited littoral substrate that would become established would likely form small, discrete pockets along the lake margin. The vegetation establishment would attract a variety of animals, including birds and small mammals. Additional species would colonize these small riparian communities, resulting in a limited, but distinct, food pathway between the pit lake water and higher trophic levels.

The ecological risk assessment used key indicator species, as discussed above. Based on this screening-level assessment and comparisons to other pit lakes in Nevada, it is likely that big game use (i.e., mule deer and bighorn sheep) would be limited, due to planned access restrictions and other available habitat in the region. However, a number of upland wildlife species could occupy the habitats surrounding the pit lake. As discussed for the risk assessment indicator species, bats could occupy the crevices and cracks in the pit walls. Some passerines and shorebirds could occur within the appropriate habitat types, which would include cliff walls, riparian vegetation adjacent to the lake margin, and upland areas. Although the ecological risk assessment did not examine exposure pathways for raptor species, nesting raptors could use the cliff substrate for nesting, as the walls begin to erode and ledges become available. See Appendix C (Section C.1.1.3) for additional discussion on the selection of receptor species for the ecological risk assessment, relative to potential exposure pathways.

Based on the screening-level risk assessment (Parametrix 1996a), adverse impacts to terrestrial wildlife could result from the projected antimony levels from both acute and chronic exposures. Limited data are available on the short- and long-term effects to animals from ingestion of antimony. Toxicological benchmark values for chronic mammalian exposures and acute and chronic avian exposures were derived using a rat species as the test animal (Schroeder et al. 1970; National Institute for Occupational Safety and Health 1985). Although these test results are limited in applicability and the screening-level risk assessment is considered conservative, the assessment concluded that long-term adverse impacts could result from the final pit water chemistry, even if individuals obtained forage and water from other sources in addition to the pit lake. The screening-level risk assessment identified the following wildlife receptors and chemicals of potential concern requiring a baseline risk assessment:

- Little brown myotis (a bat species) was found to be potentially at risk from exposure to aluminum, antimony, inorganic mercury, selenium, thallium, and zinc

- Cliff swallow was found to be potentially at risk from exposure to antimony, inorganic mercury, selenium, and thallium
- Spotted sandpiper was found to be potentially at risk from exposure to antimony and selenium

The purpose of the baseline ecological risk assessment was to further examine the chemicals of concern that have the potential for adverse effects based on the results of the screening-level risk assessment. The baseline risk assessment re-evaluated key assumptions used in the screening-level risk assessment and refined these assumptions to produce a more realistic estimation of potential risk.

The screening-level risk assessment included assumptions that resulted in uncertainties about the risk estimations (see Section C.1.4 and ***Table C-9*** in Appendix C). In general, these assumptions resulted in an overestimation of risk to receptor species.

In the baseline risk assessment, some of the assumptions were modified to provide what is believed to be more realistic estimations of exposure and/or effects. Using the revised estimates of exposure and effects, new hazard quotients were calculated for the chemicals and species that were found to be at potential risk in the screening-level risk assessment.

The only hazard quotients greater than 1.0 were for the little brown myotis for the metal selenium. These hazard quotients occurred in Year 5 of lake development for both the No Action alternative and Proposed Action pit lakes. The selenium hazard quotients are not considered significant because of their magnitude (they barely exceeded 1.0), the knowledge that these hazard quotients were not statistically distinguishable from 1.0 because of the uncertainties inherent in the assumptions and calculations, and understanding that the toxicity threshold values were conservative values given the use of safety factors in their derivation. For example, while a hazard quotient of 1.1 was based on selenium concentrations in the north lake of the No Action alternative pit at 5 years (***Table C-10;*** Appendix C), the projected foraging of the bat over both the south and north pit lakes would result in an average hazard quotient of 0.7. No risks to other receptor organisms were identified. Therefore, the baseline risk assessment estimates that none of the receptor organisms would be at risk from the Twin Creeks Mine No Action alternative pit lake.

Water Quantity Impacts to Terrestrial Wildlife. The potential for drawdown of naturally occurring seeps, springs, and perennial streams from mine dewatering is presented in Section 3.2.2, Water Quantity and Quality.

No potential impacts to terrestrial wildlife from mine dewatering activities would be expected immediately after mine closure under the No Action alternative. However, some effects to surface water sources for wildlife may occur 50 to 100 years after the end of mining, affecting flows in the Little Humboldt River and water availability in Hot Springs. In addition, naturally occurring seeps and springs that occur in the foothills of the Snowstorm Mountains and along the northern portion of the Osgood Mountains may be affected. A comprehensive inventory of all springs within the potential drawdown areas has not been conducted. It is possible that other springs within the drawdown area could experience a reduction or cessation of flow. No impacts to flow in the Humboldt River in the study area are anticipated.

If the flows in the lower perennial reach of Jake Creek are dependent on discharge from the regional ground water system, this reach could experience a reduction in flow in the postmining period. A reduction in flow in this reach of Jake Creek would increase adverse impacts to wildlife. As discussed in Section 3.5.1.1, water availability is the limiting factor for most wildlife species in northern Nevada. Loss of surface water would reduce the habitat's relative carrying capacity and the associated species' densities and composition. Jake Creek provides available water for wildlife consumption and a greater diversity of vegetation for cover and foraging opportunities than other water sources in the project area, such as Kelly Creek Spring or Garret Spring. Therefore, long-term effects to the surface water flow in Jake Creek could significantly impact wildlife resources dependent on these areas for their survival.

Mine dewatering and reinfiltration activities would result in a short-term beneficial impact to both resident and migratory birds. Waterfowl, shorebirds, and raptors would use the reinfiltration basins for foraging and resting. Nesting would be expected to be limited, due to SFPG's commitment to remove emergent vegetation (see Section 2.3.10). This water source would attract a number of species in the arid climate of northern Nevada, particularly migratory birds. However, the long-term impacts to wildlife from these basins are currently unknown. Water inundation and evaporation could potentially increase salt accumulation in the soil, depending on the soil types. Increased soil salinity may not adversely affect birds using these basins. The increased salinity may actually increase invertebrates, providing a broader prey base for migratory and resident birds. Impacts from evaporation could be problematic, however, if selenium, nitrates, arsenic, or boron began to increase, which could adversely affect foraging birds. Increasing metals could bioaccumulate in foraging wildlife populations. Adverse impacts to bird reproduction by increasing metals or other chronic or acute impacts to resident or migrant avian populations would violate the Migratory Bird Treaty Act.

Other issues involving the development of the water reinfiltration basins would be the potential transmission of avian diseases, such as avian cholera or botulism, as SFPG adjusts the water levels to increase infiltration and prevent the establishment of vegetation.

Hazardous Materials. The probability of a hazardous materials spill (e.g., sodium cyanide, diesel fuel, or acid solutions) along the transportation route is discussed in Section 3.15, Hazardous Materials. The transportation analysis calculated that the number of spills anticipated during the life of the project (through the year 2000) along the entire two-lane access road from Golconda would be approximately 0.2, 0.7, and 0.01 for cyanide, diesel, and acid, respectively. Although the spill probabilities are low, a spill scenario was identified for natural resources occurring along the transportation route. The analysis of potential impacts to resident and migratory wildlife from a toxic release was based on this spill scenario and focused on the access road between Golconda and the mine, which crosses the Humboldt River. The Humboldt River was chosen as the most sensitive receptor located along the two-lane road to the mine. However, the Humboldt River bridge has been recently widened and rebuilt, which would decrease the potential for truck accidents at the river crossing.

If a large amount of sodium cyanide, diesel, or acids were spilled into the river channel, wildlife habitat would be lost and direct mortalities would occur to the organisms that came into contact with the materials. If a spill occurred during the spring or early summer, a greater number of species would be affected than in the winter. Ground-nesting birds may be impacted, with the potential loss of adult birds, eggs, or nestlings along the channel perimeter. A hazardous spill also could affect other vertebrate and invertebrate species that rely on the riparian habitat for feeding or cover. These losses could, in turn, impact prey availability, indirectly affecting more upland species. Releases of diesel fuel into the riparian system would result in more long-term impacts to natural resources than from either cyanide or acids. Hydrocarbon contamination could reduce the amount of cover and forage availability for wildlife species for a complete breeding season.

In summary, the level of impacts to the Humboldt River system from a hazardous materials spill relative to the duration and length of reach affected would depend on the size of the spill, time of year or season, physical characteristics of the channel and vegetation, cleanup and control techniques, and susceptibility of the dominant organisms. The long-term effects would depend on the buffering capacity of the water, soils, and vegetation, and the recharge or water dilution factors. Impacts could range from temporary vegetation loss to the widespread loss of riparian habitat and associated organisms. Site remediation would be key to minimizing adverse impacts and re-establishing the riparian system, if necessary. SFPG has developed a Spill Prevention, Control, and Countermeasures Plan (JBR Environmental Consultants, Inc. 1996) for on-site hazardous materials spills to help minimize any short- or long-term effects. Transporters would be responsible for the cleanup of spills during the transport of hazardous materials (see Section 3.15, Hazardous Materials).

Aquatic Biology

The effects of sedimentation from construction of mine facilities, access/haul roads, and other disturbance activities would occur mainly within the Rabbit Creek drainage. In addition, exploration activities and placement of tailings and overburden and interburden storage areas would occur adjacent to Rabbit Creek. Along Rabbit Creek and its tributaries, increased sedimentation would occur only during periods of storm water runoff. Sedimentation would occur in localized areas of Rabbit Creek on a temporary basis as a result of surface disturbance in the mine areas and along the road corridors. In addition, the continued construction of the reinfiltration basin would disturb soils along approximately

0.5 mile of Rabbit Creek and 0.8 mile of Kelly Creek.

By using required sedimentation control measures, sedimentation impacts would be limited in terms of the area affected and the relative increase in suspended material. Previous studies in Rabbit Creek and the lower portion of Kelly Creek have shown that speckled dace is the only fish species present. As previously described, flows in Rabbit Creek and Kelly Creek immediately below its confluence with Rabbit Creek are attributed to mine discharge. Macroinvertebrate communities are characterized by relatively low densities and diversities in both streams. Sedimentation impacts to aquatic communities would not be considered significant because of the short duration of impacts and the fact that no important game fish species occur in the Rabbit Creek drainage and the lower portion of Kelly Creek.

Dewatering activities for the No Action alternative would affect flows in the Little Humboldt River. Based on the hydrological analysis (see Section 3.2.2, Water Quantity and Quality), flows in the Little Humboldt River located below Chimney Reservoir would be decreased approximately 0.2 to 0.5 cubic-feet-per-second (see ***Table 3-9***). These reductions would represent approximately 10 percent of the average low flow conditions. The relatively small flow changes would result in minor impacts to habitat for aquatic communities in the Little Humboldt River. Since the viability of game fish species would not be affected by the flow changes, impacts would not be considered significant.

The flows in the lower perennial reach of Jake Creek are dependent in part on discharge of ground water. Therefore, as the cone of drawdown extends into the Jake Creek area, the baseflow or ground water discharge to the stream could potentially be reduced. The magnitude of change and length of impacted reach are not possible to predict with certainty but would depend on the site-specific conditions, particularly the interconnection between the stream and the regional ground water system. The predicted postmining drawdown (***Figure 3-27***) would encompass the lower 3-mile segment of the perennial reach of Jake Creek. If this entire 3-mile segment were eliminated from the postmining drawdown, this would represent approximately 24 percent of the overall length that supports important game fish species. Flow reductions would affect habitat for brook and rainbow trout in Jake Creek. If portions of Jake Creek with important habitat, i.e., spawning, juvenile rearing, and pools for adults were eliminated, impacts would be considered significant because reproduction would not sustain numbers at premining levels.

Dewatering activities also could potentially affect springs and seeps in the project area, as discussed in Section 3.2.2, Water Quantity and Quality. Flow reductions could decrease water flow in springs, which would affect the composition and distribution of aquatic plants, attached algae, invertebrates, and nongame fish species. As shown in ***Table 3-9***, the maximum predicted baseflow reduction is approximately 12 percent for the Hot Spring discharge area. Of particular concern would be potential impacts on springsnails, which exhibit a very limited distribution in the Great Basin. Springsnails were not found in six springs located within the project area (Garret, Kelly Creek, Jake, Alkali, Hot Springs, and an unnamed). Based on the survey of these springs, dewatering would not affect any known springsnail population. However, potential habitat for springsnails may exist in other springs, which are located within the predicted drawdown area.

The potential exists for aquatic biota to be exposed to chemicals as a result of accidental spills or leaks during mining operations, and transport of hazardous materials to the mine. Spills or leaks from mining activities could involve breaching of tailings areas, heap leach pads, and solution ponds. The overburden and interburden storage areas located adjacent to Rabbit Creek could contribute acid-generating materials to Rabbit and Kelly creeks during runoff. Chemicals also could be spilled during transport to the mine site and storage at mine facility locations. The chemicals that represent potential toxicity concerns for aquatic biota include hydrogen sulfide, cyanide, lime, fuels, and trace metals.

The level of impact from a spill or leak on aquatic communities would depend on the magnitude, duration, location, and timing of a spill or leak. As a result of the intermittent nature of streams within the project area, potential spills or leaks at the project site during average and low flow conditions would be contained in localized areas. A spill or leak that reached Rabbit and/or Kelly creeks could potentially expose aquatic macroinvertebrates and speckled dace to toxic concentrations for a short period. The abundance and composition of aquatic organisms may decrease for several months to one year, depending upon the variables listed above. Organisms would begin recolonizing the affected area after toxic conditions subside. A major spill or leak of chemicals from the project site during extremely high flow conditions could transport contaminants into the Humboldt River. However, relatively high water volumes in the Humboldt River and Kelly Creek runoff would dilute the concentrations of any potential contaminants. The additional increase in contaminant concentrations from a spill originating within the mine area would be considered minor. The impacts of potential spills or leaks from the project site on aquatic communities would not be considered significant for the following reasons: (1) absence of important game fish species in Rabbit and lower Kelly creeks; (2) prevalence of intermittent flows in streams located downgradient of the mine area; and (3) dilution effect of any spills entering the Humboldt River due to water volume.

If a spill occurred in the Humboldt River during transport of chemicals to the mine, warm water game fish species could be exposed to toxic conditions in localized areas. If the spill caused mortalities for game fish species in the Humboldt River, impacts would be considered significant. Toxic conditions, if present, would exist for a short period of time (i.e., several hours up to several days). In general, the early life stages of fish and other aquatic organisms would be the most sensitive to any contaminants.

SFPG would implement measures to reduce the possibility of a spill or leak. The tailings and heap leach facilities would be designed for zero-discharge with a closed system and double-lined solution ponds. SFPG has constructed a bioremediation site to treat hydrocarbon-contaminated soils. SFPG's Spill Prevention, Control, and Countermeasures Plan (JBR Environmental Consultants, Inc. 1996) would be implemented if a spill or leak occurred.

<u>Threatened, Endangered, or Sensitive Species</u>

Terrestrial Wildlife. The impact analysis for sensitive terrestrial wildlife species emphasizes the potential impacts to the species identified in Section 3.5.1.3, addressing only the applicable project components for each species.

No impacts to the peregrine falcon would be anticipated under the No Action alternative. No active nesting occurs near the project area, no riparian habitat would be directly removed by mine expansion, and migrating birds would likely avoid the mine area during project operations. The infrequent occurrence of migrating birds would likely preclude potential effects, due to a reduction in water resources within the region. Additionally, no prominent peregrine falcon use of the Humboldt River downstream of the primary transportation corridor crossing has been documented; therefore, impacts from a hazardous materials spill are unlikely.

The impact analysis for sensitive species examined the probability of a hazardous material spill into the Humboldt River, crossed by the transportation corridor, potentially impacting both aquatic and terrestrial species that depend on this portion of the river. Potential impacts to five sensitive species were addressed, due to their potential presence. These species included the bald eagle, white-faced ibis, black tern, western least bittern, and Nevada viceroy, since either these species or suitable habitats are known to occur downstream of the Humboldt River crossing.

The spill scenario calculated that the probability of a hazardous materials spill along the access road from Golconda to the mine would be 0.2, 0.9, and 0.02 spills for sodium cyanide, diesel, and acid, respectively, for the life of the mine (through the year 2000). Although the probability of a hazardous spill is low, a large cyanide, diesel, or acid release could adversely affect sensitive organisms associated with the Humboldt River drainage. As discussed for general wildlife under the No Action alternative in Section 3.5.2.2, a number of variables would determine the relative impacts to both aquatic and terrestrial organisms. It is important to note that the rebuilt bridge crossing of the Humboldt River would reduce the likelihood of a spill at this location.

For the bald eagle, a spill into the channel could remove potential prey and prevent foraging eagles from using the area until final remediation has been completed. If this were to occur, it would result in an insignificant, short-term loss of available foraging habitat along the specific reach of the river affected by the spill. No additional indirect impacts to wintering eagles would be expected, since contaminated animals (e.g., fish, waterfowl) would likely be removed during a spill cleanup; in addition, the presence of the emergency personnel would preclude birds from foraging in the area until finalremediation. Possible direct impacts to the three sensitive water birds and butterfly would depend on the amount of the release, season, buffering capacity of the water, ground water and surface water recharges, and remediation time. If the spill were to occur during the spring and early summer, habitat loss and direct mortalities would be considered significant short-term impacts to breeding individuals; however, no significant or long-term impacts to the local populations would be expected.

No adverse impacts to the northern goshawk would be expected under the No Action alternative. Based on the ground water analysis presented in Section 3.2.2, Water Quantity and Quality, higher elevational seeps, springs, or streams would not likely be affected by this alternative. Therefore, no impacts to riparian habitat (e.g., aspen) would occur, which typically support breeding goshawks.

Although the ferruginous hawk is known to occur in the project region, no nesting activities have been documented. The vegetation communities and topography immediately surrounding the Twin Creeks Mine do not provide optimal nesting habitat for this species. Individuals may forage in the area, although suitable prey bases or small mammal concentrations are limited near the mine area. Based on these factors, no direct impacts to nesting or foraging ferruginous hawks would be expected from mine-related activities. Impacts to surface water sources and riparian vegetation from project dewatering could indirectly affect this species, if decreasing water availability 50 to 100 years after the end of mining were to result in declining prey populations for foraging hawks.

Burrowing owls have been documented nesting in the project region. Although this species could occur in any of the vegetation types that would be disturbed by the No Action alternative, owls would typically be limited to more open areas with good visibility. Removal of 3,136 acres of potential habitat could directly affect the burrowing owl. Surface disturbance would result in the loss of potential nesting habitat for this species, and if the disturbance occurred during the breeding season, direct mortality could result to incubating adults or young owlets within nest burrows. In addition, the annual reproductive potential would be lost for breeding birds. No impacts to the known nest site located northeast of the mine area would occur. Owls would likely continue to use the area along Rabbit Creek following construction of the drainage diversion. Based on these anticipated impacts, the No Action alternative would result in adverse impacts to the burrowing owl that would continue through the life of the mine (short-term). This loss would be considered significant to the scattered breeding individuals, but it would not be considered significant to the local population, since habitat in the project area is not considered optimal, and no burrowing owl concentrations occur in the mine area. Owls would likely reinhabit the region following mine reclamation.

Potential impacts to the loggerhead shrike would parallel that of the burrowing owl. However, optimal nesting habitat, including large shrubs and greasewood stringers that are commonly occupied by nesting birds, occur outside of the project area. Although potential nesting habitat (large shrubs) is limited within the areas of anticipated disturbance, the removal of active nests during the breeding season could result in the loss of eggs or nestlings. This loss of active nest sites would significantly affect the breeding shrikes in the disturbance area, but would not significantly affect the local populations. Potential impacts to the shallow water table associated with the lower portion of the Kelly Creek basin could result in decreasing greasewood in the basin. Loss of greasewood from mine dewatering activities would result in a long-term loss of potential nesting habitat for the shrike.

No direct impacts to the white-faced ibis, black tern, or western least bittern would occur under the No Action alternative, due to the lack of appropriate water resources on site. The potential indirect effects to these water birds would be limited to possible reduction in flows within the Little Humboldt River and a possible hazardous materials spill into the Humboldt River along the primary transportation corridor (see the bald eagle discussion). The anticipated decrease in flows in the Little Humboldt River below Chimney Reservoir may result in a minor impact to potential nesting habitat for these water bird species.

Of the sensitive bat species identified for the project area, the small-footed myotis, long-eared myotis, long-legged myotis, Townsend's big-eared bat, and spotted bat could occur in the project area. However, no habitat in and near the mine area would likely support concentrations of bats.

Therefore, no direct, significant impacts to sensitive bat species would be expected under the No Action alternative. Potential indirect effects would be associated with possible water drawdown along the perennial streams and springs located along the Snowstorm Mountains at 50 to 100 years after the end of mining. For the No Action alternative, the lower perennial portion of Jake Creek may be impacted in the postmining period. Loss of available water and riparian vegetation from drawdown could impact foraging and roosting bat species that use this area during the summer period.

Little is known about the potential occurrence of the Preble's shrew in the project area. If the shrew were present in the mine area, development activities would likely directly impact this species. Adults and young would be lost for the life of the project. Animals would likely return upon final site reclamation.

Habitat for the pygmy rabbit is marginal in the project area, and no sign of this species was recorded during the 1994 baseline field surveys (WESTEC 1994a). Although potential habitat for the pygmy rabbit may be removed by the No Action alternative, the impacts to animals would be considered minor.

No direct adverse impacts to the spotted frog would be anticipated from the No Action alternative, since no perennial waters would be directly removed by the project. The continued dewatering activities during project operation could result in a beneficial short-term impact to the spotted frog, if this species were to occupy the aquatic habitats located along Rabbit Creek or the reinfiltration basins. The potential long-term drawdown effects to naturally occurring streams and springs could adversely affect this species, if present.

<u>Aquatic Biology</u>

Lahontan Cutthroat Trout. No potential habitat or existing Lahontan cutthroat trout populations occur within the area to be affected by construction and operation activities. The closest population is located in the South Fork of the Little Humboldt River, which is situated in a drainage on the north side of the Snowstorm Mountains. Since the No Action alternative would not affect the South Fork of the Little Humboldt River, there would be no impacts to this species.

California Floater. Potential habitat for this freshwater mussel may exist in the Humboldt River, based on the presence of historic populations. No recent studies have been conducted to document its presence or absence. Sedimentation and flow changes resulting from the No Action alternative would have minimal effect on the Humboldt River. Potential water quality changes due to spills or leaks would be confined mainly to Rabbit and Kelly creeks. A major spill or leak from the mine area could reach the Humboldt River only during high flow conditions. As discussed above, concentrations of any contaminants during high flow would be diluted due to relatively high water volumes. A spill into the Humboldt River during transport of chemicals could possibly expose aquatic biota to toxic conditions. However, spill risks would be considered low based on traffic accident data. Impacts to the California floater would not be considered significant because (1) spill risks associated with chemical transport are relatively low (see Section 3.15, Hazardous Materials), and (2) no known California floater populations have been found in the Humboldt River.

3.5.2.2 Proposed Action

<u>Terrestrial Wildlife</u>

The majority of the anticipated impacts to terrestrial wildlife resources from the Proposed Action would be the same as those discussed for the No Action alternative in Section 3.5.2.1. Incremental mine development would result in additional direct and indirect impacts. Direct impacts would include habitat loss, habitat fragmentation, mortalities, and displacement of animals. Indirect impacts would include increased human presence, increased noise, a potential decrease in water availability, and a possible loss of riparian habitat. The following discussion focuses on the anticipated impacts to terrestrial wildlife from the Proposed Action that would differ from those identified for the No Action alternative.

The Proposed Action would disturb 4,663 acres and 351 acres of native vegetation on public and private lands, respectively. Of the 5,014 acres of native habitats affected, 1,488 acres have burned (20 acres of the Wyoming big sagebrush and 1,468 acres of mixed shrub). Of the dominant plant communities affected by the Proposed Action, the most important to wildlife resources would be the 1,170 acres of Wyoming big sagebrush, 1,041 acres of mixed shrub, and 193 acres of basin big sagebrush. Of the 5,217 total acres disturbed under the Proposed Action, 4,391 acres would be reclaimed (short-term), leaving 826 acres not reclaimed for postmining use (long-term). However, as discussed for the No Action alternative, the predominant plant communities that would be directly removed by the Proposed Action occur throughout the basin and in the surrounding valleys. Loss of this upland vegetation (i.e., Wyoming big sagebrush, mixed shrub, saltbush, low sagebrush, and basin big sagebrush) would neither significantly alter the overall trends in terrestrial wildlife use in the basin, nor would the losses significantly affect forage availability under the Proposed Action. Potential indirect habitat loss and degradation are discussed further for the water quantity analysis.

The construction contractor and/or SFPG transport of 150 construction employees would decrease the potential for increased vehicle mortalities, illegal shooting, and harassment of big game animals. However, a temporary increase in the recreational use of the surrounding area during the 12-month construction phase, including hunting, would be expected from the expanded human population and additional access into the project area. This increased use would likely result in low to moderate impacts to big game animals within the region, which is discussed further for cumulative impacts in Section 3.5.3. Potential impacts to these big game species from mine dewatering activities are discussed below.

Water Quality. The results of the screening-level and baseline ecological risk assessments conducted for the Twin Creeks Project (see Appendix C) are summarized for the No Action alternative in Section 3.5.2.1. The assumptions and anticipated effects from the ecological risk assessment of the Proposed Action parallel those discussed for the No Action alternative. The primary difference in the Proposed Action analysis is that the period required to reach equilibrium in the pit lake would be 230 years for the Proposed Action versus the 127 years estimated for the No Action alternative. The potential impacts discussed for terrestrial wildlife resources would be similar for the Proposed Action as those identified for the No Action alternative.

Water Quantity. As discussed for the No Action alternative, Section 3.5.2.1, mine-induced drawdown would likely result in significant long-term impacts to wildlife resources in the postmining period. At the end of the proposed mining period for the Proposed Action, the potential loss of surface water sources would be limited to scattered seeps and springs in the Osgood Mountains that are connected to the ground water regime. Additional springs in both the Osgood and Snowstorm Mountains have not been documented or monitored; therefore, the potential future impacts are difficult to predict. If these springs are perched above the ground water table, then no impacts to terrestrial wildlife would be anticipated. However, if any seeps and springs occurring along the foothill region are connected to ground water, then available surface water could be affected within mule deer summer and winter ranges, in addition to potential effects to sage grouse brooding habitat. Given the current information for this portion of the project area, the extent of these potential impacts is unknown. Since these springs may support genetically isolated populations, loss of seeps or springs may result in loss of genetic diversity and local populations.

The predicted ground water drawdown 50 years after the end of mining for the Proposed Action would potentially affect the lower Jake Creek drainage and extend farther into the Osgood Mountains. Although some uncertainty exists with the ground water data interpretation, no flow effects would be anticipated for the lower portions of Kelly Creek. In the event that the lower ground water levels resulted in reduced stream and spring flow, the riparian vegetation would likely decrease, reducing the vegetative structure, composition, and diversity. As water levels decrease, riparian obligates would be the first plants to decline. Continual ground water reduction would result in increasing stresses on riparian-dependent plants, particularly during the hot, dry period July through September. Assuming that the root zone for most of these riparian plants is fairly shallow (6 inches to 3 feet), woody shrubs and trees would be impacted by decreased water levels, as the ground water levels decrease.

Loss of riparian vegetation would in turn reduce the carrying capacity of the riparian communities; increase water temperature and evapotranspiration; and eventually decrease the number of organisms that rely on these areas for breeding, foraging, resting, and cover. This loss would be significant for regional wildlife resources, which could directly and indirectly affect (1) big game, such as mule deer, pronghorn, California bighorn sheep, and mountain lion; (2) upland game birds, such as sage grouse, chukar, mountain quail, mourning dove, and

California quail; and (3) nongame mammals and birds, including sensitive bat species, songbirds, and raptors. Other more indirect effects would be the loss of small mammals, amphibians, and reptiles occurring in and near the riparian zone, reducing the prey availability for local predators. These long-term impacts would be considered significant.

The predicted drawdown at 100 years after mining for the Proposed Action could affect higher elevational stream reaches, which would impact a greater diversity of wildlife and plant species. Any loss of water in the upper reaches of Jake Creek, in addition to potential effects to localized springs along the lower foothills of the Snowstorm Mountains, could significantly alter specific habitat availability and species' use. Reductions in available water and riparian habitat would adversely affect the value of the designated mule deer crucial summer and yearlong ranges, bighorn sheep crucial and yearlong ranges, and sage grouse seasonal ranges located along the western slope of the Snowstorm Mountains. No effects were identified for the high-altitude springs in the mountains, based on the large seasonal fluctuations and the likelihood that many of these originate from perched ground water. Other animal groups that could be adversely impacted by the potential long-term loss of available water and riparian vegetation would include resident bat species and raptors. Decreased water flows in the Jake Creek canyon would significantly alter this high-quality habitat, which has retained a greater ecological diversity than the surrounding areas, due to restricted access. As discussed in Section 3.2.2, Water Quantity and Quality, any reduction in flow would likely persist for the foreseeable future.

No impacts to flows in the Humboldt River are anticipated; therefore, no impacts to wildlife or plants occurring along this river corridor would occur from the Proposed Action. Other water sources that could be impacted would include the Little Humboldt River and Hot Springs. In the 100-year postmining period, the Little Humboldt is predicted to experience a maximum reduction of 19 percent in the average baseflow. No significant change in flows at the Hot Springs is anticipated during the mine operation. However, in the postmining period, the flows are predicted to initially increase up to approximately 10 percent during the initial 40-year postmining period due to ground water mounding from reinfiltration activities. In the 40- to 100-year postmining period, the flows in the Hot Springs are predicted to be reduced up to approximately 27 percent from the average estimated baseflow (***Table 3-14***). The initial 40-year period of increased water flow in Hot Springs would support a greater number of animals that typically use this area, which would equate to a short-term beneficial impact for wildlife resources. The subsequent declining flows in both the Little Humboldt River and Hot Springs would result in both short- and long-term impacts, resulting in the same significant adverse impacts to wildlife and their associated habitat, as discussed for the other perennial water sources above. Cumulative long-term impacts are discussed in Section 3.5.3.

The proposed diversion of Rabbit Creek would only affect ephemeral flow. This diversion would not be considered a significant impact to area wildlife.

Biodiversity. To address the potential effects to biodiversity under the Proposed Action, the terrestrial wildlife analysis focused on the possible long-term impacts to the perennial streams and springs and their associated riparian habitat. In the event that mine dewatering resulted in long-term effects to these systems and the organisms dependent on them, indirect impacts to the regional biodiversity could occur. The scale of these potential effects cannot be specified, but would be relevant to the potential loss of vegetative structure, genetic variability, and species composition. The loss of rare species or community structures (e.g., deciduous, riparian habitat) would affect the diversity of the system. These losses would decrease the habitat availability, genetic potential within a population, and functional diversity of the system, thereby adversely impacting the regional biodiversity.

Hazardous Materials. Under the Proposed Action, the potential short- and long-term impacts to wildlife resources from a hazardous material spill into the Humboldt River during project operation would parallel the discussion presented for the No Action alternative in Section 3.5.2.1. However, the spill probabilities calculated for the three hazardous materials analyzed, would be higher for the Proposed Action, with 0.9, 2.7, and 0.8 spills for sodium cyanide, diesel, and acids, respectively, for the two-lane access road to the mine. As stated for the No Action alternative, the rebuilt Humboldt River bridge would reduce the likelihood of a spill at this location.

<u>Aquatic Biology</u>

In comparison to the No Action alternative, sedimentation impacts from the Proposed Action would be lower in Rabbit Creek but higher in Kelly Creek. Intermittent flow would be diverted out of Rabbit Creek on the north end of the project area via a diversion channel. An approximate 2-mile section of the existing Rabbit Creek channel would remain on the south end of the project area, which would receive mine return flow. As a result of constructing the diversion channel, temporary sedimentation would occur in Kelly Creek. Stormwater runoff also would drain into Kelly Creek via the diversion channel at a location situated approximately 4 miles upstream of the existing confluence between Rabbit and Kelly creeks. Flow in Kelly Creek would be limited to periods during and immediately after storm events. Sedimentation impacts resulting from the construction of the reinfiltration basins would be the same as those discussed for the No Action alternative. Sedimentation would occur in Kelly Creek and a 2-mile section of Rabbit Creek on a temporary basis, as a result of surface disturbance in the mine areas and along the road corridors. Sedimentation control measures would be used to limit sedimentation impacts to localized areas near disturbance activities. As previously discussed, no game fish or other important aquatic species occur in the portion of Kelly and Rabbit creeks located adjacent to the mine area. Sedimentation impacts to aquatic communities would not be considered significant because of the short duration of impacts and the fact that no important game fish species occur in these stream segments.

Construction of the water diversion channels would remove existing low quality aquatic habitat. Approximately 5 miles of stream habitat would be removed by constructing the Rabbit Creek diversion channel. Of the 5 miles of stream channel removed, approximately 1 mile is perennial and 4 miles are intermittent. The section of Rabbit Creek sustained by mine water discharge represents the only permanent habitat available for aquatic organisms. Assuming an average width of approximately 6 feet in this section, an estimated 31,680 square feet of habitat would be removed in Rabbit Creek. Construction of the Far West and West Side Diversions would remove aquatic habitat in six small, intermittent tributary streams to Rabbit Creek. The intermittent nature of these tributaries would only provide habitat during periods when water is available. No important game fish would be affected by these stream diversions, since speckled dace is the only species present in the Rabbit Creek drainage. Habitat quality is considered low, as indicated by low densities and diversities for macroinvertebrate communities. Since no important aquatic species inhabit Rabbit Creek and its tributaries, impacts would not be considered significant.

Dewatering activities associated with the Proposed Action would affect flows in the Little Humboldt River below Chimney Reservoir. The maximum predicted baseflow reduction for the Little Humboldt would represent approximately 19 percent of the average low flow conditions (see ***Table 3-14***). The additional flow reduction resulting from the Proposed Action would represent minor impacts to habitat for aquatic communities in the Little Humboldt River. Therefore, impacts of the dewatering activities would not be considered significant.

The effects of dewatering activities associated with the Proposed Action on Jake Creek could potentially increase compared to the impacts discussed for the No Action alternative. Flow changes could potentially affect trout habitat in Jake Creek. The magnitude of change and length of impacted reach are not possible to predict with certainty but would depend on the site-specific conditions, particularly the interconnection between the stream and the regional ground water system. As shown in ***Figures 3-31*** and ***3-32,*** the regional ground water system is predicted to be affected in the vicinity of Jake Creak during the postmining period. The area of drawdown encompassed within the 10-foot drawdown contour is predicted to project beneath the lower 3-mile segment at 50 years postmining, and the lower 5-mile segment at 100 years postmining. If these segments were eliminated because of postmining drawdown, this would represent approximately 24 percent of the trout habitat after 50 years, and 40 percent after 100 years. Although flow changes may reduce available habitat in the lower perennial reach, habitat would still be available for trout in the upper tributaries of Jake Creek. However, reduction of flow in the lower perennial portion of Jake Creek could potentially reduce, alter, or remove important seasonal and yearlong habitat (i.e., spawning, juvenile rearing, and pools for adults) for brook and rainbow trout. A reduction in important fish habitat would be considered a significant impact because reproduction would not sustain numbers at premining levels.

In addition, impacts of dewatering on seeps and springs would be similar to the No Action alternative. Water levels could be reduced in seeps and springs that are located within the ground water drawdown area, which could affect aquatic communities. No significant change in flows at the Hot Springs is anticipated during the mine operation. However, in the postmining period, the flows are predicted to initially increase up to approximately 10 percent during the initial 40-year postmining period due to ground water mounding from reinfiltration activities. In the 40- to 100-year postmining period, the flows in the Hot Springs are predicted to be reduced up to approximately 27 percent from the average estimated baseflow (***Table 3-14***). This reduction would likely persist for the foreseeable future. The initial increase in flow would likely result in a beneficial impact to the aquatic community. The later reduction in flows would result in an adverse impact to the local aquatic habitat. Dewatering would not affect any known springsnail populations; however, potential habitat may exist in other springs within the predicted drawdown area.

In general, the impact of a possible spill or leak on aquatic communities due to the Proposed Action would be similar to the discussion for the No Action alternative. The level of impact from a spill or leak on aquatic communities would depend on the magnitude, duration, location, and timing of a spill or leak. A larger area of contaminant sources would exist for the Proposed Action, as reflected in the increased acreages for the overburden and interburden storage areas, tailings storage areas, and heap leach pads. The overburden and interburden storage areas could contribute acid-generating materials to lower Kelly Creek during runoff. By following best management practices and measures to reduce potential spills or leaks, risks of a spill should not increase for the Proposed Action. The impact of a possible spill or leak on aquatic communities in Rabbit and Kelly creeks and the Humboldt River during mining and postmining activities would not be considered significant, as discussed for the No Action alternative. If game fish mortalities resulted from a spill into the Humboldt River during chemical transport to the mine, impacts would be considered significant.

<u>Threatened, Endangered, or Sensitive Species</u>

Terrestrial Wildlife. The impact analysis for threatened, endangered, and other sensitive species potentially affected by the Proposed Action parallels that presented for the No Action alternative in Section 3.5.2.1. Only the project components that may potentially affect a sensitive species are discussed. No additional impacts beyond those discussed for the No Action alternative were identified for the peregrine falcon, ferruginous hawk, loggerhead shrike, Preble's shrew, pygmy rabbit, and spotted frog.

Potential effects to the bald eagle, white-faced ibis, black tern, western least bittern, and Nevada viceroy would be the same as those described for the No Action alternative. However, the spill probabilities calculated for the three hazardous material groups and the Humboldt River crossing, would be higher for the Proposed Action, with 1.0, 2.7, and 0.62 spills for sodium cyanide, diesel, and acids, respectively, for the life of the mine (through the year 2011). Potential impacts from a spill into the river channel would be the same, possibly affecting potential prey species for wintering bald eagles, directly affecting breeding or foraging shorebirds, or indirectly impacting vegetation (e.g., willows) that supports invertebrate species such as the Nevada viceroy. As stated for the No Action alternative, no adverse impacts to the bald eagle would be anticipated, due to: (1) the low probability of an accident and resulting spill and (2) the sporadic use of the specific reach of the river by wintering birds. If a spill were to directly impact nesting shorebirds or breeding butterflies, individuals could be significantly affected for that season. However, no long-term impacts would be anticipated for the reasons stated above. As discussed for the No Action alternative, the rebuilt bridge across the Humboldt River along the transportation route between Golconda and the Twin Creeks Mine would minimize the potential for truck accidents at this sensitive riparian location.

Effects to the northern goshawk from the Proposed Action would be limited to potential long-term loss of riparian habitat associated with the perennial water sources located along the western slope of the Snowstorm Mountains. Potential impacts to the goshawk would be considered significant, if dense riparian or aspen habitat were lost along the higher elevational water sources, including Jake Creek. No impacts to the Kelly Creek drainage from water drawdown are currently anticipated.

Habitat loss estimated for the burrowing owl could total 5,201 acres for both public and private lands; however, the amount of suitable habitat within the 5,201 acres that would be disturbed by the Proposed Action is not currently known. Other short-and long-term impacts to this resident species are presented in Section 3.5.2.1 for the No Action alternative.

Potential impacts to sensitive bat species would be similar to those discussed for the No Action alternative. However, the potential long-term effects to ground water and the associated surface water availability would be greater for the Proposed Action both at mine closure and in the postmining period. The loss of water availability or riparian habitat important to bat foraging would be considered a significant adverse impact. The complexity of the vegetation (i.e., understory density relative to canopy cover) and the proximity of the riparian habitat to bat roost sites would determine whether the riparian habitat could support foraging bat species.

SFPG has developed specific enhancement measures for terrestrial wildlife as part of its site reclamation plan (Section 2.4.11). These measures are discussed for the No Action alternative and would be the same for the Proposed Action.

Aquatic Biology. Since the Proposed Action would not affect the South Fork of the Little Humboldt River, there would be no impacts to the Lahontan cutthroat trout.

Sedimentation and flow changes resulting from the Proposed Action would not affect the Humboldt River, which represents potential habitat for the California floater. If spills or leaks occurred during mining and postmining activities, potential water quality changes would be confined mainly to Rabbit and Kelly creeks. A major spill or leak from the mine area could possibly reach the Humboldt River only during high flow conditions. As discussed above, concentrations of any contaminants during high flow would be diluted due to relatively high water volume. A spill into the Humboldt River during transport of chemicals could possibly result in toxicity concerns in localized areas, but spill risks would be low. Therefore, impacts to the California floater, if present, would not be considered significant.

3.5.2.3 Other Project Alternatives

<u>Partial Vista Pit Backfill</u>

Terrestrial Wildlife. Potential impacts to wildlife from the Partial Vista Pit Backfill alternative would be the same as those discussed for the No Action alternative, Section 3.5.2.1.

Aquatic Biology. The partial backfilling of the Vista Pit could slightly reduce the amount of overburden and interburden that would be placed along Rabbit Creek which would minimize potential impacts on water quality in Rabbit and Kelly creeks. Potential impacts of sedimentation and contamination on aquatic invertebrates and nongame fish due to partial backfilling of the Vista Pit would be similar to the Proposed Action.

<u>Selective Handling of Overburden and Interburden Alternative</u>

Terrestrial Wildlife. Potential impacts to wildlife from the Selective Handling of Overburden and Interburden alternative would be the same as those discussed for the No Action alternative, Section 3.5.2.1.

Aquatic Biology. As discussed in Section 3.2.2.5, Water Resources, selective handling would achieve similar protection to water resources as the proposed materials handling plan. Therefore, potential impacts to aquatic resources for this alternative are anticipated to be the same as for the Proposed Action.

<u>Overburden and Interburden Storage Area Reclamation Alternatives</u>

Terrestrial Wildlife. Potential impacts to wildlife from alternative 1 of the overburden and interburden storage area alternatives would be the same as those discussed for the No Action alternative, Section 3.5.2.1. The alternative 2 postmining scenario would disturb 200 additional acres over that disturbed for the Proposed Action. Of these 200 acres, 17.4 acres would be mixed shrub and 26 acres would be seeded areas in the Bullhead Seeding pasture.

Aquatic Biology. The alternative 1 postmining topography scenario would have the same footprint as the Proposed Action, with rounded corners and increased height. The impact of this alternative on aquatic biota would be the same as discussed for the Proposed Action, since the new contours would not change potential effects on water quality.

The alternative 2 postmining topography scenario would disturb an additional 200 acres and be located closer to the Rabbit Creek diversion channel. The additional area of disturbance would contribute to increased sedimentation during runoff and locate increased amounts of overburden and interburden material closer to Rabbit Creek. Slight increases in sedimentation could occur in localized areas of Rabbit Creek due to this alternative. Macroinvertebrates and nongame fish populations in these streams could be affected by increased suspended sediment loads on a short term basis. Impacts would not be significant because of the short duration of impacts and the absence of game fish species. Macroinvertebrates and nongame fish would be affected by these water quality changes, as discussed in Section 3.5.2.1.

3.5.3 Cumulative Impacts

3.5.3.1 Terrestrial Wildlife

The cumulative impact area for wildlife resources extends from the Little Humboldt River to the north, Snowstorm Mountains to the east, the Humboldt River to the south, and the Osgood Mountains to the west. The cumulative impact analysis emphasized the regional resources and their susceptibility to the cumulative actions identified for this project. The analysis assumed that: (1) human use of the cumulative impact area will continue to increase with or without implementation of the Proposed Action, (2) wildlife habitats are currently at their respective carrying capacities, and (3) wildfire impacts have been detrimental to wildlife resources in the cumulative impact area. The reasonably foreseeable future actions analyzed for wildlife resources encompassed the anticipated activities by SFPG for the Twin Creeks Mine, in addition to the regional activities forecasted for the cumulative impact area, which includes mining, livestock grazing, and agriculture.

The range within the cumulative impact area has been previously degraded, including effects from wildfires, which have increased weed infestations and erosion, thereby lowering the relative range productivity. Combined with these factors, the regional mining activities have led to increased habitat loss and fragmentation; animal displacement; lowering of the habitats' carrying capacities; and increased human use, presence, and harassment of wildlife. All of these factors have also resulted in declining riparian values in the cumulative impact area.

Other cumulative impacts from these activities parallel those discussed for the Proposed Action. The increased number of roads from mine exploration improves access into remote areas. The work forces associated with the mining activity increase overall traffic levels in the region, in addition to increasing the employees' exposure to the area. This exposure typically results in additional use of the region, thereby increasing pressure on resident wildlife populations. Certain resources are more susceptible to impacts than others, such as riparian zones, seeps and springs, seasonal ranges, movement corridors, and active breeding sites (e.g., leks, raptor nests, brooding habitat). Impacts to high-profile species are proportional to the increase in human presence, land use and recreational demands, and other regional development. The location of these resources, relative to the duration of the human disturbance, is pertinent to the degree or level of anticipated cumulative impacts.

The current mining operations throughout the cumulative impact area continues to attract both resident and migratory birds to on-site water sources. The potential accessibility to toxic solutions associated with the mining activities could result in increased bird mortalities. However, the Nevada regulations currently protect wildlife from lethal solutions by mitigation requirements.

Potential cumulative effects to surface water availability and riparian vegetation from ground water drawdown from past, present, and future ground water withdrawal for mines and for agricultural purposes would generally parallel the impacts discussed for the Proposed Action. However, continued ground water withdrawal could potentially further reduce discharge in the Little Humboldt River, the Hot Springs area, and any other perennial surface water sources dependent on discharge from the regional ground water system. Additional seeps and springs may be affected, particularly in the Osgood Mountains (***Figure 3-38***). Significant impacts to terrestrial wildlife would likely occur under the cumulative drawdown at 100 years after the end of mining, since the drawdown contours would extend into the Kelly Creek and Jake Creek drainages, encompassing Jake Creek canyon (***Figure 3-39***). However, anticipated short- and long-term effects to wildlife resources would be the same as those discussed for the Proposed Action 100 years after mining, including potential reduction in habitat carrying capacities; habitat loss and degradation along the riparian corridors; and lower water availability for big game, upland game, nongame, and sensitive species.

The extent of the cumulative impacts from the ongoing mining operations within the cumulative impact area, the Proposed Action, and the other ground water withdrawals occurring in both the Kelly Creek basin and in Eden Valley are difficult to identify. Therefore, the long-term cumulative impacts to terrestrial wildlife resources from ground water drawdown are difficult to predict and cannot be quantified. Considering the increased area of drawdown, it is likely that these long-term impacts throughout the project region would be higher than those discussed for the Proposed Action alone.

As discussed in Section 3.5.1, Affected Environment, managing for maximum species diversity may actually decrease the natural biodiversity. For example, increasing the "edge" in an area often increases the species diversity or richness, but may attract opportunistic, "weedy" species that out-compete indigenous species at risk, affecting the integrity of the system. General principles outlined by the Council on Environmental Quality (1993) emphasize: ecosystem management, minimization of habitat fragmentation, native species, unique or ecologically important species and environments, natural processes, genetic diversity, flexibility, and monitoring for effects. If effects on biodiversity are to be adequately assessed, the analysis of impacts to the biological system must be conducted on an ecosystem or regional scale, taking into account cumulative impacts. Potential cumulative impacts to the regional biodiversity are based on the discussion of environmental consequences to terrestrial wildlife (Section 3.5.2). The additional impacts to available surface water from potential cumulative ground water effects could adversely impact the regional biodiversity, as discussed for the Proposed Action. Although these impacts cannot be quantified, it is important to note these potential long-term issues for the cumulative impact area.

Interrelated mining projects in the cumulative impact area that would be pertinent to the wildlife analysis include the mines occurring north of Interstate 80 and the Humboldt River (i.e., Getchell, Pinson, and Preble Mines). Of these three mines, Getchell and Pinson are currently active. It is assumed that these two mines, in addition to Twin Creek's current operations, transport hazardous materials along the same access corridor that would be used for the Proposed Action. The probability of a hazardous materials spill into the Humboldt River from the three active mines would be greater than that calculated for the Proposed Action. However, the probability is still estimated to be low, based on the frequency of material shipments. In the event that a hazardous material spill occurred, the adverse impacts to terrestrial organisms would be the same as those discussed for the Proposed Action.

3.5.3.2 Aquatic Biology

Interrelated mining projects that are located in the cumulative impact area include three in the Kelly Creek drainage (Getchell, Pinson, and Preble Mines) and five in the Humboldt River drainage (Lone Tree, Marigold, Trenton Canyon, Mule Canyon, and Phoenix Mines). Soil disturbance activities associated with the two active mines in the Kelly Creek drainage (Getchell and Pinson) would combine with the Twin Creeks Mine to increase sedimentation in Kelly Creek. Since the lower portion of Kelly Creek is intermittent, sediment effects would occur mainly during periods after storm events. No game fish species are present in lower Kelly Creek; therefore, impacts would be limited to speckled dace and macroinvertebrates. During high flow periods, these projects would contribute relatively small sediment loads to the Humboldt River. The five mines listed above also would increase sediment loads to the Humboldt River, especially the mines located in close proximity to the Humboldt River. Implementation of sediment control measures would be used to minimize sediment increases for all projects. It is expected that the warm water game fish present in the Humboldt River would be able to tolerate the short duration of increased sedimentation.

Potential spills or leaks from mining and postmining activities and transportation of chemicals could occur for any of the mines listed above. Impacts on aquatic communities would depend on the same factors discussed for the Twin Creeks Mine. Spills or leaks in the Kelly Creek drainage could affect macroinvertebrates and nongame fish species. Since the Twin Creeks, Getchell, and Pinson mines are located 10 to 20 miles from the Humboldt River, potential spill or leak effects on water quality in the Humboldt River would be considered minor. Spills or leaks from the mines near the Humboldt River could expose aquatic organisms to toxic concentrations. The

Twin Creeks Mine would not contribute to temperature increases in the Humboldt River, which is an issue for other mines.

Ground water withdrawals associated with mine dewatering and other third-party ground water withdrawals could potentially affect flows in several streams that eventually drain into the Humboldt River, and springs and seeps. Cumulative water use could further reduce flows in the Little Humboldt River, the Hot Springs area, and other perennial surface water sources dependent on discharge from the regional ground water system (possibly including Jake Creek). Potential flow reductions in Jake Creek due to cumulative ground water withdrawals would be similar to the Proposed Action. As shown in ***Figures 3-38*** and ***3-39***, the cumulative impact area (as defined by the 10-foot drawdown contour) would be expanded to include intermittent streams in the southern portion of Kelly Creek Valley. Collectively, ground water withdrawals also could potentially affect water levels in springs and seeps, some of which represent potential habitat for springsnails. Further loss of habitat for this group of invertebrates would reduce their distribution in the Great Basin.

3.5.3.3 Threatened, Endangered, or Sensitive Species

<u>Terrestrial Wildlife</u>

The cumulative impact area and impact assumptions for threatened, endangered, candidate, and BLM sensitive species were the same as those developed for general wildlife (Section 3.5.3.1). Predominant cumulative issues for sensitive species in the project region involve the incremental mining activities from historic, present, and future mine projects; increased human access and use of the area; increased potential for toxic effects through exposure to hazardous materials, such as sodium cyanide; and the drawdown of ground water levels, potentially impacting surface water availability and associated vegetation. Direct habitat loss within the cumulative effects area would involve the burrowing owl, loggerhead shrike, and pygmy rabbit. However, it is impossible to quantify the incremental habitat loss for these wide-ranging species, since they occur sporadically throughout the project region. Other sensitive species that may be affected by the development in the cumulative impact area would be those associated with the naturally occurring seeps, springs, and perennial streams that may be affected by the long-term water drawdown, as discussed for Terrestrial Wildlife in Section 3.5.3.1 and shown in ***Figures 3-38*** and ***3-39*** for the Proposed Action.

If higher elevational surface water sources were impacted by changes in ground water availability, breeding and foraging habitat for the northern goshawk could be adversely impacted. If decreasing water availability resulted in declining prey populations within the Kelly Creek basin, the ferruginous hawk and burrowing owl could be affected. Anticipated reductions in flow rates in the Little Humboldt River could limit potential breeding or foraging habitat for sensitive shorebirds, such as the white-faced ibis, black tern, or western least bittern. Declining open water and riparian vegetation would adversely affect foraging areas for area bat species. Overall, the primary concerns relative to sensitive species that occur in the cumulative effects area would be the potential long-term impacts to surface water availability, riparian vegetation, and other plant communities that may be tied to shallow ground water levels (e.g., greasewood).

<u>Aquatic Biology</u>

The Twin Creeks Mine would not contribute additional impacts to Lahontan cutthroat trout or California floater; therefore, the proposed project would not contribute to cumulative impacts to these species.

3.5.4 Monitoring and Mitigation Measures

3.5.4.1 Terrestrial Wildlife

As presented in Section 3.2.4, Water Quantity and Quality Monitoring and Mitigation Measures, SFPG would monitor pit lake water quality during mine reclamation and closure. The existing monitoring programs for potential wildlife mortalities associated with the current mining operations would be expanded to determine if additional mortalities or injuries are occurring. The cyanide solution ponds, heap leach facilities, and tailings facilities would be examined in accordance with the permit requirements.

TW-1: To protect sage grouse that may breed in the project area, active lek surveys would be conducted between March 1 and May 15 in areas proposed for disturbance that may support breeding grouse. Surveys would extend beyond any documented active lek, encompassing a 2-mile radius, if the disturbance area is considered suitable nesting or brooding habitat. SFPG would coordinate with the BLM regarding the delineation of these survey areas, since habitat is marginal throughout a majority of the project area. If an active lek is present, no construction activities would be allowed from 2 hours before dawn to 10:00 a.m. within 1 mile of the active lek between March 1 and May 15. In the event that an active nest site or brooding area is documented, mine construction would avoid directly impacting these areas. SFPG would coordinate with the BLM to establish appropriate buffer zones, if applicable.

TW-2: All recorded data from monitoring of potential wildlife mortalities would be submitted to the BLM and Nevada Division of Wildlife, in accordance with the State's regulations. If the solution ponds, heap leach pads, or tailings facilities cause increased wildlife mortalities, SFPG would consult with the BLM and Nevada Division of Wildlife to develop the appropriate protection measures to reduce or eliminate the problem.

TW-3: Baseline inventories would be conducted for naturally occurring seeps, springs, and perennial drainages. During these surveys, it would be determined whether the water sources currently support breeding amphibians (e.g., spotted frog) or other sensitive wildlife species. If significant impacts to riparian resources or sensitive species were identified, SFPG would coordinate with the BLM, U.S. Fish and Wildlife Service, and the Nevada Division of Wildlife to identify and implement appropriate mitigation measures. These measures could include identification of wetlands, springs, or perennial streams that could be reclaimed for wildlife use or areas where wetland areas may be created. Mitigation ratios for surface water effects would be based on a ratio of 1:1. Appropriate mitigation also may include on-site measures, such as placement of guzzlers or other wildlife watering devices, as deemed adequate by the BLM, or fencing (including maintenance) of portions of water sources in the project area to improve relative habitat quality.

TW-4: As described in WR-4 (Section 3.2.4), a hydrologic data collection and evaluation program (including additional numerical flow modeling, if necessary) would be used to further define segments of Jake Creek that could be affected by mine-induced drawdown. If the results of this study indicate that the mine-induced drawdown could reduce flows in Jake Creek, a mitigation plan would be established to offset predicted future adverse impacts to terrestrial wildlife resources. Mitigation may include water augmentation measures outlined in WR-5 (Section 3.2.4) or other appropriate habitat enhancement programs. The BLM and the State of Nevada would be responsible for determining site-specific mitigation measures for potential loss of habitat and water availability to wildlife along Jake Creek.

TW-5: New electrical spur lines would be constructed to meet the raptor protection design requirements identified by Olendorff et al. (1981).

3.5.4.2 Aquatic Biology

AB-1: Uncertainties concerning the impacts of dewatering on trout populations in Jake Creek exist; therefore, a hydrologic data collection and evaluation program would be performed as described in WR-4 (Section 3.2.4) to define the interconnection between Jake Creek and the regional ground water aquifer system. If the results of this study determine that the flows in Jake Creek could be reduced as a result of mine-induced drawdown, then the numerical model would be modified accordingly and rerun to predict the magnitude of change that could potentially occur during the postclosure period (see WR-4). The results of the revised numerical model would be used to identify areas along Jake Creek that could be potentially impacted. An aquatic survey would be conducted to establish baseline populations and habitat conditions along potentially affected segments of Jake Creek. The scope of the aquatic survey would be determined in conjunction with the Nevada Division of Wildlife. If the results of the survey indicate that predicted flow reductions could affect important seasonal or yearlong trout habitat, (i.e. spawning, juvenile rearing, and pools for adults), a mitigation plan would be established to offset any predicted future impact to the fishery. Mitigation for predicted effects would be performed prior to final closure of the mine. Mitigation may include measures outlined in WR-5 (Section 3.2.4) or habitat enhancement and/or stocking programs in another trout stream, such as Kelly Creek. The BLM and the State of Nevada would be responsible for determining the location of habitat enhancement and/or stocking.

AB-2: A hydrological baseline inventory would be conducted in springs, as discussed in WR-3. Potential impacts of dewatering on possible springsnail habitat would be determined by conducting a springsnail survey in springs within areas potentially impacted by ground water drawdown. Emphasis would be placed on any springs with the following characteristics: relatively high discharges (greater than 15 gallons per minute), well defined channels, riparian vegetation, and dense aquatic vegetation. If springsnails are found in any of the springs potentially affected by dewatering, habitat restoration, or supplemental water supplied to the spring(s) would be considered as mitigation, as discussed in WR-4. If habitat restoration or water supplementation are not practicable, snails would be relocated to suitable habitat in unaffected springs. These springs would be fenced to provide protection from livestock.

AB-3: Construction activities with the potential to contribute sediment to Kelly Creek and the Humboldt River would follow required measures to reduce sedimentation. These measures are discussed in Section 3.2.4 (Water Quantity and Quality).

3.5.4.3 Threatened, Endangered, or Sensitive Species

Terrestrial Wildlife

No additional mitigation measures or monitoring recommendations have been developed for threatened, endangered, or other sensitive species beyond those presented for Terrestrial Wildlife (Section 3.5.4.1).

Aquatic Biology

No mitigation measures are required for the Lahontan cutthroat trout or California floater since populations do not occur in areas to be affected by construction and operation. Implementation of the Comprehensive Spill Response Plan would minimize long-term effects on historic habitat for the California floater in the Humboldt River.

3.5.5 Residual Adverse Effects

3.5.5.1 Terrestrial Wildlife

Primary residual impacts to terrestrial wildlife would include the: (1) long-term loss of 826 acres of unreclaimed acres (i.e., the pits) for the Proposed Action; (2) potential long-term effects to water availability and habitat for terrestrial wildlife from mine-induced lowering of the water table; and (3) potential toxic effects to wildlife from elevated levels of antimony in the pit lake after mine closure. Other residual impacts would include animal displacement, increased human presence, and potential wildlife mortalities associated with the spill of hazardous materials along the transportation corridor for the life of the project.

3.5.5.2 Aquatic Biology

If significant impacts occur in Jake Creek or springs containing springsnails, residual adverse effects may result from the Proposed Action. The impact of a chemical spill into the Humboldt River during material transport would not represent a residual effect. If toxic conditions existed in a localized area, the duration of the impact would be short term. Aquatic organisms would recolonize the affected area after toxic conditions subside.

3.5.5.3 Threatened, Endangered, or Sensitive Species.

Terrestrial Wildlife

Residual impacts to sensitive terrestrial wildlife species would include the short-and long-term habitat loss for the western burrowing owl, loggerhead shrike, and pygmy rabbit. Declining ground water levels may result in: (1) reduced prey availability for the ferruginous hawk and burrowing owl; (2) decreased breeding or foraging habitat for the white-faced ibis, black tern, and western least bittern along the Little Humboldt River; and (3) reduced foraging habitat for sensitive bat species.

Aquatic Biology

Since Lahontan cutthroat trout and California floater would not be affected in the area of proposed construction and mining operations, there would be no residual adverse effects on these species. In addition, residual adverse effects would not exist for historic California floater habitat in the Humboldt River, as discussed in Section 3.5.5.2.

3.6 Range Resources

3.6.1 Affected Environment

3.6.1.1 Regional Study Area

The proposed project involves a combination of public and private lands located almost entirely within the Bullhead grazing allotment administered by the BLM. This allotment encompasses 170,456 acres in Humboldt and Elko Counties; it is managed jointly by the Winnemucca and Elko BLM District Offices. All of the range resources directly or indirectly affected by the proposed project lie within Humboldt County and within the Paradise-Denio Resource Area of the Winnemucca District of the BLM. Within the Winnemucca District, the Bullhead allotment covers 89,757 acres of BLM-administered public lands and 18,450 acres of private lands. The grazing permittee for the entire allotment is the Nevada First Corporation of Winnemucca, Nevada, which uses the allotment for cattle grazing. The allotment also provides forage for wild horses, mule deer, pronghorn, and bighorn sheep.

Approximately 418 acres in the southwest corner of the proposed project (Section 36, Township 39 North, Range 42 East) are on public land in the adjoining Osgood allotment for which the Christensen Ranch is the only permittee. Similarly, another small portion of the project is proposed for Section 15, Township 38 North, Range 43 East, which lies on private land in the Jake Creek allotment with grazing leased to the Hammond Ranch. Because the disturbance areas in the Osgood and Jake Creek allotments represent very small percentages of these allotments and occur adjacent to the allotment boundaries, they are not expected to create significant impacts on management of the allotments. Therefore, most of the following discussion will focus on the Bullhead allotment where the majority of impacts would occur.

Grazing on the Bullhead allotment has been conducted under provisions of the Paradise-Denio Management Framework Plan of July 1982 (BLM 1982), which was prepared subsequent to the Paradise-Denio Environmental Impact Statement of September 1981 (BLM 1981b). An updated allotment management plan was approved on April 4, 1985 (BLM 1985b). Under this management framework, the Total Grazing Preference for the allotment is 19,283 animal unit months on the public lands within the allotment. An animal unit month represents the quantity of forage necessary to sustain a cow and calf combination for one month. An additional 1,051 animal unit months are available on the private lands within the allotment boundary, but are not included in the allotment plans. ***Table 3-28*** shows the status of grazing preference on the public lands within the allotment.

TABLE 3-28
Bullhead Grazing Allotment Grazing Preference

Grazing Preference	Animal Unit Months
Total Preference	19,283
Suspended Preference	7,233
Active Preference	12,050
Temporary Non-use	3,700
Available Use	8,350

Under the allotment management plan in effect through 1994, the Nevada First Corporation is licensed for a cattle operation only. For the use period beginning April 1 of each year and continuing through September 30, the permittee may graze 1,000 head of cattle on BLM-administered lands and utilize a maximum of 5,475 animal unit months. For the use period beginning October 1 of each year and continuing through December 15, the permittee may graze 1,284 head of cattle on BLM-administered lands and utilize a maximum of 2,874 animal unit months.

Monitoring data collected over the past several years indicate that a number of areas in the allotment, especially streambank riparian, wetland riparian, and aspen habitats, have been receiving heavy to severe use, and the vegetation utilization objectives are not being met. Therefore, the BLM conducted an evaluation of grazing management on the allotment and issued a Final Multiple Use Decision for the Bullhead Allotment (BLM 1994a) to correct this pattern of overutilization. This revision of the grazing management plan involves a reduction of the Active Grazing Preference for livestock from 12,050 animal unit months to 4,600 animal unit months over a 5-year period.

The Final Multiple Use Decision also identifies specific forage allocations (in terms of animal unit months of use) for wild horses (1,680), mule deer (1,029), pronghorn (101), and bighorn sheep (190). The allocation for wild horses represents a reduction from the consumption level of the 1994 population, while the numbers for big game represent no changes from 1994 conditions but are substantially higher than the 48 animal unit months allocated to big game in the 1981 EIS (BLM 1981b). The Final Multiple Use Decision is currently under appeal to the Office of Hearings and Appeals.

The Bullhead allotment is subdivided into eight management pastures plus the Bullhead Seeding, which serves as a holding area (***Figure 3-48***). Three of the pastures (First Creek, Kinney, and Snowstorm) are further split under current management plans into east and west or north and south components. Under terms of the Final Multiple Use Decision, these pastures are managed in a seasonal, rest rotation program that takes into account topography and elevation factors, availability of water sources, range condition and species composition, range improvement objectives for wetlands and riparian areas, and wildlife and wild horse management objectives.

The Final Multiple Use Decision (BLM 1994a) addresses the failure of the previous allotment management program to meet the multiple-use objectives for the allotment. The BLM's analysis of utilization and use pattern mapping on the allotment determined that livestock use was the primary factor in the nonachievement of the multiple-use objectives in the summer pastures, and livestock and wild horses were the primary factors inhibiting achievement of the multiple-use objectives in the spring pastures. The management approach outlined in the Final Multiple Use Decision is intended to protect and improve the range condition in those areas of the allotment exhibiting heavy and severe use, improve stream habitat conditions, improve the water quality ofthe South Fork of the Little Humboldt River, and ensure the sustained forage production for a combination of livestock, wild horse, and wildlife use.

In order to achieve these multiple-use objectives, the BLM has determined that it is necessary to reduce by 45 percent the active preference for livestock grazing in the allotment. This phased reduction is illustrated in ***Table 3-29*** which presents the scheduled animal unit months of livestock use for each pasture from 1995 through 2000.

In addition to this livestock usage of the various pastures, the BLM plans to manage the allotment to accommodate a wild horse herd of 140 adult animals in the Snowstorm Herd Management Area. The proposed allocation of horses by pasture is as follows: First Creek - 59; Castle Ridge - 34; and Dry Hills 47. The excess of wild horses on the allotment (the 1993 total adult horse population was estimated at 238 animals) are being removed to achieve the desired population number.

Wild horse usage in the vicinity of the Twin Creeks Mine occurs primarily north and west of the existing mine operations and proposed expansion area, which are located outside the Snowstorm Herd Management Area (***Figure 3-48***). Wild horses use the Dry Hills and Rabbit pastures outside of the Snowstorm Herd Management Area boundary. A gather of wild horses was conducted in October 1994 that resulted in a population of 120 to 130 horses remaining in the Snowstorm Herd Management Area. A census taken in September 1995 counted 176 horses in the management area, of which 30 were in the Dry Hills pasture and 10 were in the Rabbit pasture.

Wildlife populations are not considered to be a contributing factor in the failure to achieve multiple-use objectives for the allotment; consequently, no changes in wildlife usage of the allotment are anticipated. The Final Multiple Use Decision presents expected usage levels for wildlife of 1,029 animal unit months for mule deer, 101 animal unit months for pronghorn, and 190 animal unit months for bighorn sheep.

3.6.1.2 Project Study Area

Existing mine operations have disturbed approximately 3,182 acres of public lands and 1,912 acres of private lands within the Rabbit, Dry Hills, and Bullhead seeding pastures of the Bullhead allotment as of December 31, 1994. The distribution of this existing disturbance by management pasture is shown in ***Table 3-30***.

The Rabbit pasture, being at the lowest elevation within the allotment and easily accessible, has been and will continue to be used primarily for winter grazing. The pasture is approximately 18,820 acres in size. The Dry Hills pasture,

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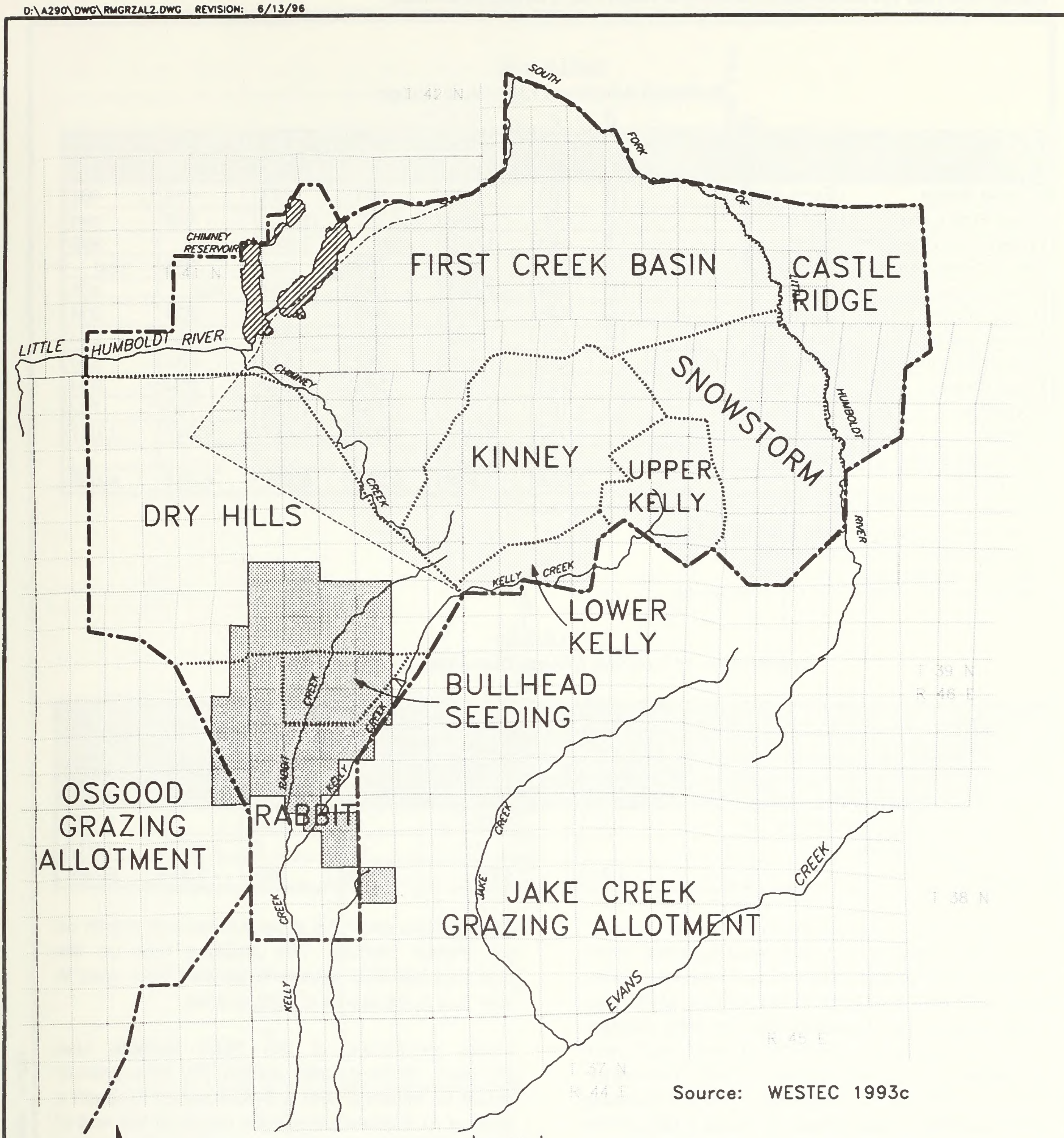


Legend

- Grazing Allotment Boundary
- Pasture Boundary
- Snowstorm Mountains Wild Horse Herd Management Area
- Twin Creek Mine Permit Area

Twin Creeks Mine

Figure 3-48

Bullhead Grazing Allotment

TABLE 3-29
Bullhead Allotment Livestock Usage

Pasture	Season[1]	Animal Unit Months of Use					
		1995	1996	1997	1998	1999	2000
Castle Ridge	Early Spring	898	898	683	683	469	469
East First Creek	Spring	1,606	rest	1,292	rest	980	rest
West First Creek	Spring	rest	1,606	rest	1,292	rest	980
North Snowstorm	Spring	1,021	rest	708	rest	395	rest
West Kinney	Spring	rest	1,021	rest	708	rest	406
Lower Kelly	Summer	448	448	342	342	234	234
Upper Kelly	Summer	448	448	342	342	234	234
South Snowstorm	Summer	448	448	342	342	234	234
East Kinney	Summer	448	448	342	342	234	234
Dry Hills	Winter	1,184	1,184	1,184	1,184	767	767
Rabbit	Winter	1,047	1,047	1,047	1,047	1,047	1,047
Bullhead Seeding	Holding	-	-	-	-	-	-
TOTALS		**7,548**	**7,548**	**6,282**	**6,282**	**4,594**	**4,605**

[1]Season:
Early spring season = March 1 to March 31
Spring season = April 1 to June 30
Summer season = July 1 to August 31
Winter season = November 1 to February 28

TABLE 3-30
Distribution of Existing Mining Disturbance by Pasture

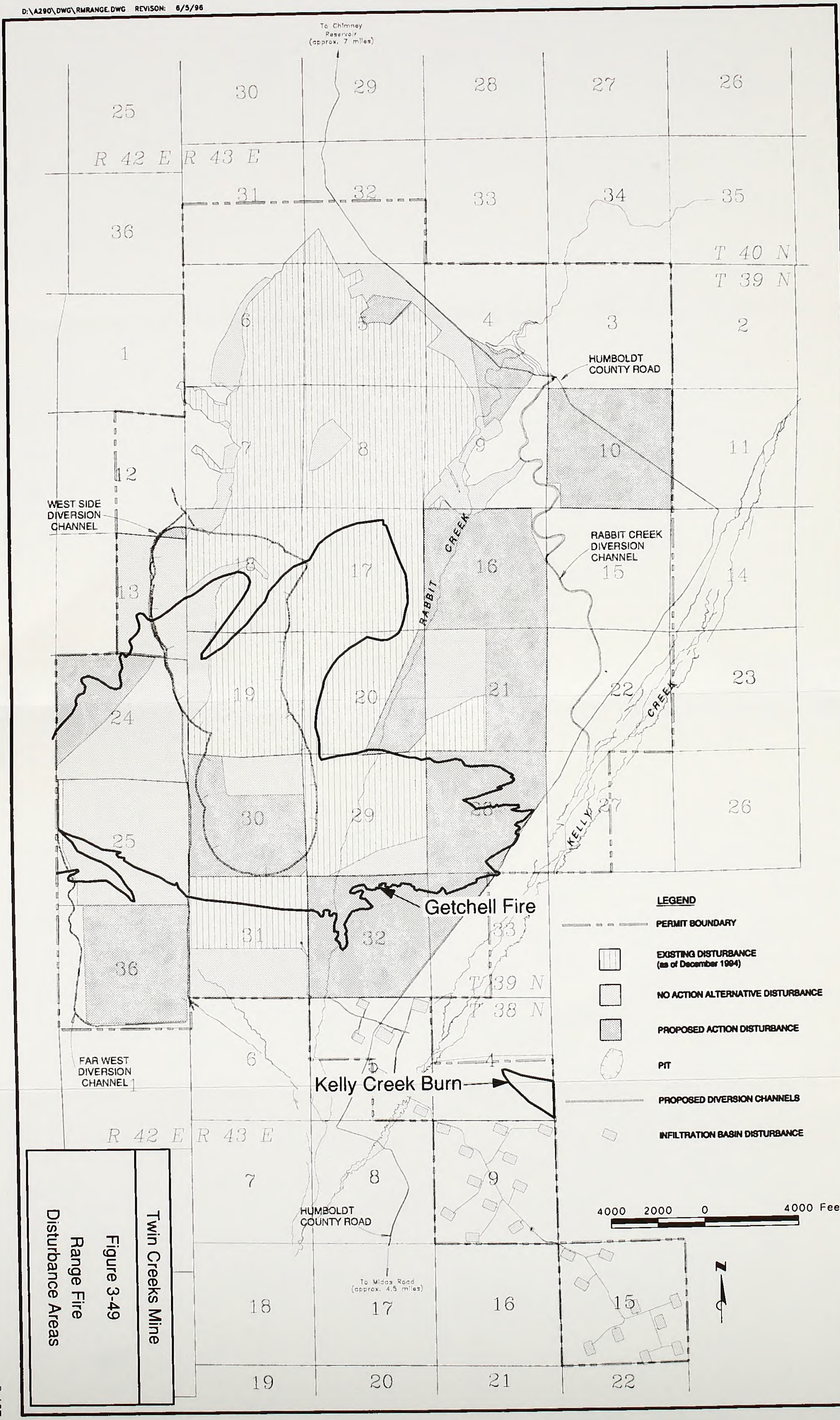
Mine Component	Acreage of Disturbance					
	Dry Hills Pasture	Bullhead Seeding Pasture		Rabbit Pasture		Totals
	Public	Public	Private	Public	Private	
Former Chimney Creek Mine	1,911	778	0	493	0	3,182
Former Rabbit Creek Mine	0	0	434	0	1,478	1,912
TOTALS	**1,911**	**778**	**434**	**493**	**1,478**	**5,094**

encompassing approximately 41,890 acres, has been used as a spring grazing area (April through June) in a two pasture rest rotation system along with the First Creek basin pasture. Under the Final Multiple Use Decision, the Dry Hills pasture joins the Rabbit pasture in being used each year for winter grazing (November through February). The Bullhead Seeding, encompassing approximately 3,840 acres, of which 2,080 acres have been seeded, has been and will continue to be used as a holding pasture to facilitate livestock movements to and from winter and spring use areas.

Stocking rates in 1995 on these potentially affected pastures (after adjustment of the available acreages to correct for the current areas of mine disturbance) were approximately 33.6 acres/animal unit month on the Dry Hills pasture and 17.5 acres/animal unit month on the Rabbit pasture. The stocking rate on the Bullhead Seeding pasture is variable from year to year due to its use as a holding area.

Under provisions of the Final Multiple Use Decision, stocking rates on the Dry Hills pasture would be modified over a 5-year period to reach a level of 51.9 acres/animal unit month at the end of this period. No changes are planned in the Rabbit pasture stocking rate.

The proposed mine expansion includes areas affected by range fires during the past decade (***Figure 3-49***). The Getchell fire in May 1985 started southwest of the current Twin Creeks Mine and burned approximately 4,592 acres, including approximately 2,324 acres of BLM-administered lands (BLM 1985b). The burned area includes a



Twin Creeks Mine

Figure 3-49
Range Fire
Disturbance Areas

sizable portion of the existing mine and proposed expansion area. A second fire, the Kelly Creek fire, occurred southeast of the project area in July 1988. The burned area extends from the point of ignition in Section 4, Township 38 North, Range 43 East eastward to Jake Creek and encompasses approximately 2,000 acres. Most of this burn, however, lies outside the expected area of impact from the Proposed Action.

Existing range improvements on the three affected pastures of the Bullhead allotment include fences around each of the pastures, three small stock ponds in the Dry Hills pasture to capture ephemeral runoff, and a well in SWSW Section 9, Township 39 North, Range 43 East, owned by Nevada First Corporation, that originally provided stock water to troughs in both the Bullhead seeding and Rabbit pastures. This well and pipeline system have been impacted by the existing mining operation, but replacement water has been provided in the Rabbit pasture by the mine dewatering discharge stream.

3.6.2 Environmental Consequences

Impacts to range resources would be considered significant if the Proposed Action, No Action alternative, or other project alternatives result in any of the following:

- Disturbance of grazing areas sufficient to result in a temporary forage loss (during the life of the mine) of 25 percent or greater, or a long-term forage loss (exceeding the life of the mine plus the reclamation period) of 10 percent or greater on one or more of the management pastures on the allotment

- Loss of key grazing areas (e.g., Bullhead seeding) that would necessitate major revisions in the grazing management approach for the remainder of the allotment

- Excessive grazing pressures on local plant communities or areas (greater than 100 acres) that would lead to irreparable degradation of the range resource in terms of plant community composition or productivity

- Loss of stock water sources in one or more pastures necessitating water haulage or nonusage of these areas

Additional range impacts that could result from the proposed expansion of mining operations include increased mortality of livestock from vehicle collisions and increased frequency of range gates being left open allowing livestock to stray from designated pastures.

Livestock/vehicle collisions are most frequent on the paved section of roadway leading from Golconda to the Twin Creeks Mine and other mines in the area. As a matter of mine policy, collisions associated with Twin Creeks Mine vehicles are reported to the mine and damages are paid to the livestock owner. Drivers of private vehicles are individually liable for damages to livestock under provisions of state law. Livestock/vehicle collisions have not been frequent in the mine vicinity and the proposed mine expansion is not expected to result in a significant increase in vehicle trips to and from the mine, therefore, significant increases in livestock/vehicle collisions are not expected.

Most mine traffic enters and leaves the mine area through the security gate; a cattle guard is used at this access point to exclude livestock. Secondary access points to the mine are accompanied by locked steel gates to control and minimize vehicle traffic while excluding livestock. The Twin Creeks Mine policy for employees and contractors working in outlying areas dictates that range gates should be left as found unless signs are posted specifying that the gate should be left open or closed. Therefore, it does not appear likely that the proposed mine expansion activities would result in significant increases in stray livestock incidents.

There would be no impacts to wild horses in the Snowstorm Herd Management Area. Impacts to wild horses in the Dry Hills and Rabbit pastures outside of the management area would be similar to the impacts to terrestrial wildlife described in Section 3.5, Wildlife and Fisheries Resources. If the proposed Kelly Creek Spring fence is built, it would divide the Dry Hills pasture and bring the wild horse use area closer to the actual Snowstorm Herd Management Area boundary. Any horses south of the fence, within the proposed mine expansion area, would be gathered at the next removal following fence construction. No wild horses would remain in the project area following the removal; therefore, there would be no subsequent impacts to wild horses.

3.6.2.1 No Action Alternative

Disturbance of Available Grazing Areas/Loss of Key Grazing Areas

The No Action alternative would involve additional expansion of mine pits and overburden and interburden storage areas, process facilities, and ancillary facilities on public grazing lands administered by the BLM as shown in ***Table 3-31***. ***Figure 3-50*** shows the distribution of these affected areas with respect to the Dry Hills, Rabbit, and Bullhead Seeding pastures. This alternative would disturb approximately 850 acres of additional public lands beyond the existing mine disturbance. Approximately 71 percent (607 acres) of this additional disturbance would occur in the Rabbit pasture. The projected acreages of disturbance for the Dry Hills (239 acres) and Rabbit (607 acres) pastures equate to approximately 1 percent and 3 percent of these pastures, respectively. These acreages of disturbance do not exceed the significance criteria outlined above, and no key grazing areas are included in the projected disturbance areas. Therefore, the No Action alternative would have no significant impacts on grazing areas.

Increase in Grazing Pressure

The disturbances outlined above would lead to increased grazing pressures on the remaining areas in both the Dry Hills and Rabbit pastures during the winter use period. However, the increased grazing pressure would not result in irreparable degradation of the range resource and would not be a significant impact.

Loss of Stock Water Sources

Existing mine activities have removed the primary historic stock watering sources in the Dry Hills, Bullhead Seeding, and Rabbit pastures (e.g., the well in Section 9, Township 39 North, Range 43 East, and associated pipelines and tanks). This impact is currently being mitigated through discharge of dewatering water from the mine into the Rabbit Creek drainage and by the mine supplying water to various livestock watering troughs around the facilities. Such discharges are expected to continue through the life of the mining operation. The absence of reliable livestock watering sources in these pastures following mining would be considered a significant impact to livestock grazing in the allotment. At this time, SFPG, the BLM, and the grazing permittee have not finalized plans for providing livestock water sources following mining. Subject to regulatory approval, it may be practical to convert one or more of the mine dewatering wells to this purpose following mining.

3.6.2.2 Proposed Action

Disturbance of Available Grazing Areas/Loss of Key Grazing Areas

The Proposed Action would involve creation or expansion of mine pits, overburden and interburden storage areas, tailings impoundments, leach pads, and drainage channels on public grazing lands administered by the BLM as shown in ***Table 3-32***. ***Figure 3-50*** shows the distribution of these affected areas with respect to the Dry Hills, Rabbit, and Bullhead Seeding pastures. The Proposed Action would remove a total of approximately 5,138 acres of currently available public rangeland in the Bullhead allotment and 418 acres in the Osgood allotment. Approximately 43 percent of the disturbance in the Bullhead allotment would be in the Rabbit pasture, about 31 percent in the Bullhead Seeding, and 26 percent in the Dry Hills pasture. While the expected acreages of disturbance from the Proposed Action in the Dry Hills pasture and Rabbit pasture constitute relatively small percentages of these pastures (approximately 3 percent and 15 percent, respectively), the expected disturbance and excluded area in the Bullhead Seeding (1,603 acres) would affect over 40 percent of this pasture with the majority occurring on the seeded portion of the pasture (see Section 3.4.2.2).

The projected disturbance and excluded area of 1,603 acres in the Bullhead Seeding would compromise this area in terms of its current function as a grazing resource and as a holding pasture to facilitate live stock movements to and from winter and spring use areas. Representatives of Nevada First Corporation (the grazing permittee) indicated that the Bullhead Seeding has historically provided some of the best grazing in the lower elevation portions of the allotment (Bengochea and Echevarria 1995). The loss of this grazing resource and the associated ability to use this pasture as a holding area would be a significant impact.

TABLE 3-31
Distribution of Public Lands on Bullhead Allotment
Affected by the No Action Alternative

Project Component	Location	Affected Acreage by Pasture			
		Dry Hills	Rabbit	Bullhead Seeding	Totals
Open Pits					
Vista Pit	Sec. 6 & 7, T39N, R43E	51			51
South Pit	Sec. 18 & 30, T39N, R43E		117		117
South Pit	Sec. 12, T39N, R42E				0
South Pit	Sec. 17 & 20, T39N, R43E				0
Overburden/Interburden Storage Areas					
A	Sec. 16, T39N, R43E				0
B	Sec. 20, T39N, R43E				0
C	Sec. 21, T39N, R43E				0
D	Sec. 28, T39N, R43E				0
I	Sec. 24, T39N, R42E		371		371
I	Sec. 32, T39N, R43E				0
J	Sec. 31 & 32, T40N, R43E and Sec. 5 & 6, T39N, R43E				0
D	Sec. 8, T39N, R43E				0
Limestone Stockpile	Sec. 5 & 6, T39N, R43E	64			64
Process Facilities	Sec. 8, T39N, R43E	21			21
Tailings Storage Areas					
A	Sec. 4 & 9, T39N, R43E	52			52
B	Sec 10, T39N, R43E				0
Leach Pads					
A	Sec. 36, T39N, R42E				0
D	Sec. 8, T39N, R43E				0
Drainage Diversion Channels					0
Ponds					0
Ancillary Facilities					0
Exploration Activities	(100 acres total)[1]	25	75		100
Well Pads/Pipelines	(40 acres total)[1]	12	24	4	40
Access/Haul Roads	(34 acres total)[1]	14	20		34
TOTALS		**239**	**607**	**4**	**850**

[1]Acreage distribution by pasture based on SFPG estimation.

TABLE 3-32
Distribution of Public Lands on Bullhead Allotment Affected by the Proposed Action

Project Component	Location	Affected Acreage by Pasture			
		Dry Hills	Rabbit	Bullhead Seeding	Totals
Open Pits					
Vista Pit	Sec. 6 & 7, T39N, R43E				0
South Pit	Sec. 18 & 30, T39N, R43E		614		614
South Pit	Sec. 12, T39N, R42E	10			10
South Pit	Sec. 17 & 20, T39N, R43E			5	5
Overburden/Interburden Storage Areas					
A	Sec. 16, T39N, R43E			624	624
A	Sec. 20, T39N, R43E			186	186
G	Sec. 2[illegible], T39N, R43E			321	321
A	Sec. 28, T39N, R43E		526		526
G	Sec. 30, T39N, R43E		52		52
H	Sec. 24, T39N, R42E		235		235
A	Sec. 32, T39N, R43E		605		605
J	Sec. 31 & 32, T40N, R43E and Sec. 5 & 6, T39N, R43E	7			7
A	Sec. 5, T39N, R43E	50			90
Limestone Stockpile	Sec. 5 & 6, T39N, R43E				0
Process Facilities	Sec. 5, T39N, R43E				0
Tailings Storage Areas					
A	Sec. 4 & 9, T39N, R43E	297			297
A	Sec 10, T39N, R43E	626			626
Leach Pads					
A[1]	Sec. 36, T39N, R42E		98		98
C	Sec. 30, T39N, R43E		53		53
D	Sec. 5, T39N, R43E	55			55
Drainage Diversion Channels	Rabbit Creek Diversion[2]	38		32	70
	West Side Diversion[2]		14		14
Undisturbed Area Excluded by Rabbit Creek Diversion Fence	Secs.9, 10, 15, and 22, T29N, R43E	255		435	690
Ponds					0
Ancillary Facilities					0
Exploration Activities					0
Well Pads/Pipelines					0
Access/Haul Roads					0
TOTALS		**1,338**	**2,197**	**1,603**	**5,138**

[1]An additional 405 acres of disturbance associated with leach pad A would occur in the adjoining Osgood grazing allotment southwest in Sections 25 and 36, Township 39 North, Range 42 East under the Proposed Action.

[2]An additional 13 acres of disturbance associated with the Far West Diversion would occur in the adjoining Osgood grazing allotment in Sections 25 and 36, Township 39 North, Range 42 East under the Proposed Action.

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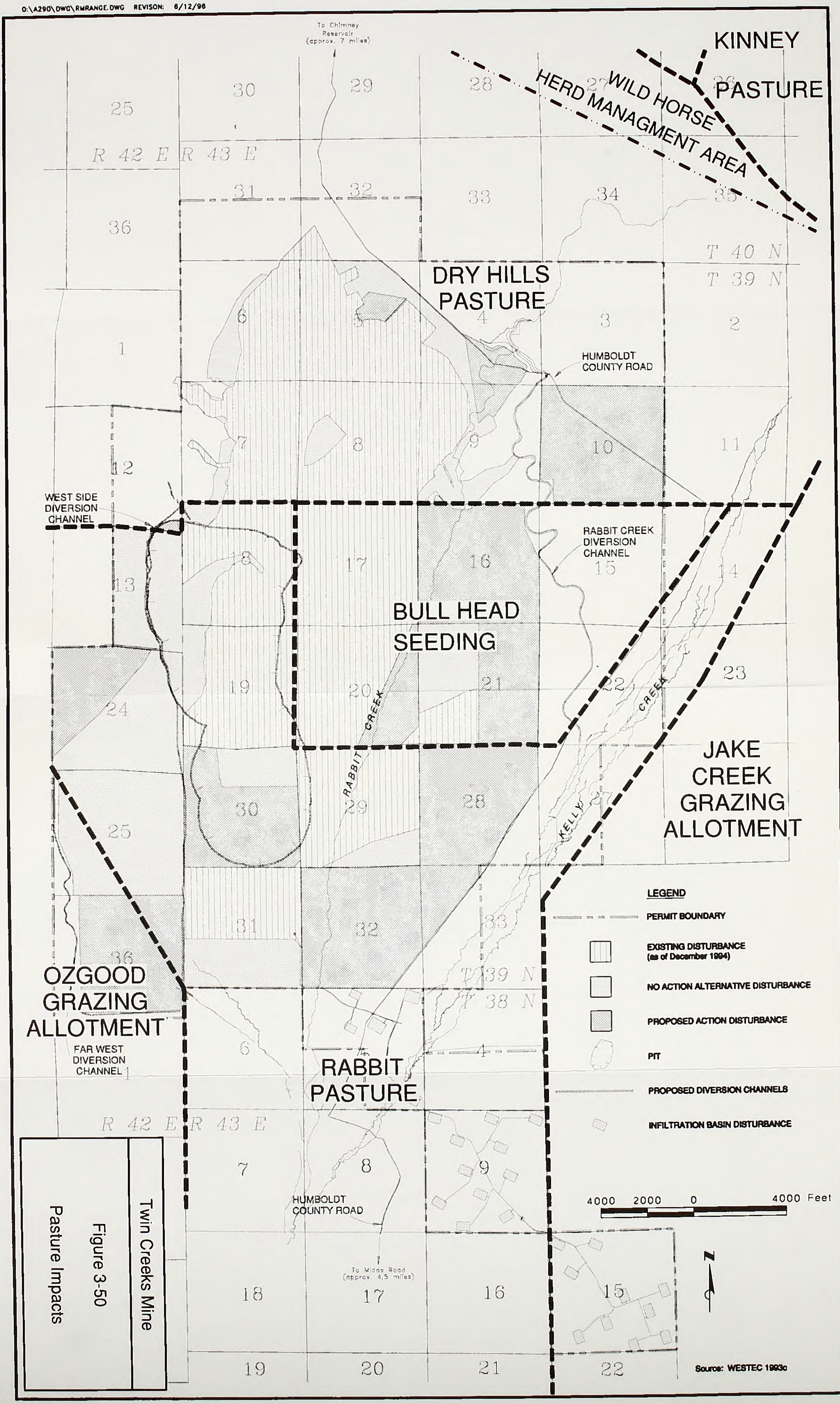


Twin Creeks Mine

Figure 3-50

Pasture Impacts

Increase In Grazing Pressure

The projected mine disturbances in the Dry Hills and Rabbit pastures would lead to corresponding increases in grazing pressures in the remaining areas in these pastures during the winter use period; however, the estimated levels of displaced use (approximately 3 and 15 percent, respectively) during this period are not expected to result in significant degradation of the range resources involved and would not be a significant impact.

Loss of Stock Water Sources

The loss of livestock watering sources associated with the Proposed Action would be similar to that discussed above for the No Action alternative, except that mine operations within the Bullhead Seeding would preclude livestock access from the Rabbit Creek drainage and any associated water flow. The proposed Rabbit Creek Diversion may provide water access in this pasture under similar flow conditions, but is not expected to provide a permanent, reliable livestock watering source.

The absence of reliable livestock watering sources in these pastures following mining would be considered a significant impact to livestock grazing in the allotment. At this time, SFPG, the BLM, and the grazing permittee have not finalized plans for providing livestock water sources following mining. Subject to regulatory approval, it may be practical to convert one or more of the mine dewatering wells to this purpose following mining.

3.6.2.3 Other Project Alternatives

Partial Vista Pit Backfill Alternative

This alternative is not expected to result in a change from the Proposed Action in the overall acreage of surface disturbance and would result in impacts to range resources similar to the Proposed Action.

Selective Handling of Overburden and Interburden Alternative

Separate handling and placement of acid-generating material would not result in any changes to the extent and distribution of disturbance to grazing resources, and is not expected to result in any change in reclamation success on these overburden and interburden storage areas.

Overburden and Interburden Storage Area Reclamation Alternatives

Alternative 1 would not change the extent or distribution of surface disturbance from the Proposed Action and, therefore, would have similar impacts on range resources. Alternative 2 would result in approximately 200 acres of additional surface disturbance in Sections 15, 22, and 27, Township 39 North, Range 43 East to accommodate the desired reconfiguration of the storage facility. The majority of this disturbance (about 66 percent) would occur on private lands in Sections 22 and 27, including lands not owned by SFPG, with the remaining 34 percent occurring in Section 15. This entire area is currently managed as part of the Bullhead Seeding. Most of this increased disturbance area would occur within the grazing exclusion area associated with the proposed fencing of the Rabbit Creek Diversion channel. Therefore, this alternative would contribute to the significant impacts already described under the Proposed Action, but would not create any new significant impacts.

3.6.3 Cumulative Impacts

Cumulative impacts were evaluated with respect to the grazing resources and management of the Bullhead allotment. On this basis, the primary other activities contributing to cumulative impacts are the past and ongoing mining operations at the Twin Creeks Mine and its predecessor operations (the former Chimney Creek and Rabbit Creek Mines). Reasonably foreseeable future actions within this cumulative impacts area primarily relate to potential expansion activities at the Twin Creeks Mine as outlined in Section 2.6.2.1.

According to BLM records, development of the former Chimney Creek Mine resulted in the removal of an estimated 6,000 acres of public grazing land, with an approximate forage loss of 250 animal unit months. This removal was confined primarily to the Dry Hills pasture. The BLM estimates that development of the former Rabbit Creek Mine resulted in the fencing of approximately 2,000 acres of private grazing land contained in the Rabbit and Bullhead Seeding pastures.

Development of both former operations affected livestock management and the range resources on both public and private lands in the southern portion of the Dry Hills pasture, the Rabbit pasture, and the Bullhead Seeding pasture. Additional disturbances discussed above for the Proposed Action would bring the total affected public lands (including area excluded by fencing) to approximately 9,588 acres in these three pastures, or about 15 percent of their total. While the historic loss of grazing resources on the Dry Hills and Rabbit pastures, combined with the expected acreage to be impacted by the Proposed Action, are not considered to be a significant cumulative impact, the cumulative losses occurring in the Bullhead Seeding pasture, represent a significant cumulative impact to the range resources and management of this pasture.

Along with the loss of forage and grazing areas, the mining operations have impacted the distribution and availability of livestock watering sources as the original well and pipeline distribution system was removed from Section 9, Township 39 North, Range 43 East. Proposed and potential future operations would contribute to additional impacts associated with stock water availability and distribution through drainage alterations and elimination of small impoundments. This loss of livestock watering sources in the Dry Hills, Rabbit, and Bullhead Seeding pastures is a significant cumulative impact.

3.6.4 Monitoring and Mitigation Measures

Both the former Chimney Creek and Rabbit Creek Mines have provided alternate livestock watering sources from mine dewatering discharge and have assisted in the improvement of existing water sources, which has improved livestock distribution in the general mine area.

SFPG and Nevada First Corporation have evaluated and agreed upon a number of voluntary mitigation measures to offset the expected grazing impacts from the Proposed Action (Resource Concepts, Inc. 1995). These mitigation measures include the following components:

- Fencing of project facilities to minimize interference with ranching operations, including construction of a new fence southwesterly from Kelly Creek Spring to meet the relocated county road in NE Section 4, Township 39 North, Range 43 East
- Development of replacement or additional water sources in affected pastures

3.6.4.1 Project Fencing

Additional areas would be fenced as necessary to prevent livestock access to the active mining and reclamation areas. It is expected that most of the perimeter fencing around the mine area would be left in place following reclamation to allow management of the reclaimed areas as a separate grazing unit(s).

East Side Fencing

Upon construction of the Rabbit Creek Diversion, the mine perimeter fence would be moved outward into Sections 10, 15, and 22, Township 39 North, Range 43 East to encompass the diversion channel. This fence would exclude grazing on approximately 690 acres of undisturbed lands along the Rabbit Creek Diversion channel.

Kelly Creek Spring Fence

A fence would be constructed from Kelly Creek Spring to the relocated county road in NE Section 4, Township 39 North, Range 43 East to separate the Dry Hills pasture into two management units. The smaller southeast unit could serve as a functional replacement for the Bullhead Seeding pasture in livestock movement and management.

Reinfiltration Area Fencing

Fences would be constructed around individual basins rather than fencing off large areas for this facility.

West Side Fencing

The mine perimeter fencing would be moved outward to encompass additional sections as the mining operation expands in this direction.

3.6.4.2 Water Development and Distribution

SFPG has cooperated with the BLM and the grazing permittee (Nevada First Corporation) to provide livestock water from various well sites and from the Rabbit Creek drainage. SFPG has agreed to mitigate the expected disturbance of existing watering sources through installation of additional water troughs and facilities as outlined below:

- Move the existing trough in SE Section 24, Township 39 North, Range 42 East to SESE Section 12, Township 39 North, Range 42 East.
- Maintain the water trough in Section 6, Township 38 North, Range 43 East.
- Provide a water trough in Section 17, Township 38 North, Range 43 East if and when flow is stopped in Rabbit Creek.
- Provide a water trough in Section 4, Township 39 North, Range 43 East when Sections 5 and 9 are fenced.
- Maintain the water trough in Section 9, Township 39 North, Range 43 East until this area is fenced.
- Install a water trough in Section 15, Township 39 North, Range 43 East. Install a water trough in Section 10, Township 39 North Range 43 East if the area is not used for a tailings facility.
- Install two water troughs in Section 4, Township 39 North, Range 43 East, one on each side of the new fence to Kelly Creek Spring where it meets the relocated county road.

3.6.5 Residual Adverse Effects

Once mitigation measures are implemented, and if suitable water sources are maintained following mine closure, the primary residual adverse effects of the Proposed Action would be determined by the approaches and ultimate success of the reclamation program. Prompt reclamation resulting in the establishment of stable, productive forage species compatible with the surrounding natural plant communities would minimize the residual adverse impacts to range resources. Following mine closure and reclamation, the majority of the disturbed areas would be reclaimed, with the exception of the open pits, which would represent approximately 1,189 acres (13 percent) of the total 8,898 acres of affected public lands.

3.7 Paleontological Resources

3.7.1 Affected Environment

A review of the paleontological potential in the project area was conducted by Dr. James Firby. Firby (1995) notes that the potential for paleontological resources is subjectively determined by (1) the presence of fossil material recorded in the literature for this area, (2) the presence of fossils elsewhere within a stratigraphic unit mapped or recorded as present within the project area, and (3) the favorability of a stratigraphic unit to contain fossil material based on its assumed depositional environment. Firby (1995) further states that:

> Significance of an area or resource is subjectively judged on: 1) the kind of fossil material (e.g., all vertebrate fossils are said to have significance), 2) the uniqueness of the resource (e.g., the type area of a particular species), or 3) an assemblage of fossils which have particular value due to their joint presence. It is these several factors which, taken separately or in concert, determine if any area will be "sensitive" to planned disturbance, and if so what can be done to mitigate that sensitivity.

Only two fossil localities are noted within the project area, and both are plotted on the U.S. Geological Survey Dry Hills South 7.5' quadrangle. One is registered as U.S. Geological Survey locality USGS 15381 - PC and contains molluscan fauna, which have been collected by that agency. Firby (1995) notes that:

> While this locality indicates moderate potential for marine invertebrate paleontological resources, they are not normally rated above low significance or sensitivity. However, as this locality is the possible type area of a new species of the gastropod Glabrocingulum, its significance must be rated as moderate.

The second location is assigned to the Ordivician Valmy Formation and contains poorly preserved trilobite fauna. The locality is registered as U.S. Geological Survey locality USGS D - 151 - CO, and the significance and sensitivity are rated as low.

3.7.2 Environmental Consequences

To be considered significant, a paleontological resource must retain integrity and satisfy at least one of the criteria listed below:

- The resource is a unique or site-specific invertebrate or paleobotanical fossil occurring in formations that are found in the proposed project area.
- The resource qualifies as significant or critical and requires protection under the Antiquities Act of 1906.

Potential direct impacts to paleontological resources from the proposed project would be limited to areas of disturbance; potential indirect impacts could result from increased accessibility to fossil beds.

3.7.2.1 No Action Alternative

Neither of the two fossil localities reported by Firby (1995) would be directly impacted by the No Action alternative; therefore, there would be no significant impacts to paleontological resources. Indirect impacts could include the unauthorized collection of specimens during and after construction, and during operation of the mine, although this is unlikely due to the rarity of resources.

3.7.2.2 Proposed Action

Impacts to paleontological resources would be the same as described under the No Action alternative.

3.7.2.3 Other Project Alternatives

Impacts to paleontological resources would be the same as described under the No Action alternative.

3.7.3 Cumulative Impacts

No direct or indirect adverse impacts to paleontological resources would occur from the Proposed Action, No Action alternative, or other project alternatives; therefore, no cumulative impacts to paleontological resources would occur.

3.7.4 Monitoring and Mitigation Measures

No monitoring or mitigation is recommended for this resource. Because fossils are usually buried, their locations cannot be confirmed until excavation occurs. If significant fossilferous deposits are located during construction, operation, or reclamation, measures would be taken to identify and preserve the fossils.

3.7.5 Residual Adverse Effects

Since the two fossil localities noted within the project area would not be adversely impacted, no residual adverse effects would occur.

3.8 Cultural Resources

3.8.1 Affected Environment

3.8.1.1 Prehistoric Background

The project area is in the central subregion of the Great Basin, very near the boundary between it, the northern subregion, and the Lahontan basin. The subregions, as defined in various recent syntheses (Jennings 1986; Aikens 1982), are somewhat arbitrary, chosen because they are convenient units for discussing the history of regional research. These divisions, however, also reflect regionally distinctive "artifact inventories and...the variable adaptations made to local environments" (Jennings 1986). The boundaries separating the subregions are, therefore, not sharply defined. Instead, they represent a border strip of varying width, where the environmental and cultural differences between subregions intermix.

The project area's archaeological and environmental context is best described with reference to the central subregion, the Lahontan basin, and adjacent portions of the northern subregion.

The prehistoric populations of the central, Lahontan, and northern subregions were at a cultural stage termed Western Archaic from approximately 9,000 to 10,000 years ago until the earliest Euro-American contact. Relatively small groups foraged much of the year as they harvested a wide range of available animals and plant foods, including seeds. They also collected storable surplus for use at more sedentary winter settlements. This general adaptive strategy is recognized archaeologically through artifact assemblages, food remains, and settlement patterns. The archaeological pattern reflects environmental characteristics and so varies both regionally, in response to the environmental variability attributable to latitude and elevation, and temporally, in response to Mid- and Late Holocene climatic cycles. The most dramatic archaeological pattern changes appear to have occurred between the earliest, or Pre-Archaic, and Early Archaic periods (Davis 1982; Elston 1982, 1986).

Pre-Archaic assemblages in the project area are characterized by well-made flaked stone artifacts produced by biface reduction. Assemblages include relatively large-stemmed or concave-based points that are collaterally flaked and ground along lower edges of the stem or base (Great Basin Stemmed or Great Basin Concave series), crescents (sometimes referred to as Great Basin Transverse points), and/or occasionally fluted points. At larger sites, associated artifacts include steep-edged side and end scrapers, large choppers, hammerstones, and a variety of apparently multi-purpose tools with strongly concave edges (spokeshaves) and projections (gravers or spurs). Without the diagnostic points or crescents, Pre-Archaic assemblages may not always be recognized because other items in the tool kit differ from later equivalent types predominantly in size and raw material. A raw material preference for basalt, rhyolite, and other relatively coarse-grained silicates was characteristic of Pre-Archaic populations, although obsidian was also used for points, crescents, and other objects at Rye Patch and on the Black Rock Desert (Rusco and Davis 1987; Clewlow 1968). Most large Pre-Archaic sites are relatively dispersed lithic scatters along pluvial lakeshores (Clewlow 1968; Layton 1970), but sites are known for upland and riverine situations as well. With the exception of the relatively large Pre-Archaic site at Rye Patch, most of the latter are small sites or isolated occurrences of points or crescents (Rusco and Davis 1987; Elston 1982). Except for the size and artifact density in the lithic scatters, there is no apparent differentiation in site types.

Early Archaic assemblages in the project area and its vicinity are characterized by smaller projectile points and flaked stone tools—largely unshaped, unretouched flake knives, or scrapers. Artifacts generally exhibit random flake scar patterns. Most are made from presumably local obsidians and, less commonly, chert, jasper, chalcedony, and agates. Milling equipment occurs in some Early Archaic assemblages and becomes progressively more common in later phases. There is a directional change toward the production of progressively smaller points and other flaked stone artifacts throughout the later Western Archaic. In the Black Rock Desert and High Rock country, Early Archaic sites occur frequently in the same contexts as Pre-Archaic sites (Clewlow 1968); at Rye Patch, they represent small components of sites more intensively occupied during later periods. On the basis of the only Early Archaic site with house remains known in the Lahontan basin, Elston infers that the "household group was large, perhaps on the order of an extended family" (Elston 1982). Middle and Late Archaic sites tend to be larger and occur in a wider range of locales—more frequently in uplands. Site types are differentiated on the basis of the presence and relative amount of various artifact classes such as milling equipment, projectile points, and other tool types, as well as site size and density.

3.8.1.2 Historic Background

The main sources used to describe the historic background are Smith et al. 1983 and Walsh et al. 1995. The first presence of Euro-Americans in the vicinity of the project area was associated with the search for fur trapping areas. In 1828, Peter Skene Ogden, representing the Hudson's Bay Company, led a party from Oregon into Nevada near Denio. During this trek, his group located the Humboldt River. In the following years, the Ogden Party further explored the region in search of fur trapping areas. Later trips led to the discovery of the terminus of the Humboldt River and the Humboldt Sink. In 1833, Joseph Walker's trapping party, associated with the Bonneville Expedition, explored the Humboldt River on an east to west route that ultimately took the group across the Sierra. Their route would later become the Emigrant Trail. Emigrants first traveled along the Humboldt River in the early 1840s bringing with them the first livestock. The region was subject to further exploration through the 1840s. Massive migration along the emigrant routes occurred after the 1848 discovery of gold in California. Massive sheep drives passed through the region beginning in the early 1850s and continuing into the early 1900s.

From 1860 to 1870, the region experienced rapid growth in prospecting and the development of mining and mills. This growth led to increased tension with the Indians. During the mid-1860s, military forts were established to restrain the conflict. During the same period, the region experienced expansion of transportation networks, including stage and railroad, as well as the initiation of agriculture and cattle drives.

3.8.1.3 Cultural Resources Identified in the Project Area

Several previous archaeological studies have been conducted in the vicinity of the project area.

In 1969, an archaeological reconnaissance of the Winnemucca - Battle Mountain area was conducted by the University of Nevada Reno, Nevada Archaeological Survey and crossed the project area (Stephenson and Wilkinson 1969). A total of 11 lithic scatters, a lithic scatter and campsite, a rock shelter, and 2 lithic scatters with historic buildings, including the Person Ranch, were inventoried. No determinations of eligibility were made for these sites.

Busby, Spencer, and Swezey (1976) conducted excavations at Stolen Shelter. Although the deposits in the shelter were greatly disturbed by unauthorized excavations, the site deposits yielded projectile points which date from the Middle Archaic (Humboldt and Elko Series) to the Late Archaic (Rosegate and Desert Series). Unfortunately, the points do not serve as good temporal indicators due to the disturbance in the site sediments. A hearth feature was uncovered in the excavation, but no radiocarbon date was obtained.

Ypsilantis and Jackson (1978) of the BLM conducted cultural resource surveys for a number of soil test pits in the project area. No cultural resources were identified as a result of the surveys.

A single lithic scatter was recorded by Pedrick (1981a) in the Rabbit Springs Maintenance and Pipeline Project area. No recommendation of eligibility to the National Register of Historic Places was made.

BLM archaeologist Pedrick (1981b) did a survey for the Purple Sage Reservoir in 1981. The survey resulted in the inventory of one isolated artifact.

Again in 1981, Pedrick of the BLM conducted a cultural resource survey for the Surprise Spring Reservoir (Pedrick 1981c). A single lithic scatter was inventoried. The site was not evaluated for the National Register of Historic Places, but avoidance and fencing were recommended.

In 1982, BLM archaeologist Pedrick conducted an archaeological survey for Snowstorm Fence #4875 and inventoried eight lithic scatters (Pedrick 1982). None of the sites were recommended as eligible to the National Register of Historic Places and all of the sites were either avoided or fenced.

Polk (1985) conducted a cultural resources survey of the Gold Fields Mining Corporation's Chimney Creek Project. Site CrNV-21-3386, a lithic scatter and camp site, was recommended for testing. The site was tested and recommended as not eligible to the National Register of Historic Places.

R. Smith (1985) conducted a cultural resource inventory of the Kelly Spring Holding Fence project. No cultural resources were identified.

A cultural resources inventory of 6.5 miles of fence parallel to the Kelly Creek road was conducted by Cluff (1985). A single lithic scatter that was recommended as not eligible to the National Register of Historic Places was recorded.

Stephenson (1985) conducted a cultural resources investigation of an access road corridor and gravel pit expansion. No cultural resources were identified.

Site 26Hu1815, a field camp, was subject to further evaluation by Burke (1986a). The site was determined to be not eligible to the National Register of Historic Places.

Also in 1986, Burke conducted a cultural resources inventory for the Gold Fields Operating Company Chimney Creek Project Parcel. A total of 14 sites, including 10 lithic scatters, 2 prospects, a historic trash scatter, and a lithic scatter/camp site, were inventoried. Site CrNV-21-3717, the lithic scatter/camp, was recommended for evaluative testing (Burke 1986b). All of the other sites were recommended as not eligible to the National Register of Historic Places.

Burke also conducted a cultural resources inventory of two parcels for the Gold Fields Operating Company (Burke 1986c). The survey resulted in the identification of one lithic scatter that was determined to be not eligible to the National Register of Historic Places.

In 1986, Rawson of the BLM conducted a cultural resources inventory for the Bullhead Pipeline Extension (Rawson 1986a). No cultural resources were identified.

Also in 1986, Rawson (BLM) surveyed a 0.5-mile-long corridor for the Goldfields Pipeline Extension project (Rawson 1986b). No cultural resources were identified.

A cultural resources survey for three proposed guzzler sites at Chimney Creek, Humboldt County, Nevada was conducted by Vierra (1987). No cultural resources were identified.

Wells (1987) surveyed 650 acres for the Chimney Creek Pipeline right-of-way. Three lithic scatters were recorded, none of which were determined to be eligible to the National Register of Historic Places.

McCabe (1987) conducted a cultural resources inventory of the Sierra Pacific 120-kV transmission line corridor from the Valmy Power Station to the Getchell Mine. A single lithic scatter was recorded and determined to be not eligible to the National Register of Historic Places.

P.C. Green (1988) conducted a cultural resources inventory of 212 acres for the Gold Fields Mining Corporation's Chimney Creek Project and recorded a single lithic scatter. The site was recommended as not eligible to the National Register of Historic Places.

In 1988, McCabe conducted a survey of a 570-acre parcel for the Gold Fields Chimney Creek Project. A total of five lithic scatters were recorded (McCabe 1988b), but none were recommended as eligible to the National Register of Historic Places.

H.S. Green (1988) of the BLM conducted a survey of a waterline and access road for SFPG. No cultural resources were identified.

White (1989) of the BLM conducted a 4-acre survey of livestock water pipelines at Gold Fields. No cultural resources were identified.

In a cultural resources inventory of approximately 92 acres for access roads, drill sites, and a block parcel, McCabe (1990) inventoried three sites including two lithic scatters and a large field/base camp. While the lithic scatters were determined as not eligible to the National Register of Historic Places, the field/base camp was determined eligible.

Burke and Clay (1992) were contracted to perform a Class III cultural resources inventory of three drill pads and access roads for SFPG. This project resulted in two isolated artifacts being recorded.

A total of 8.6 miles of 120-kV transmission line corridor was surveyed by Johnson (1992) for Sierra Pacific Power Company. A large multi-component site, including a lithic scatter and the historic Duvivier homestead, were recorded. The prehistoric component was recommended as not eligible to the National Register of Historic Places, and the historic component was recommended for evaluative testing.

In 1993, McCabe conducted a survey of drill pads and roads for the Twin Creeks Exploration Project. A total of four lithic scatters were recorded. Of these, three were recommended as eligible to the National Register of Historic Places.

Walsh and McCabe (1996a) conducted a cultural resources inventory of 4,903 acres for SFPG. A total of 4 previously documented sites, 84 isolated artifacts, and 58 new archaeological sites were recorded. All but one of these sites are prehistoric. Of the 62 archaeological sites, a total of 14 were recommended as eligible to the National Register of Historic Places.

A total of 7,562 acres were surveyed by Archaeological Research Services, Inc. between July 1993 and December 1993 for SFPG (Walsh and McCabe 1996b). The investigation resulted in the recording of 2 previously documented sites, 85 isolated artifacts, and 67 new sites. Of the new sites, one is a historic trash scatter, one contains both prehistoric and historic components, and the remainder are prehistoric. A total of 19 of the sites were recommended as eligible to the National Register of Historic Places.

Between July 1993 and January 1994, Archaeological Research Services, Inc. conducted a cultural resources inventory of 5,665 acres (Walsh and McCabe 1996c). This investigation resulted in the inventory of 4 previously documented sites, 63 isolated artifacts, and 61 new sites. Of the new sites, 7 are historic, 4 have both prehistoric and historic components, and the remainder are prehistoric. A total of 25 sites were recommended as eligible to the National Register of Historic Places.

In 1994, Peterson and his associates from Western Cultural Resource Management, Inc. conducted a cultural resources inventory of 2,125 acres for SFPG's Dry Hills Pass Project (Stoner et. al. 1994). A total of 67 sites and 32 isolated artifacts were inventoried. All of the sites are prehistoric with the exception of one that also has an historic component. One site was recommended as eligible to the National Register of Historic Places.

Walsh et. al. (1996) prepared a Class I Overview for the Twin Creeks Mine. This overview documents existing sites and develops a research context. In addition, pertinent environmental data were gathered and archaeological resources were interpreted in this context. The entire project area was also ranked for sensitivity based on a record search, National Register of Historic Places site density, and archaeological interpretations. This acted as a guide for the level of inventory recommended. Finally, the document recommends that future studies in the project area are guided by a management plan that includes systematic collection of baseline data, evaluation of previously recorded sites for National Register of Historic Places eligibility, and that it is used to guide future archaeological investigations within the project area.

__Prehistoric Resources__

A total of 290 archaeological sites have been recorded within the project area (Appendix E). Of these, a total of 260 are prehistoric, and 16 contain both prehistoric and historic components (***Table 3-33***). Please note that this total does not include isolated artifacts. It should also be noted that many (39) of the sites recorded in the late 1960s and 1970s were never evaluated for the National Register of Historic Places (Appendix E). In addition, 2 of the 290 sites have been determined to be eligible to the National Register of Historic Places with State Historic Preservation Office concurrence; 40 sites have been determined not eligible with State Historic Preservation Office concurrence, and 2 sites have been determined eligible pending further evaluation. A total of 58 sites have been recommended (judged) eligible and 149 sites judged ineligible by archaeological contractors. Documentation from these sites, however, has not yet been reviewed by the BLM, and State Historic Preservation Office consultation is pending.

Prehistoric sites in the project area date to the past 8,000 years. The prehistoric site types include the following:

- Hunting blinds
- Lithic scatters
- Lithic quarries or lithic prospects
- Field or base camps
- Residential base camps
- Rock shelters

A complete count of each site type is presented in ***Table 3-33***.

TABLE 3-33
Resource Types and Counts

Resource Type	Number
Prehistoric Sites	
hunting blind	2
lithic and ceramic scatter	4
lithic scatter/tool concentration	2
lithic scatter	206
lithic quarry or prospect/lithic scatter	13
lithic scatter/field or base camp	25
residential base camp	8
rock shelter	3
PREHISTORIC RESOURCES TOTAL	**260**
Multi-component Resources	
field or base camp/historic isolate or trash scatter	3
lithic scatter/historic component	5
residential base camp/historic component	4
MULTI-COMPONENT RESOURCES TOTAL	**16**
Historic Archaeological Sites	
ethnohistoric (Shoshone Mike Massacre site)	4
rock cairn	8
trash scatters	5
Historic Architectural Sites	
mining complex (including the Getchell)	4
ranch complex	2
rock wall	8
Historic Engineering Sites	
irrigation system	1
Historic Landscape Sites	
prospecting sites	2
HISTORIC RESOURCES TOTAL	**14**
TOTAL PREHISTORIC & HISTORIC RESOURCES	**290**

Historic Resources

Of the 290 archaeological sites recorded within the project area (Appendix E), a total of 14 are historic and consist of:

- Historic archaeological sites, primarily trash scatters
- Historic architectural sites including mining and ranch complexes
- Historic engineering site (an irrigation system)
- Historic landscape sites (prospects)

Table 3-33 provides complete counts of each site type.

Summary of Resource Eligibility

The significance of a cultural resource is an assessment of the importance of a cultural resource to the citizens of the United States and indicates that a site has attributes that qualify it for inclusion on the National Register of Historic Places. In order to be considered eligible for inclusion in the National Register of Historic Places, a cultural resource must retain integrity and satisfy at least one of the four following significance criteria:

- Be associated with events significant to broad patterns of history (36 Code of Federal Regulations 60.4a)
- Be associated with the lives of persons significant in the past (36 Code of Federal Regulations 60.4b)
- Embody distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; or represent a distinguishable entity whose components lack individual distinction (36 Code of Federal Regulations 60.4c)

- Have yielded or may yield information important to history or prehistory (36 Code of Federal Regulations 60.4d)

Appendix E lists all resources within the project area and their National Register of Historic Places status.

3.8.1.4 Ethnography

The project area and surrounding areas appear to have been jointly occupied or used by both Northern Paiute and Western Shoshone groups. Specifically, the southern part includes the westernmost territory traditionally used by the Tosawihi Shoshone subgroup, and the northern part includes territory used by the Yamosopo subgroup, of the Northern Paiute.

Involved Tribal Groups

Tribal groups that are potentially affected by proposed activities in the project area are expected to be communities that include descendants of Yamosopo Paiute and Tosawihi Shoshone. Ethnographic studies of Western Shoshone communities by Richard Clemmer (1972, 1974, 1978) and later studies undertaken in connection with environmental studies of proposed missile site construction (Clemmer-Smith 1981) and mining in Western Shoshone country, including the location of the Tosawihi opalite quarry (Clemmer 1990; Rusco and Raven 1992), resulted in the identification of descendants of Nineteenth Century Tosawihi on several reservations and colonies in northeastern Nevada. It is reasonable to expect that there are living descendants of people who once lived in Yamosopo country as well.

Inquiries have been directed by the BLM in letters to the following tribal governments: Lovelock Colony (Paiute); Winnemucca Colony (Paiute and Shoshone); Fort McDermitt Tribal Council (Paiute); Duck Valley Tribal Council (Paiute and Shoshone); councils of Battle Mountain, Elko, and South Fork Bands of the Te-Moak Tribes of Western Shoshone; and the Fort Hall Shoshone-Bannock Tribal Council. In addition, the Western Shoshone Historic Preservation Society and Western Shoshone National Council received inquiry letters.

Follow-up contacts by telephone have been made. Tribal chairpersons from McDermitt, Duck Valley, and Lovelock have identified cultural resources specialists or Paiute individuals with knowledge of the project area to be involved in a tour of the site and further consultation. Western Shoshone individuals from Battle Mountain and Wells have expressed interest in attending a site tour to determine whether elders in their community may have knowledge of the area. A tour of the project area was conducted in April 1996 to solicit comments from interested and knowledgeable Native Americans.

Preliminary discussions indicate that there are elders at Duck Valley who lived in or used the project area, and there may be others at McDermitt. Issues raised on the tour include disturbance to burials and a commemorative marker of a massacre of Native Americans, impacts to medicinal plant resources, and impacts to existing springs.

Ethnographic and Ethnohistorical Information

The project area was apparently used both by Northern Paiute and Western Shoshone people in the late historic times, as remembered by people who spoke with ethnographers Stewart and Steward in the 1930s. Stewart (1939:Map 1) shows a Paiute *yamosopo* area on the Little Humboldt River drainage in Paradise Valley along the Santa Rosa Mountains. He was unable to locate any individual from the *yamosopo* area and used information from people in neighboring areas to set the boundaries of the area. Stewart was told by a Paiute man at McDermitt that *yamosopo* shared the hunting area on the headwaters of the Little Humboldt River with Shoshone and that the band was "mixed with Shoshoni" (i.e., intermarried) (Stewart 1939). The Northern Paiute history (ITCN 1976:44) says that "*Yamosopu Tuviwa ga wa* (Half Moon Valley Dwellers) occupied Paradise Valley until they were moved to the Fort McDermitt Reservation."

Stewart's boundary of Paiute territory in the vicinity of the project area may be slightly too far to the east. Stewart (1939) cites a 1936 Steward article in setting the westernmost boundary of the Western Shoshone (and, by implication, the easternmost boundary of the Northern Paiute) as "just west of Battle Mountain and the mountains west of Reese River." However, Steward elsewhere asserts that Western Shoshone people lived as far west of Battle Mountain as Iron Point, approximately 20 miles northwest of Battle Mountain: "East of Iron Point the Humboldt River Valley was entirely Shoshoni" (1938). Steward (1938) describes this westernmost Shoshone area as follows:

> One area of concentration was along the fertile lowlands of the Humboldt River between Battle Mountain and Iron Point. The population was fairly dense (one estimate is 500 persons in 1,280 square miles) but the winter encampments were somewhat smaller and less permanent than those of most Shoshoni and lacked headmen. There were few large winter villages. Instead, related families associated in groups of three to five. They generally foraged together during the year and chose a winter camp site where seeds and fish were plentiful. These sites varied from year to year.

Steward (1938) indicates that Northern Paiute and Western Shoshone in this area intermarried. They sometimes participated together in antelope hunts at *pu:wunuk:* (translated as "plain against the foothill") near Iron Point under direction of a Northern Paiute shaman. A description of an antelope drive at *pu:wunuk:* as observed by a Western Shoshone man born in the 1850s is provided in Steward (1941).

Two named wintering areas were *Pagowe*, along the Humboldt River upstream from Herin, where 20 to 30 people stayed, and *Bohowia* (translated as "sagebrush pass") near Iron Point where perhaps 10 families wintered (Steward 1938). Steward (1938) mentions a rabbit drive center at Rock House, *Pagawi* (probably same as the wintering place *Pagowe*, since rabbit hunts in this part of Western Shoshone territory were held in the winter [Steward 1941]).

Steward also says that Shoshone from this area sometimes went north "to the headwaters of the Owyhee River and other tributaries of the Snake River to get salmon" (1938). This suggests that, even if they did not have villages within the project area, Shoshone likely crossed the area as they moved seasonally to procure food.

Potential Traditional Cultural Properties

Recent ethnographic studies indicate that properties of current cultural and specifically religious importance that are potentially eligible for the National Register of Historic Places as Traditional Cultural Properties in areas traditionally used by Shoshone and Paiute people might include prominent landforms and springs, rock art sites, rock shelters or caves, historic or prehistoric residential sites, and burials (Clemmer-Smith 1981; Miller 1983). In recent studies for specific environmental assessments or environmental impact statements, Paiute and Shoshone individuals have identified the following kinds of properties:

(1) Known burials (Rusco 1994), (Rusco and Raven 1992; Harney 1995)

(2) Sources of minerals (Rusco and Raven 1992) or plants used in healing

(3) Residential sites known to living individuals (Rusco 1994)

(4) Prominent landforms known to be used for vision or power quests by known individuals (Rusco and Raven 1992; Rusco 1994)

Interviews with Paiute and Shoshone individuals concerning specific land-altering projects have identified the kinds of archaeological sites that would be considered potentially eligible for the National Register of Historic Places and are regarded as elements of tribal cultural heritage (Rusco 1986-1995).

3.8.2 Environmental Consequences

The significance of a cultural resource is an assessment of the importance of a cultural resource to the citizens of the United States that indicates whether a site has attributes that qualify it for inclusion in the National Register of Historic Places. In order to be considered eligible for inclusion in the National Register of Historic Places, a cultural resource must retain integrity and satisfy at least one of the four significance criteria defined in 36 Code of Federal Regulations part 60.4. These criteria are listed below:

- 36 Code of Federal Regulations 60.4a—Associated with events significant to broad patterns of history
- 36 Code of Federal Regulations 60.4b—Associated with the lives of persons significant in the past
- 36 Code of Federal Regulations 60.4c—Embody distinctive characteristics of a type, period, or method of construction; represent the work of a master; possess high artistic values; or represent a distinguishable entity whose components lack individual distinction

- 36 Code of Federal Regulations 60.4d—Yielded or may yield information important to history or prehistory

Appendix E lists all resources within the project area and their National Register of Historic Places status.

Direct physical impacts to cultural resources could occur during ground-disturbing activities associated with the construction of new facilities, as well as reclamation activities around the existing mine. Indirect impacts could result from increased erosion or improved access, which make sites more vulnerable to accidental or deliberate disturbance and illegal collecting.

3.8.2.1 No Action Alternative

Direct impacts to cultural resources could occur during reclamation activities for the currently permitted facilities. Indirect impacts could result from increased erosion or improved access, which makes sites more vulnerable to accidental or deliberate disturbance and illegal collecting. Potential impacts to Traditional Cultural Properties and Native American values include covering of burials, disturbance of medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be covered by an overburden and interburden storage area. Known burials may also be covered by an overburden and interburden storage area. The Native American consultation process is still underway to identify impact areas as precisely as possible.

3.8.2.2 Proposed Action

Under the proposed plan of operations, no sites that have been determined to be eligible to the National Register of Historic Places would be directly impacted by the Proposed Action. One unevaluated site, CrNV-21-5543, would be directly impacted by the construction of overburden and interburden storage areas. A total of seven sites that have been judged not-eligible would be directly impacted by overburden and interburden storage areas and tailings facilities. These include sites CrNV-21-3386, -3689, -4452, -4453, -4460, -5859, and -5860. A total of four sites that have been judged eligible by the archaeological contractor would be directly impacted by tailings or overburden and interburden storage areas. These include sites 26Hu3231, CrNV-21-5864, -5866, and -5867. Final determinations of eligibility for these sites are pending BLM and State Historic Preservation Office review. Potential impacts to Traditional Cultural Properties and Native American values include disturbance of burials, disturbance of medicinal plant resources, and drying of springs. A sign marking the approximate location of a historic massacre of Native Americans would be either covered by an overburden and interburden storage area or disturbed during construction of a heap leach pad. Known burials may also be covered by an overburden and interburden storage area or disturbed by construction of a heap leach pad. The Native American consultation process is still underway to identify impact areas as precisely as possible.

3.8.2.3 Other Project Alternatives

Overburden and interburden storage area alternative 1 would have no adverse impacts to cultural resources as it has the same footprint as the Proposed Action, and no unevaluated or eligible sites to the National Register of Historic Places would be directly impacted. Alternative 2 would disturb an additional 200 acres in order to accommodate the expanded storage area. One site that has been judged eligible by the archaeological contractor would be directly impacted by the expanded tailings storage area.

Impacts to cultural resources and Native American traditional values under the Partial Vista Pit Backfill and Selective Handling of Overburden and Interburden alternatives would be the same as described for the Proposed Action.

3.8.3 Cumulative Impacts

Direct adverse impacts under the Proposed Action and alternatives to historic properties are unknown pending BLM and State Historic Preservation Office review; therefore, cumulative impacts are unknown.

3.8.4 Monitoring and Mitigation Measures

Monitoring and mitigation measures are unknown pending final determinations of eligibility for those sites that would be directly impacted.

SFPG recognizes the serious consequences of disturbance and unauthorized collection of cultural resources. In compliance with the Archaeological Resources Protection Act of 1979, as amended (16 USC 470), the following information would be distributed to all consultants, contractors, and employees of the Twin Creeks Mine:

> *SFPG activities in the permitted project area are being conducted within an area of potential prehistoric and historic significance. Undue and unauthorized impacts to the resources carries a significant penalty: up to $100,000 fine, up to a 5-year jail sentence, cost of restoration, value of resource, and forfeiture of vehicle or equipment. Protect your Country's resources, report violations to the land management agency where the violation took place. On public land, contact either the U.S. Forest Service or the BLM. Your information may be valuable. Rewards can be up to $500.*

3.8.5 Residual Adverse Effects

Residual adverse effects to prehistoric and historic properties are unknown pending BLM and State Historic Preservation Office review.

3.9 Air Quality

3.9.1 Affected Environment

3.9.1.1 Terrain, Climate, and Meteorology

The Twin Creeks Mine is located in the northern portion of the Great Basin, northeast of Winnemucca, Nevada. The mine is located within the Humboldt River hydrographic basin and within the Kelly Creek Area subbasin 66, as delineated by the Nevada Division of Environmental Protection. The surrounding terrain consists of alternating mountain ranges and sagebrush-covered valleys, with the mine site located in a valley between the Osgood and Snowstorm Mountain ranges. The valley slopes gently to the south with elevations ranging from approximately 5,200 feet in the northern part of the project area to approximately 4,600 feet in the southern sections. Elevations within the Osgood Mountains range from approximately 5,400 to nearly 8,700 feet and within the Snowstorm Mountains from 6,000 to 7,100 feet.

The climate of this region is a semi-arid or steppe climate characterized by dry, hot summers and cold winters (Trewartha and Horn 1980). The project area lies just to the north of an arid or desert climatic zone. These climates typically have very low annual precipitation (less than 10 inches), low relative humidity, clear skies, and large diurnal temperature variations because of the dryness of the air. Annual climatic precipitation records for Winnemucca (Brown 1960) clearly demonstrate this phenomenon, with normal annual precipitation of only 8.75 inches (***Table 3-34***).

On-site meteorological data obtained from the Twin Creeks Mine for 1994 show the annual precipitation at 7.3 inches. The majority of the precipitation comes in the winter months, from October through March. Occasional thunderstorms develop during the summer, but do not produce much precipitation. The hot, dry air at lower levels near ground surface causes the precipitation to evaporate before reaching the ground.

The climatic record (***Table 3-35***) indicates normal maximum temperatures in the range of 80° to 100°F in the summer and 30° to 40°F in the winter. Normal minimum temperatures range from 40° to 50°F in the summer and 15° to 25°F in the winter. On-site meteorological data for 1994 show a maximum temperature of 98.6°F occurring in July and a minimum of -0.2°F occurring in December, with an average temperature for the year of 50.3°F.

Moisture acts to insulate radiated heat, and since the air in the project area is so dry, most of the daytime heating is radiated away from the surface, allowing the temperature to drop significantly at night, even in the summer. This cooling at night produces temperature inversions where colder air is at the surface with warmer air above. These inversions create what are known as "stable" air masses since they are not prone to thermodynamic mixing. Stability plays a key role in the dispersion of air contaminants since stable layers near the earth's surface trap pollutants. During the afternoon hours, the air becomes neutral, or unstable, as rapid heating occurs at the surface and pollutants are more readily dispersed into the atmosphere. Also, the mixing height, or the height above the surface of the earth in which pollutants are mixed by convection and turbulence, is affected by the daytime heating and nighttime cooling. During the day, the mixing height rises to approximately 2,500 feet, but at night and into the early morning, especially in the winter, the mixing height may be only 200 to 300 feet (Holtzworth 1972). The mixing height and inversion layer are somewhat synonymous during these early morning hours.

The climatic record for Winnemucca indicates that wind direction exhibits a bimodal distribution, with the primary mode being southwesterly, especially in the summer months, and the secondary mode being northeasterly, mostly during the winter. This is well supported by the fact that low pressure systems tend to track to the north of the city during the summer and to the south during the winter. However, as can be seen in ***Figure 3-51***, the on-site wind data at the Twin Creeks Mine for 1994 shows a different distribution with the predominant wind being out of the northwest to northerly direction. This can be attributed to localized orographic and thermally induced effects caused by the proximity of the site to the Osgood and Snowstorm Mountains, and the orientation of the valley in which the mine is located. On otherwise calm nights, the rapid cooling of the ground surface causes the air above to cool. Colder air is more dense and will flow downhill into the valley. Since the valley slopes to the south throughout this area, a localized northerly wind is induced at night. Also, southwesterly winds in the region would be impeded by the Osgood Mountain range and channeled around and over this range, resulting in a more westerly to northwesterly

TABLE 3-34
Monthly Precipitation Data
Winnemucca, Nevada

Month	Precipitation (Inches)[1]
January	0.9
February	0.74
March	0.83
April	0.81
May	0.91
June	0.77
July	0.26
August	0.28
September	0.36
October	0.68
November	0.85
December	0.87
ANNUAL TOTAL	**8.23**

[1]Precipitation is averaged over a period of record from 1928 to September 1995.
Source: National Oceanic and Atmospheric Administration, Western Region Climate Center 1982-1985.

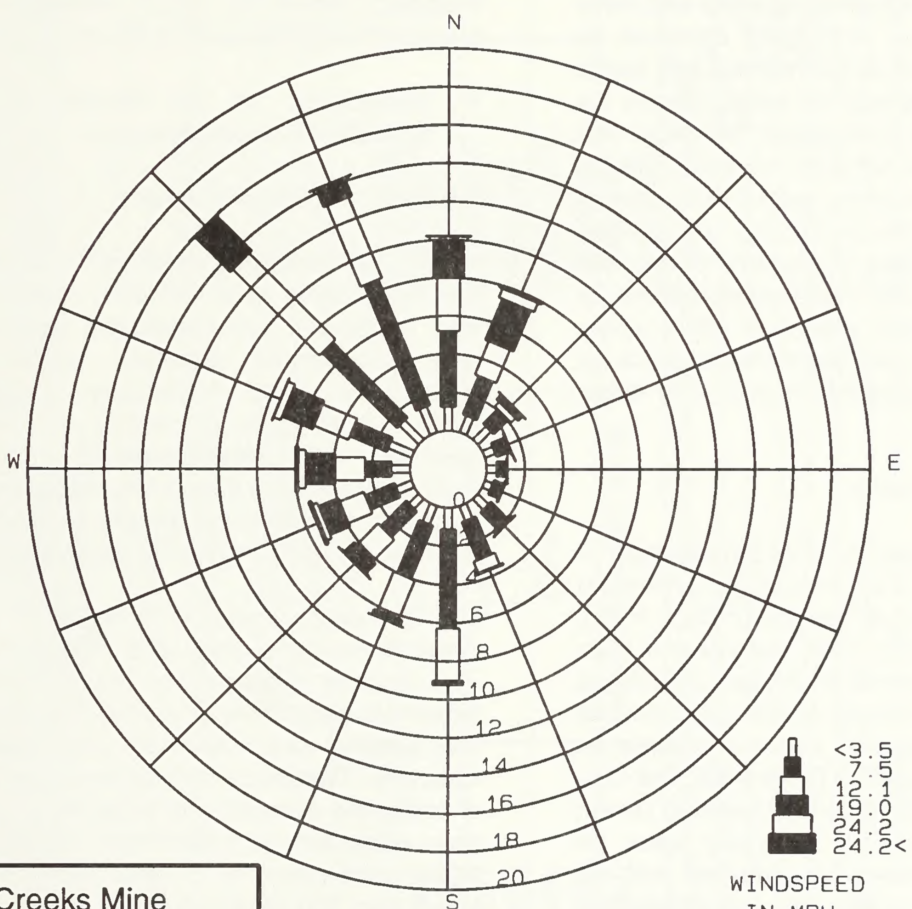
TABLE 3-35
Minimum, Maximum, and Average Temperatures[1] (°F)
Winnemucca, Nevada

Month	Period Minimum	Average Minimum	Period Maximum	Average Maximum	Average
January	-5.3	16.8	51.7	40.9	28.8
February	1.7	22.3	58.0	47.3	34.8
March	18.5	25.8	65.5	54.0	39.9
April	20.4	30.7	71.8	62.7	46.7
May	31.6	38.6	83.1	72.0	55.3
June	39.8	45.9	92.3	81.5	69.7
July	46.0	52.4	96.3	92.4	72.4
August	49.1	49.1	96.5	90.4	69.7
September	32.8	39.6	87.3	80.7	60.1
October	23.8	30.4	77.5	68.0	49.2
November	12.3	22.6	63.7	52.2	37.4
December	1.4	17.9	52.6	43.1	30.5
ANNUAL AVERAGE	**29.1**	**32.7**	**69.3**	**65.4**	**49.0**

[1]Temperatures are averaged over a period of record from 1928 to September 1995.
Source: National Oceanic and Atmospheric Administration, Western Region Climate Center 1982-1985.

TWIN CREEKS MINE METEOROLOGICAL DATA
WIND ROSE ANALYSIS (PERCENT)
1/ 1/94 through 12/31/94

WIND DIRECTION	WIND SPEED (MI/HR) <= 3.5	<= 7.5	<=12.1	<=19.0	<=24.2	>24.2	TOTAL	AVG SPEED
N	1.25	3.95	2.78	1.99	0.18	0.05	10.20	8.48
NNE	0.93	2.16	1.86	2.33	0.51	0.05	7.84	10.23
NE	0.95	1.09	0.30	0.34	0.05	0.00	2.73	6.16
ENE	0.57	0.76	0.05	0.01	0.01	0.00	1.40	4.34
E	0.50	0.53	0.05	0.02	0.00	0.00	1.10	4.23
ESE	0.42	0.54	0.08	0.00	0.00	0.00	1.05	4.45
SE	0.77	1.16	0.21	0.05	0.00	0.00	2.19	4.62
SSE	0.81	2.13	0.64	0.08	0.00	0.00	3.66	5.59
S	1.12	5.13	2.74	0.25	0.00	0.00	9.25	6.56
SSW	1.02	2.99	2.18	0.31	0.01	0.00	6.50	6.95
SW	0.70	1.89	1.56	0.71	0.04	0.04	4.93	7.88
WSW	0.87	1.67	1.34	1.12	0.25	0.16	5.42	9.30
W	0.97	1.38	1.56	1.55	0.39	0.16	6.00	10.12
WNW	1.32	2.09	1.93	1.74	0.39	0.02	7.49	9.12
NW	1.40	5.55	6.39	2.61	0.04	0.01	16.00	8.47
NNW	1.45	7.11	4.59	0.94	0.08	0.01	14.19	7.22
CALM	0.04						0.04	
TOTAL	15.09	40.12	28.27	14.08	1.95	0.50	100.00	



Wind Rose Analysis

Twin Creeks Mine

Figure 3-51

Windrose Analysis

component at the mine site. Wind speeds are generally in the 8 to 10 mile per hour range, with stronger winds coming in the winter months as more frequent synoptic scale storm systems pass through the region. However, strong localized winds can accompany summertime thunderstorms, especially if the lower levels are exceptionally dry. The precipitation from these storms often evaporates before reaching the ground. Evaporation is a cooling process, and as such, heat is removed from the surrounding air during the phase change from liquid to gas. This cooled air becomes much heavier than the surrounding air, and rapidly descends toward the ground, where it disperses. This effect can cause gusty winds in the vicinity of these storms, and, which if strong enough, produce the phenomenon known as a microburst.

Wind speed, stability, and mixing height are the three most critical factors influencing the dispersion of pollutants in the atmosphere. If winds are light, emissions from point sources accumulate and move slowly downwind, thus prolonging exposure to higher concentrations of contaminants. Light winds combined with stable air and low mixing heights (as typically seen on calm, cold winter mornings) can significantly affect the behavior of point source emissions since the pollutants are not only moving very slowly away from the source, but they are also trapped in the lower layers of the atmosphere near the surface. However, with higher winds (above 12 miles per hour), fugitive emissions from mining operations and storage piles are increased because the stronger winds transport heavier and larger particles.

3.9.1.2 Ambient Air Quality

Air quality can be defined by the concentration of various pollutants and their interactions within the atmosphere, as well as their impacts on flora, fauna, and overall human health. Both national and state ambient air quality standards have been established to set threshold concentrations for various pollutants and are used for comparison to actual ambient air data to assess the air quality (***Table 3-36***). The U.S. Environmental Protection Agency classifies certain areas as non-attainment or attainment areas for individual pollutants based on whether ambient concentrations of those pollutants have violated the air quality standard. In areas where insufficient data are available to make an attainment status assessment, the area is designated as unclassifiable and is treated as an attainment area for regulatory purposes. The Twin Creeks Mine is in an area designated unclassifiable, as is much of the State of Nevada and, therefore, is considered an attainment area.

Both long-term climatic factors and short-term weather fluctuations are considered part of the air quality resource because of their effects on the dispersion of pollutants into the atmosphere.

3.9.2 Environmental Consequences

Impacts to air quality were judged against the State of Nevada and National Ambient Air Quality Standards. These standards represent the maximum air concentrations of a given pollutant determined to have no detrimental effects on public health and/or the environment. National Ambient Air Quality Standard levels are also recognized by the State of Nevada.

Impacts to air quality would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Exceedance of the Nevada or National Ambient Air Quality Standards

3.9.2.1 No Action Alternative

Mining, ore-processing, and construction activities at the Twin Creeks Mine would be a source of both total suspended particulates and particulates that have aerodynamic diameters smaller than 10 micrometers (PM_{10}) (collectively referred to as fugitive dust). Ore processing operations, and gasoline and diesel-powered vehicles and equipment would be the primary sources of gaseous pollutants such as sulfur dioxide, oxides of nitrogen (nitrogen dioxide), and volatile organic compounds.

The air quality impact of a fugitive dust source depends on the quantity and drift potential of the dust particles released into the atmosphere. The larger dust particles settle out near the source, while fine particles are dispersed over much greater distances. Theoretical drift distances, as a function of particulate diameter and mean wind speed, have been computed for fugitive dust emissions. For a typical wind speed of 10 miles per hour, particles larger than 100 micrometers are likely to settle out within 20 to 30 feet from the source. (For comparison, a human hair has a thickness of about 100 micrometers). Particles 30 to 100 micrometers, depending on the extent of atmospheric turbulence, are likely to settle within a few hundred feet. Dust

TABLE 3-36
Ambient Air Quality Standards

Pollutant	Averaging Time	Nevada Standards[1]	National Standards[2,3]	
		Concentration[2]	Primary[4]	Secondary[5]
Sulfur dioxide	Annual Arithmetic Mean	80 µg/m³ (0.03 ppm)	80 µg/m³ (0.03 ppm)	---
	24 hours	365 µg/m³ (0.14 ppm)	365 µg/m³ (0.14 ppm)	---
	3 hours	1,300 µg/m³ (0.5 ppm)	---	1,300 µg/m³ (0.5 ppm)
PM_{10}[6]	Annual Arithmetic Mean	50 µg/m³	50 µg/m³	50 µg/m³
	24 hour	150 µg/m³	150 µg/m³	150 µg/m³
Ozone[7]	1 hour	235 µg/m³ (0.12 ppm)	235 µg/m³ (0.12 ppm)	Same as Primary Standards
Carbon Monoxide (<5,000 feet MSL)	8 hours	10,000 µg/m³ (9.0 ppm)	10,000 µg/m³ (9 ppm)	Same as Primary Standards
Carbon Monoxide (≥5,000 feet MSL)	8 hours	6,670 µg/m³ (6.0 ppm)	---	---
Carbon Monoxide (at any elevation)	1 hour	40,000 µg/m³ (35 ppm)	40,000 µg/m³ (35 ppm)	Same as Primary Standards
Nitrogen dioxide	Annual Arithmetic Mean	100 µg/m³ (0.05 ppm)	100 µg/m³ (0.05 ppm)	Same as Primary Standards

[1]Nevada standards are values that are not to be exceeded where the general public has access.

[2]Concentrations are expressed first in micrograms per cubic meter (µg/m³), and are based upon a reference temperature of 25°C and a reference pressure of 760 mm of mercury; parts per million (ppm) in this table refers to volume, or micromoles of pollutant per mole of gas.

[3]National standards, other than those based on annual averages or annual geometric means, are not to be exceeded more than once per year.

[4]National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than 3 years after that state's implementation plan is approved by the U.S. Environmental Protection Agency.

[5]National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a "reasonable time" after that state's implementation plan is approved by the U.S. Environmental Protection Agency.

[6]The Nevada State Implementation Plan adopted the Federal PM10 Standard in December 1991.

[7]The State ozone standard for Hydrographic Basin 90 (Lake Tahoe) is 195 µg/m3 (0.10 ppm).

MSL = mean sea level

Sources: Code of Federal Regulations 40 Part 50; Nevada Bureau of Air Quality.

particles smaller than 30 micrometers are generally recognized as emissions that may remain suspended indefinitely. The fraction of fugitive emissions in the various size categories is derived from the major emission source categories for a typical mining operation and is summarized in ***Table 3-37*** (U.S. Environmental Protection Agency 1985).

Construction and reclamation activities associated with the Twin Creeks Mine would cause an increase in fugitive and gaseous emissions in the local area. Air quality effects from construction would result in temporary impacts due to increases in local fugitive dust levels. Dust generated from these open sources is termed "fugitive" because it is not discharged to the atmosphere in a confined flow stream (e.g., stack, chimney, or vent). The principal sources of fugitive dust would include land clearing, earth moving, scraping, hauling, and materials storage and handling; drilling and blasting; truck loading operations; wind erosion from stockpiles; and ore handling operations. In addition, other fugitive emissions would be caused by mud/dirt carryout onto paved surfaces.

Particulate levels from construction and reclamation activities would vary, and impacts would depend on the activity location and the daily wind and weather. These activities would require a Surface Disturbance Permit from the Nevada Division of Environmental Protection, which would require that water sprays or other measures be taken to reduce fugitive dust emissions. While measures such as water sprays would reduce the amount of emissions from such activities, some level of fugitive dust emissions would be unavoidable due to the nature of the work.

During construction and reclamation, vehicle exhaust emissions would be generated; however, such emissions are small compared to fugitive emissions from earth moving, hauling, and other construction activities, and would not affect regional air quality. Although some impacts on air quality would occur during construction and reclamation, they would be transitory, limited in duration, would end at the completion of that particular phase of the work, and would not be considered significant. Once reclamation was completed, pollutant concentrations would return to background levels.

Air quality impacts due to emissions from mining operations would occur throughout the operational phase of the project. The primary pollutant would be fugitive dust particulates (total suspended particulates and PM_{10}) generated by the crushers, screen conveyors, and other processes. Other pollutants including nitrogen dioxide, carbon monoxide, and sulfur dioxide would result from exhaust from generators, boilers, vehicles, and other fuel burning equipment. Volatile organic compounds are emitted from fuel storage tanks. Total criteria pollutant emission rates at the Twin Creeks Mine are shown in ***Table 3-38***.

All criteria pollutant emission rates are less than 250 tons per year, therefore, the Twin Creeks Mine is not a "major stationary source" as defined by the U.S. Environmental Protection Agency. Air pollutant sources are deemed "major" for Prevention of Significant Deterioration purposes if their emissions exceed 250 tons per year.

Sources of fugitive dust and other criteria pollutants during the operations phase at the Twin Creeks Mine would include:

- Primary and secondary crushers
- Conveyors and stackers
- Screens
- Lime silo loading and unloading
- Smelting furnaces
- Truck loading
- Generators (gas and propane)
- Oxygen plant heater (gas)
- Steam generators (gas)
- Autoclave
- Boilers
- Overburden and ore stockpiles
- Paved and unpaved roads
- Fuel storage tanks

The State of Nevada has granted air quality permits for the existing mine operations and is reviewing a facility-wide permit application for the mine expansion project, including the existing sources. As part of the air quality permitting process for the Twin Creeks Mine, air quality modeling was performed using the planned particulate matter (PM_{10}) and gaseous emissions rates shown in ***Table 3-38***. The modeling addressed air quality conditions in the mine area and utilized on-site meteorological data. Results from modeling the various source emissions are presented in ***Table 3-39***.

The concentrations shown in the table are the maximum concentrations that would occur at the plant fenceline or outside the fenceline in areas of

TABLE 3-37
Estimated Particle Size Distribution for a Typical Mining Operation (Percent)

Process	Diameter (micrometers)					
	<2.5	2.5-5.0	5.1-10.0	10.1-15.0	15.1-30.0	>30.0
Material Handling	13	10	13	12	25	27
Unpaved Roads	10	10	16	14	30	20
Composite	11	10	14	13	28	24

Source: U.S. Environmental Protection Agency 1985.

TABLE 3-38
Total Criteria Pollutant Emissions at the Twin Creeks Mine

Pollutant	Emission Rate (tons per year)
Total suspended particulates	168.00
Particulates smaller than 10 micrometers	160.00
Carbon monoxide	130.76
Nitrogen dioxide	148.86
Sulfur dioxide	146.86
Volatile organic compounds	12.06

Source: Cole and Gillespie 1995b.

TABLE 3-39
Maximum Modeled Pollutant Concentrations Compared with National Ambient Air Quality Standards at the Twin Creeks Mine

Pollutant	Averaging Time	Model Results Concentration ($\mu g/m^3$)	National Ambient Air Quality Standards ($\mu g/m^3$) Primary	Secondary
PM_{10}	24-hour	36.4	150	150
PM_{10}	Annual	11.3	50	50
NO_2	Annual	2.13	100	Same as Primary
CO	1-hour	222.3	40,000	Same as Primary
SO_2	3-hour	30.9	---	1,300
	24-hour	7.0	365	---
	Annual	0.6	80	---
H_2S	1-hour	5.54	NA	NA
	Annual	0.04	NA	NA

Source: Cole and Gillespie 1995b; Cole 1996.

public access. These sources result in maximum concentrations of PM_{10}, nitrogen dioxide, carbon monoxide, and sulfur dioxide that would not exceed Nevada or National Ambient Air Quality Standards (Cole and Gillespie 1995a). There is no National Ambient Air Quality Standard for hydrogen sulfide. The modeling studies show that maximum 24-hour PM_{10} concentrations fall below 20.00 micrograms per cubic meter within about 1.2 miles (2 kilometers) of the mine boundary and that annual that annual concentrations of PM_{10} are less than 1 microgram per cubic meter within 0.6 mile (1 kilometer) of the mine boundary (Cole and Gillespie 1995b). Results of the modeling study indicate that the project would comply with all existing air quality standards and would not result in a significant impact to air quality. Furthermore, the No Action alternative would not have a significant impact on any Class 1 airshed for air quality or visibility since the nearest Class 1 area, the Jarbidge Wilderness, is more than 100 miles east of the project site.

3.9.2.2 Proposed Action

According to the Twin Creeks Mine air permit application, the planned mine expansion would result in a decrease from the present emissions of the gaseous pollutants nitrogen dioxide and carbon monoxide; however, sulfur dioxide emissions would increase due to process emissions associated with the Sage Mill operations (Cole and Gillespie 1995a). Impacts to air quality under the Proposed Action would be the same as described under the No Action alternative.

3.9.2.3 Other Project Alternatives

Impacts to air quality under the other project alternatives would be the same as described under the No Action alternative and Proposed Action.

3.9.3 Cumulative Impacts

Cumulative impacts to air quality could include impacts from existing Twin Creeks Mine emission sources and mining operations, the proposed expansion, reasonably foreseeable future activities at the Twin Creeks Mine, nearby existing mining operations, and background emission sources (e.g., natural background from windblown dust and traffic on unpaved roads in the region). Air impacts from mining operations tend to be localized in the vicinity of the source since the larger dust particles settle out near the source. For a typical wind speed of 10 miles per hour, particles larger than 100 micrometers are likely to settle out within 20 to 30 feet from the source. Particles 30 to 100 micrometers, depending on the extent of atmospheric turbulence, are likely to settle within a few hundred feet. Mining activities including loading, crushing, screening, and hauling tend to produce larger particles, while finer particles are generally products of combustion of diesel fuel or gas. Nearby operations, such as the Pinson Mine and the Getchell Mine, would have only limited overlap with the Twin Creeks Mine. The geographic extent of impacts from particulates due to the expansion of the Twin Creeks Mine is expected to be minimal.

Potential further expansion of pits at the Twin Creeks Mine would increase the overburden and interburden storage areas, and require an increase in ancillary facilities. However, such growth would not likely involve additional processing facilities. Further expansion would result in additional fugitive dust emissions from the disturbed areas; however, the additional emissions would be minimal compared to the entire cumulative impact area and would not have significant impacts on air quality.

The predicted maximum annual concentration of particulates at the point of closest public access beyond the property boundary is 2.3 mg/m^3 (***Table 3-39***). Adding an annual background of 9.0 mg/m^3, the total annual cumulative impact is predicted to be 11.3 mg/m^3. This would be well below the annual ambient air quality standard of 50 mg/m^3. Adding the predicted maximum 24-hour concentration of 26.2 to the background of 10.2, the total cumulative 24-hour impact would be 30.4 mg/m^3, which would not exceed the 24-hour ambient air quality standard of 150 mg/m^3. Other permitted and non-permitted sources of air emissions in the area are included in the background values. Cumulative air quality impacts would not be significant since the annual and 24-hour contributions from the mine sources would not cause the air quality in the region to degrade below national or state ambient air quality standards.

3.9.4 Monitoring and Mitigation Measures

Since significant impacts on air quality were not identified, specification of additional monitoring and/or mitigation measures is not recommended. SFPG currently has an ongoing program for monitoring particulate matter concentrations at the existing facilities. SFPG would continue monitoring ambient concentrations of particulates as well as meteorology at the mine site.

Air quality permits issued by the Nevada Division of Environmental Protection require SFPG to control emissions, including fugitive emissions, from sources at the mine site due to mining activities. SFPG would apply air pollution controls to reduce emissions during construction and operation of the mine. Baghouses with control efficiencies exceeding 99 percent are used on many of the existing facility operations, including lime storage silos, conveyors, and crushers where practical. Other operations are enclosed with fan dust systems and cyclones to reduce emissions to the atmosphere. Where baghouses are impractical, the control systems for screening and the conveying circuit would consist of fogging water sprays. Fugitive dust from all disturbed areas and unpaved roads would be controlled using water sprays, chemical stabilization, or other controls approved by the Nevada Division of Environmental Protection.

3.9.5 Residual Adverse Effects

Reclamation and revegetation would stabilize exposed soil and control fugitive dust emissions. As vegetation becomes established, particulate levels would return to what is typical for a dry desert environment. Once the mining activity ceases and wind erodible surfaces are reclaimed, the ambient air would revert to its original state. Consequently, there would be no residual adverse effects on air quality.

3.10 Land Use and Access

3.10.1 Affected Environment

3.10.1.1 Land Use

Approximately 80 percent of the land surface in Humboldt County is administered by a federal agency. The three major federal resource agencies having land management responsibilities in the county include the BLM, U.S. Fish and Wildlife Service, and U.S. Forest Service. U.S. Forest Service-administered lands are confined to the Humboldt National Forest in north-central Humboldt County. U.S. Fish and Wildlife Service-administered lands are limited to the Sheldon Antelope Range in the extreme northwest corner of the County. Lands administered by the BLM comprise the majority of public lands in the County (approximately 67 percent). Private lands comprise approximately 20 percent of Humboldt County and are primarily located near available water sources and arable lands (Tri-County Development Authority 1994). Surface management status in the project area is show in ***Figure 2-1***.

Public lands under BLM jurisdiction are managed for the multiple uses of range, hunting, forestry, watershed, mineral extraction, recreation, and wildlife habitat. The project area is contained entirely within the BLM's Paradise-Denio Resource Area, Winnemucca District. The Paradise-Denio Management Framework Plan (BLM 1982) designates land use within the project area as open for mineral exploration and development.

The project area is zoned M-3 (Open Land Use District) by Humboldt County for open space and provides for a wide variety of rural land uses. Mineral extraction industries are recognized as an accepted use within this land use classification. Mining is a principal permitted use within this zoning district and must comply with Article 10 of the Humboldt County Zoning Ordinance, which requires a Special Use Permit for temporary and permanent buildings and fences.

Land use within the project area primarily consists of livestock grazing, mineral exploration and development, dispersed recreational use, and minimal agricultural production. See Section 3.6, Range Resources, for a discussion of livestock grazing, and Section 3.11, Recreation and Wilderness, for a discussion of dispersed recreation. These lands are either public lands administered by the BLM or private lands. ***Figure 3-52*** depicts surface management status, existing rights-of-way, and range improvements in the project area.

There are three other gold mines in close proximity to the project area. They are the Getchell Mine, located approximately 2 miles to the west; and the Pinson and Preble Mines, located approximately 4 miles and 17 miles, respectively, southwest of the project area. Both the Getchell and Pinson operations are currently active. The Sierra Pacific Valmy Power Plant is another major industrial development in the project vicinity; it is located approximately 20 miles to the south-southeast.

Areas of irrigated cropland are concentrated primarily in Eden Valley, west of the project area, and in Kelly Creek Valley, south of the project area (**Figure 3-53**).

3.10.1.2 Access

Access to the project area is provided via Interstate 80, Nevada State Route 789 (Midas Road), and country and private gravel roads (see ***Figure 1-1***). Interstate 80 is the primary east-west highway in Nevada and connects the Winnemucca area with Reno to the west and Elko to the east. Nevada State Route 789 is a two-lane road that is also used to access the active Getchell and Pinson Mines. The pavement ends at the access road to the Getchell Mine and State Route 789 becomes a two-lane gravel road at this junction. Access to the project area is provided via County Road 513 (the Kelly Creek Road) and a private gravel road. The Kelly Creek Road also provides access to Chimney Reservoir and to public and private lands farther to the north. There is a security gate at the entrance to the Twin Creeks Mine to prevent unauthorized public access.

Traffic volumes on roads in Humboldt County are dominated by Interstate 80, with approximately 6,600 vehicles per day near Golconda. State Route 789 from Golconda north toward the Twin Creeks Mine carried approximately 780 vehicles per day in 1994 (Nevada Department of Transportation 1994).

Other transportation providers serving Winnemucca and vicinity are the Southern Pacific and Western Pacific Railroads, which provide freight service to Elko and Reno. Amtrak passenger service is also available. There is bus service and a general aviation airport, but no commercial air service is available (Gold Fields Operating Company 1986).

3.10.2 Environmental Consequences

The Proposed Action, No Action alternative, or other project alternatives could affect land use and access both directly and indirectly. Direct impacts may include the termination or modification of existing land uses, rights-of-way, or access routes in the project area. Indirect impacts may result in altered land use or access patterns to other use areas adjacent to or within proximity to the mine. Indirect impacts would also result if the Proposed Action or selected alternative stimulated or encouraged the development of land uses not presently anticipated, or conversely, precluded other planned or proposed uses.

Impacts to land use and access would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Incompatibility or inconsistency with land use plans, regulations, or policies adopted by local, state, or federal governments
- Establishment of land use(s) generally considered incompatible with existing land use patterns
- Changes to land use patterns that would threaten the economic viability of existing private enterprises (e.g., agriculture) or authorized uses of public lands (e.g., livestock grazing)
- Elimination or severe restriction of access to isolated parcels of private land or to public lands that are known to be used in support of private enterprises or are considered critical for established recreational activities

3.10.2.1 No Action Alternative

<u>Land Use</u>

The No Action alternative would involve both public and private lands. As currently planned, total new disturbance would be 850 acres on public land and 2,286 acres on private land, resulting in a total project disturbance of 3,136 acres (***Table 2-1***). The No Action alternative is consistent with plans and policies of the BLM that designate land use within the project area as open for mineral exploration and development. Proposed mining activities on private lands are consistent with the Humboldt County Zoning Ordinance and would require a Special Use Permit from Humboldt County for temporary and permanent buildings and fences. The No Action alternative would not conflict with adopted plans and policies and, therefore, would not result in a significant impact.

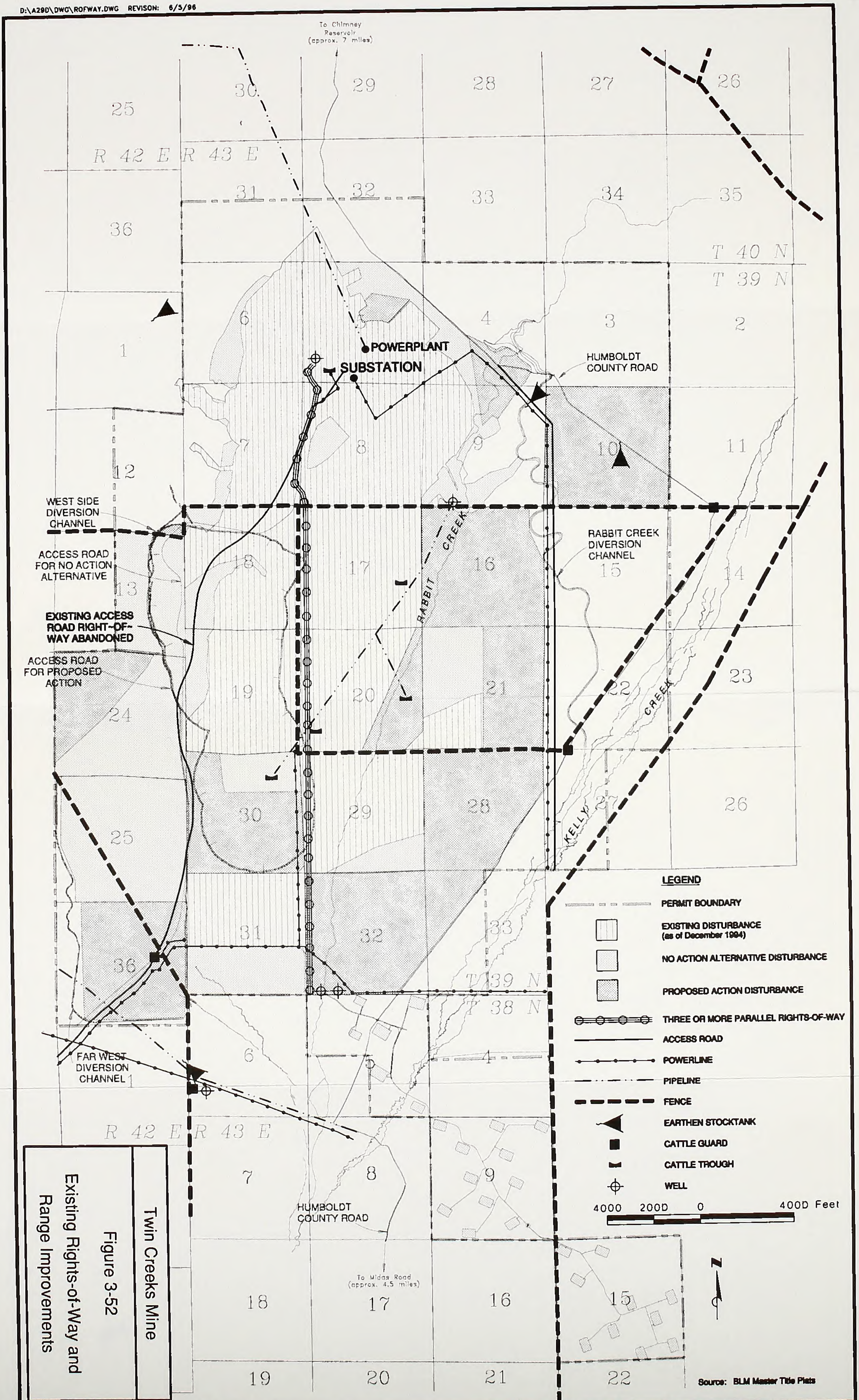
Public use of the existing project area is currently precluded. The No Action alternative also would preclude any public use of the affected lands for the life of the mine. For both safety and security reasons, public access to the active mining and processing areas would continue to be precluded to the maximum extent permitted by law during the life of mining.

The principal land uses in the vicinity of the No Action alternative, including dispersed recreation, livestock grazing, and mineral exploration and development, would not change during the life of the project. Therefore, the No Action alternative would not result in a significant impact to these land uses. However, the level of activity could change. For example, dispersed recreational use of the project area would be precluded (see Section 3.11.2.1, Recreation and Wilderness). In addition, the No Action alternative would disturb an additional 850 acres of public lands in the Dry Hills, Rabbit, and Bullhead Seeding pastures within the Bullhead grazing allotment (***Table 3-29*** and ***Figure 3-50***). The potential significance of these impacts to livestock grazing are described in Section 3.6.2.1, Range Resources.

All rights-of-way necessary to support operation of the No Action alternative are currently in place with the exception of a fresh water pipeline that is proposed to parallel the existing powerlines along the east side of the mine and a parking lot at the guard shack. The No Action alternative would result in the abandonment and relocation of a portion of the mine access road as a result of the South Pit expansion (***Figure 3-52***).

<u>Water Use</u>

Potential impacts on ground water use are discussed in Section 3.2.2, Water Quantity and Quality. Dewatering at the Twin Creeks Mine could result in drawdown of wells used to irrigate alfalfa



Twin Creeks Mine

Figure 3-52
Existing Rights-of-Way and Range Improvements

fields within eastern Eden Valley and Kelly Creek Valley (***Figure 3-53***). Drawdown of the aquifer used to support these agricultural uses may necessitate drilling additional wells to ensure a constant irrigation supply. The potential impacts to agricultural uses would be significant.

Access

The No Action alternative would have no impact on existing access to public and private lands in the project area. County Road 513 (Kelly Creek Road), which is located to the east of the Twin Creeks Mine, would remain open to the public. The security gate at the main entrance to the mine would remain to prevent unauthorized public access. Furthermore, the No Action alternative is not expected to present any barriers to access to pastures of the Bullhead grazing allotment. Therefore, the No Action alternative would not result in significant impacts to access.

Implementation of the No Action alternative is not expected to substantially increase average daily traffic volumes on County Road 513, State Route 789, and Interstate 80 since no changes are anticipated to the existing mine workforce.

Mine Closure and Reclamation

Closure and reclamation following the No Action alternative would return public lands to their premining land uses, including livestock grazing, wildlife habitat, and dispersed recreation. Some private lands would remain available for industrial use.

The required reclamation of the project area would include the reseeding of disturbed acreages except for the open pits. Reseeding would increase vegetative cover and make the area suitable for livestock grazing. Livestock grazing may be resumed after re-established vegetation is capable of supporting grazing, as determined by the BLM.

3.10.2.2 Proposed Action

Land Use

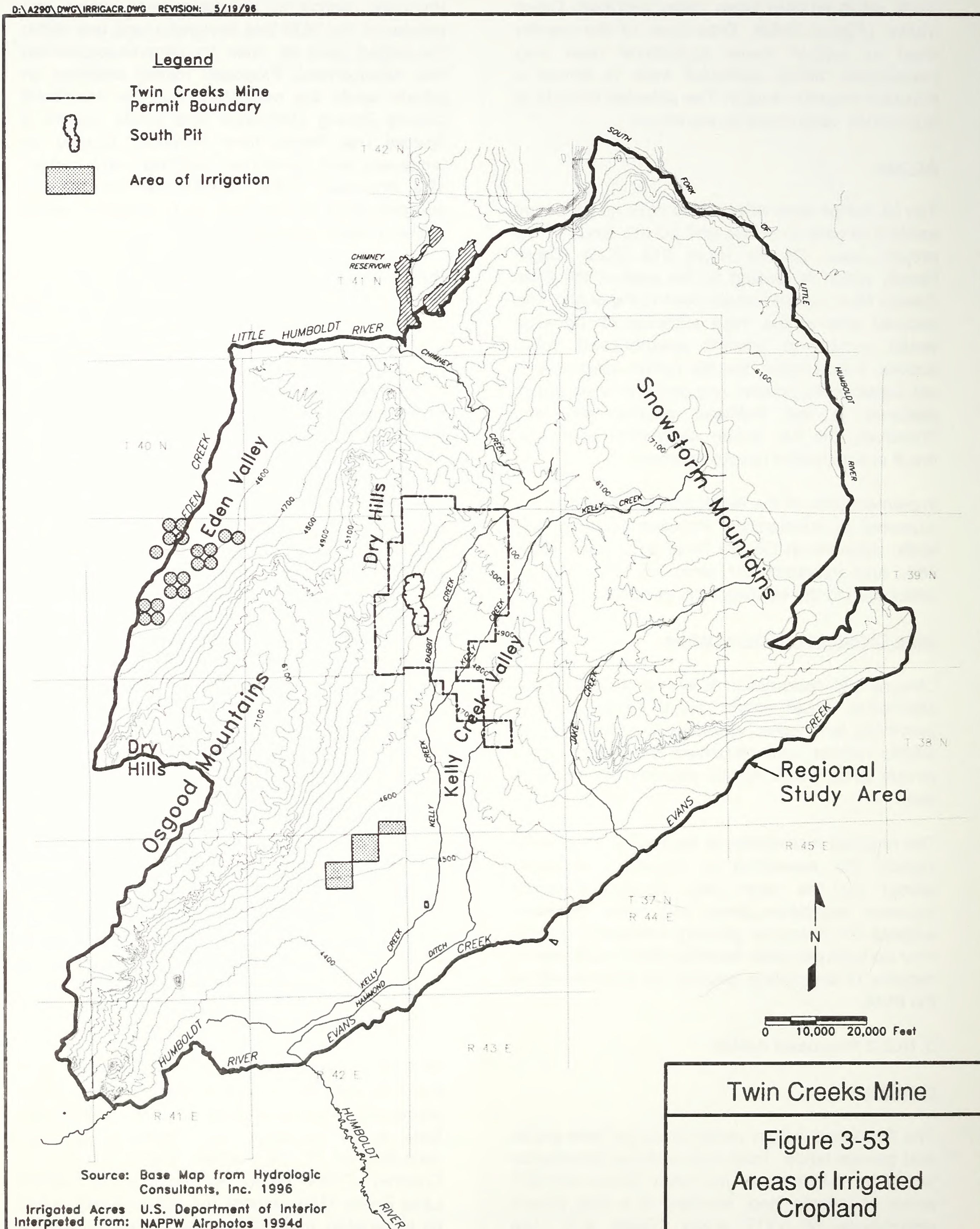
The Proposed Action would occur on both public and private lands. Total new surface disturbance would be 4,866 acres on public lands and 351 acres on private land, resulting in a total project disturbance of 5,217 acres (***Table 2-1***). The Proposed Action is consistent with plans and policies of the BLM that designate land use within the project area as open for mineral exploration and development. Proposed mining activities on private lands are consistent with the Humboldt County Zoning Ordinance and would require a Special Use Permit from Humboldt County for temporary and permanent buildings and fences. The Proposed Action would not conflict with adopted plans and policies and, therefore, would not be a significant impact.

Public use of the existing project area is currently precluded. The Proposed Action also would preclude any public use of the affected lands for the life of the mine. For both safety and security reasons, public access to the active mining and processing areas would continue to be precluded to the maximum extent permitted by law during the life of mining.

The Proposed Action would not be incompatible with existing land use patterns and, therefore, would not result in significant impacts to existing land uses. Dispersed recreational use of lands within the project area would continue to be precluded (see Section 3.11.2.1, Recreation and Wilderness). In addition, the Proposed Action would disturb or exclude grazing on an additional 5,138 acres of public lands in the Dry Hills, Rabbit, and Bullhead Seeding pastures within the Bullhead grazing allotment, and 418 acres of public lands in the Osgood allotment (***Table 3-22*** *and* ***Figure 3-50***).

Of primary concern, would be a reduction in the size of the Bullhead Seeding pasture (approximately 1,603 acres) that could compromise its current function as a high quality grazing resource and as a central holding pasture to facilitate livestock movements to and from winter and spring use pastures. Furthermore, the Proposed Action is expected to contribute to access difficulties to stock watering sources. The potential significance of these impacts to livestock grazing are described in Section 3.6.2.2, Range Resources.

All rights-of-way necessary to support operation of the Proposed Action are in place. The existing corner crossings associated with the Rabbit Creek Mine would no longer be necessary with the consolidation of the former Rabbit Creek and Chimney Creek Mines. Accordingly, all Federal Land Policy Management Act rights-of-way would be terminated, and the reclamation responsibilities



Twin Creeks Mine

Figure 3-53

Areas of Irrigated Cropland

would be transferred to the Twin Creeks Mine plan of operations and reclamation plan.

Portions of the current mine access road would be abandoned and relocated as a result of the South Pit expansion and construction of heap leach pad A (***Figure 3-52***). Relocation of the roadway around these facilities would require a new right-of-way across BLM lands in Section 18, Township 39 North, Range 43 East. Construction of leach pad A also would require adjustment of a pipeline right-of-way located in the southwest quarter of Section 36, Township 39 North, Range 42 East (***Figure 3-52***). The pipeline is used to transport water to the Osgood grazing allotment, located immediately west of the Twin Creeks Mine.

Water Use

Potential impacts on ground water use are discussed in Section 3.2, Water Quantity and Quality. Dewatering at the Twin Creeks Mine could result in drawdown of wells used to irrigate alfalfa fields within eastern Eden Valley and Kelly Creek Valley (***Figure 3-53***). The Proposed Action could result in drawdown of the aquifer used to support these agricultural uses in a more extensive area than that predicted for the No Action alternative (see Section 3.2.2, Water Quantity and Quality). Any drawdown may necessitate the drilling of additional irrigation wells to ensure a constant irrigation supply. The potential impacts to agricultural uses would be significant.

Access

The Proposed Action would not have an adverse impact on access to public and private lands in the project area. The security gate at the main entrance would remain to prevent unauthorized public access to the mine area.

The expansion of tailings area A, the construction of tailings area B, and the development of the Rabbit Creek Diversion in the northeastern portion of the mine would necessitate rerouting a portion of Humboldt County Road 513 (see Section 2.4.9). The length of the proposed reroute would total approximately 4 miles. SFPG would construct the new road on public lands around these facilities to ensure continued public access (***Figure 2-4***). Construction of the new road segment would occur prior to the construction of project facilities (during which time access would continue to be provided on the existing road) in order to allow uninterrupted public access to Chimney Reservoir and lands farther to the north (Smith 1996). Therefore, the Proposed Action would not result in significant impacts to access.

Implementation of the Proposed Action would increase average daily traffic volumes on local roadways throughout the construction phase. Additional vehicular traffic along Interstate 80, State Route 789, and County Road 513 during the 12-month construction period would result from the construction workforce of approximately 150 persons each day. Assuming that construction workers are not housed on site, and that they do not share rides, the workforce would add approximately 150 private vehicles to the daily traffic volume on these roadways. Construction-related equipment, supplies, and raw materials also would increase truck traffic on these roadways. However, construction-related traffic would be short-term (12 months), would not be expected to exceed traffic volume capacities of these routes, and would not be a significant impact on area roadways.

SFPG has indicated that no additional employment would be required during the operations phase under the Proposed Action. Therefore, average daily traffic, as a result of workers commuting to the mine, would not increase over current levels. The Proposed Action would result in an increase in the number of truck trips per day over existing levels. This increase would include additional materials brought to the Twin Creeks Mine, including 55 dump trucks per day of sulfide ore from the Mule Canyon Mine, 20 tanker trucks per day of flotation concentrate from the Lone Tree Mine, diesel fuel, blasting agents, mill reagents, and other mining and milling supplies, as well as materials shipped from the mine, including shipments of processed gold. This increase would not be expected to exceed traffic volume capacities on County Road 513, State Route 789, or Interstate 80 (see ***Figure 1-1***) and would not be a significant impact on area roadways.

The Proposed Action is expected to contribute to access difficulties to stock watering sources within the Bullhead grazing allotment. Projected traffic increases on County Road 513 (see ***Figure 1-1***) are also expected to result in a minimal increase in vehicle-livestock collisions (see Section 3.6.2.2, Range Resources). In addition, the increase in heavy truck traffic on this road would increase the amount of required maintenance on this portion of County Road 513. The Humboldt County Department of Transportation has indicated that SFPG must assume maintenance responsibilities for any county road on which they would be the primary user (Russum 1995).

Mine Closure and Reclamation

Closure and reclamation following the Proposed Action would return public lands to their premining land uses, including livestock grazing, wildlife habitat, and dispersed recreation.

The required reclamation of the project area would include the reseeding of all disturbed acreages except for the open pits. Reseeding would increase vegetative cover and make the area suitable for livestock grazing. Livestock grazing may be resumed after reestablished vegetation is capable of supporting grazing, as determined by the BLM.

3.10.2.3 Other Project Alternatives

The other project alternatives would not result in additional surface disturbance, with the exception of alternative 2 of the Overburden and Interburden Storage Area Alternatives. This alternative would require an additional 200 acres of disturbance and would encroach on private lands not owned by SFPG. This additional disturbance is minimal relative to the total project disturbance and would not be a significant impact. The other project alternatives would result in impacts to land use and access similar to those described for the Proposed Action.

3.10.3 Cumulative Impacts

Existing land uses within the cumulative impacts area, such as livestock grazing, agriculture, and dispersed recreation, could be adversely affected. Dewatering and groundwater withdrawals associated with the past, present, and reasonably foreseeable future actions identified in Section 2.6 would cumulatively result in drawdown of the groundwater aquifer that would exceed rates projected for the Proposed Action. Impacts to water resources in the cumulative impacts area are discussed in Section 3.2.3. Given that mining is an historic use in the region, it is unlikely that cumulative mine development would result in land uses that would conflict with local or federal policies, or be considered incompatible with existing land use patterns. Impacts to livestock grazing in the cumulative impacts area are discussed in Section 3.6.3 and cumulative impacts to dispersed recreational opportunities are described in Section 3.11.3.

3.10.4 Monitoring and Mitigation Measures

Land use and access mitigation relates primarily to range management and groundwater drawdown within the aquifer. Section 3.6.4, Range Resources, describes potential mitigation measures that could be implemented to minimize impacts associated with grazing distribution and access to water sources. Section 3.2.4, Water Quantity and Quality, describes potential mitigation that could be implemented to minimize impacts to the economic viability of irrigated agricultural operations within the aquifer. No other land use or access impacts would require monitoring or mitigation measures.

3.10.5 Residual Adverse Effects

Residual adverse effects to land use and access relate primarily to the success of the reclamation efforts. If reclamation efforts are successful and former land uses are continued (i.e., dispersed recreation or livestock grazing), residual adverse effects would be minimal.

3.11 Recreation and Wilderness

3.11.1 Affected Environment

3.11.1.1 Recreation

Dispersed outdoor recreation is the predominant type of recreation in the Paradise-Denio Resource Area. The BLM does not maintain current recreational use data for the public lands in the project area; however, recreational use within the vicinity of the project is assumed to be limited. This is a result of low population levels in the surrounding area and difficult access to public lands caused by the checkerboard pattern of public and private land boundaries, which serves to restrict public access across some private lands. A lack of improved roads in the region also inhibits recreational access.

Dispersed recreational activities that occur in the project area include hunting, hiking, sightseeing, rockhounding, mountain biking, and fishing on the Humboldt River. The Paradise-Denio Resource Area provides hunting opportunities for a variety of game animals, including mule deer, pronghorn, sage grouse, chukar, pygmy rabbit, and waterfowl. Hunting for big game is regulated through a quota system established by the Nevada Division of Wildlife. The quota system is oversubscribed each year for deer and pronghorn tags because demand exceeds supply.

Mule deer hunting is the predominant type of hunting in the region. Tag return data indicate that 266 bucks were harvested in western Humboldt County during the 1994 hunting season. This compares to a harvest of 198 bucks in 1993. The deer herd in this area is now increasing in numbers after a decline from 1988 to 1993 (Nevada Division of Wildlife 1995a).

The Humboldt River, located to the south of the project area, is considered a significant warm water/cool water fishery by the Nevada Division of Wildlife. Sport fish within the Humboldt River include walleye, white bass, smallmouth bass, white crappie, and channel catfish (French 1995). Summary statistics compiled by the Nevada Division of Wildlife indicate that annual angler-days on the Humboldt River averaged 5,741 during the past 14 years (Nevada Division of Wildlife 1995b).

Opportunities for primitive camping and recreational use of four-wheel drive vehicles also exist throughout the project area. Camping within the project area, however, is thought to be limited because of the absence of a year-round water supply. Most of the Paradise-Denio Resource Area is designated as open to use by off-highway vehicles. However, existing operations at the Twin Creeks, Getchell, and Pinson Mines are restricted by fencing and security guards patrolling the premises. These actions are taken for safety and security reasons and to prevent illegal camping and entry by unauthorized personnel.

No developed recreational facilities exist within the project area. Developed recreational facilities used by residents of the Winnemucca area include Chimney Reservoir, Water Canyon Park (proposed), and Rye Patch Reservoir. There are no state parks within the Paradise-Denio Resource Area or in proximity to Winnemucca.

Chimney Reservoir is operated by Humboldt County. The reservoir contains over 2,000 surface acres and is located approximately 7 miles north of the project area. Developed facilities at this site include a picnic table, pit toilet, and a boat ramp. Overnight camping is permitted at the reservoir, although running water is not available. Water levels within the reservoir have been relatively low during the past several years as a result of recent drought conditions, and angler use during calendar years 1992 through 1994 decreased to an average 375 angler-days per year. Angler-days averaged 1,240 annually for the previous 14 years (Nevada Division of Wildlife 1995b).

The proposed Water Canyon Park is located 1 mile south of the city limits of Winnemucca. This area is administered by the BLM's Sonoma-Gerlach Resource Area and currently receives heavy use from Winnemucca residents. This use has resulted in severe damage to the riparian area and elimination of the local fish population. The BLM is in the process of developing a management plan for this area, which could include developing new facilities and repairing riparian areas.

Rye Patch Reservoir is located in Pershing County approximately 60 miles south/southwest of Winnemucca. The reservoir provides up to 11,400 surface acres that are available for fishing and water sport activities (canoeing, boating, water skiing, swimming, etc.). Developed camping facilities are also available. The reservoir is managed by the state parks system, and receives heavy use during spring and summer weekends and holidays (Williams, S. 1995).

Lye Creek Campground is located approximately 20 miles north of the town of Paradise. This U.S. Forest Service-administered campground contains nine developed campsites, restrooms, and a water system. The site was expanded to 13 campsites during the 1995 summer season (Williams, T. 1995).

Developed urban recreational facilities in Humboldt County are located within Winnemucca and include basketball and tennis courts; a sports complex that includes four softball fields and is also used for soccer; three little league fields; a golf course; three city parks; several playgrounds; a bowling alley; roller rink; and two swimming pools. Rural areas of the county are generally limited in organized recreational facilities, although a community park is currently proposed in Golconda (Tri-County Development Authority 1994).

3.11.1.2 Wilderness

The North Fork Little Humboldt Wilderness Study Area is located approximately 10 miles north of the project area. This Wilderness Study Area is approximately 81,000 acres in size and provides opportunities for upland game hunting, backpacking, camping, and nature photography (Clemons 1995). The Little Humboldt River Wilderness Study Area is located approximately 10 miles northeast of the project area in western Elko County. It covers approximately 42,000 acres and offers opportunities for solitude, hunting, fishing, backpacking, camping, and wildlife viewing. Nighttime sky glow generated by current operations at the Twin Creeks Mine is visible from within this Wilderness Study Area (Treiman 1996). These Wilderness Study Areas are presently administered by the BLM in accordance with the Interim Management Policy and Guidelines for Lands Under Wilderness Review (BLM 1993) in order to prevent impairment of their wilderness values. They will be administered as such until Congress either designates them (and other Wilderness Study Areas in Nevada) as Wilderness or releases them from the wilderness review process through legislation.

The closest designated wilderness is the Santa Rosa-Paradise Peak Wilderness. This wilderness is administered by the U.S. Forest Service and is located approximately 30 miles north of Winnemucca. The Santa-Rosa Paradise Peak Wilderness is approximately 31,000 acres in size and provides opportunities for hiking, horseback riding, and primitive camping (Williams, T. 1995).

3.11.2 Environmental Consequences

Impacts to recreation and wilderness would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Permanent changes in recreation resource availability within, or adverse effects to the management of county, state, or national parks, wildlife refuges, wilderness areas, or Wilderness Study Areas
- Displacement of recreational use from an area for which there are no reasonable substitutes as a result of decreases in game population, aesthetic experience, loss of access, or other reasons directly related to the proposed project
- Reduction or loss of fisheries in the Humboldt River as a result of mine dewatering or surface water contamination
- Increased total recreation demand in the region (as measured by population change) over baseline conditions that exceeds the current supply of recreational opportunities

3.11.2.1 No Action Alternative

No parks, concentrated recreational use areas, BLM Wilderness Study Areas, designated wilderness areas, or protected natural areas would be impacted by the No Action alternative. Therefore, there would be no significant impacts to these areas under the No Action alternative. Implementation of the No Action alternative would withdraw public lands currently available for dispersed recreation. Recreational activities, such as hunting, rock collecting, and off-highway vehicle use would be prohibited within the mine during the life of the proposed project. The presence of an active mine could also inhibit recreational use of adjacent public lands as a result of human activity and noise associated with mining operations.

Overall, the displacement of dispersed recreationists would be a minimal adverse impact since existing recreational use in the project area is relatively light, and the area has abundant public, open space lands available for dispersed recreational opportunities. Public access would not be restricted on public roads near the mine site or to Chimney Reservoir (See Section 3.10.2.2). Although no specific recreational use data for public lands directly affected by the proposed project are available, the number of dispersed recreationists affected is expected to be minimal, and their displacement would not create overuse of other areas or degradation of the resource. Therefore, significant impacts would not occur from the displacement of dispersed recreationists under the No Action alternative.

Adverse impacts to big and small game populations are not anticipated as a result of implementation of the No Action alternative (see Section 3.5.2, Wildlife and Fisheries Resources). Consequently, impacts to hunting opportunities are not expected.

No adverse impacts to fisheries located in the Humboldt River are expected as a result of operations under the No Action alternative (see Section 3.5.2, Wildlife and Fisheries Resources). In addition, the probability of a release of hazardous materials into the Humboldt River during transport of mine-related reagents is low (see Section 3.15.2, Hazardous Materials). Therefore, the No Action alternative is not expected to result in a significant impact to fisheries in the Humboldt River.

Developed recreational facilities within the region are not expected to be adversely impacted through implementation of the No Action alternative. Facilities at Chimney Reservoir could experience increased use as a result of transient workers camping during the construction period. Other regional recreational facilities such as Rye Patch Reservoir could experience increased demand during the construction phase. Recreational facilities located within Winnemucca are considered adequate to serve current population levels and would be able to absorb any extra demand placed on them as a result of the addition of temporary construction-related residents to the area (DeForest 1996). Consequently, significant impacts to developed recreation facilities would not occur under the No Action alternative.

Closure and reclamation following the No Action alternative would return public lands to their premining land uses, including livestock grazing, wildlife habitat, and dispersed recreation. Except for the mine pits, all other facilities would be revegetated, and the public lands would be available for public access and dispersed recreational activities.

SFPG would limit human access to the pit lake by construction of berms and elimination of the ramps into the pit following closure. However, since human access cannot be precluded with absolute certainty, a human health risk assessment was conducted to assess the potential impacts associated with recreational use of the pit lake (see Appendix D). The risk assessment (Parametrix 1996) concluded that there would be no significant human health impacts from the limited exposure to the pit lake under the No Action alternative.

3.11.2.2 Proposed Action

Impacts under the Proposed Action would be the same as those described for the No Action alternative.

3.11.2.3 Other Project Alternatives

The other project alternatives would have no additional impacts on recreation and wilderness resources beyond those discussed for the No Action alternative and the Proposed Action.

3.11.3 Cumulative Impacts

Past and present actions within the cumulative impact area have resulted in restrictions to access of public lands for dispersed recreation. The reasonably foreseeable future actions identified in Section 2.6.2 would further restrict dispersed recreational opportunities. Therefore, cumulative mine development would adversely impact dispersed recreational opportunities within the cumulative impact area. None of the cumulative development projects would directly affect any parks, concentrated recreational use areas, designated wilderness or Wilderness Study Areas, or other protected areas in the region. Abundant public open space lands would remain available for dispersed recreational opportunities. However, it is not known at this time whether the reasonably foreseeable future actions would result in a significant increase in local population such that demand in the Winnemucca area would exceed the current supply of developed recreational opportunities. If the demand for developed recreational opportunities within the Winnemucca area were to exceed the available supply, additional facilities would need to be developed. Impacts to game pop ulations and fisheries on the Humboldt River as a result of cumulative actions are de scribed in Section 3.5.3, Wildlife and Fisheries Resources.

3.11.4 Monitoring and Mitigation Measures

No significant impacts to recreation and wilderness resources were identified; therefore, monitoring and mitigation measures are not recommended.

3.11.5 Residual Adverse Effects

No residual adverse effects to recreation and wilderness resources are expected from implementation of the proposed project.

3.12 Social and Economic Values

3.12.1 Affected Environment

This section describes existing socioeconomic conditions in the study area that includes Humboldt County, in general, and the communities of Winnemucca, Golconda, and Battle Mountain, in particular. The study area for the socioeconomic analysis was based on the location of the mine in Humboldt County and the resident locations of existing employees at the Twin Creeks Mine.

3.12.1.1 Population and Demography

Humboldt County's population trends reflect the fluctuations characteristic of the boom-bust cycles associated with the mining industry. Although population growth in the county has been consistent for several decades, annual growth rates have fluctuated dramatically. ***Table 3-40*** shows population trends between 1980 and 1994. Humboldt County's population grew by 36 percent in the 1980s, from 9,434 in 1980 to 12,844 in 1990. This represents an average annual growth rate of 3.6 percent. According to population estimates, strong growth continued into the 1990s with an average annual growth rate of 4.4 percent from 1990 to 1994. The 1994 estimated population for the county was 15,640.

The City of Winnemucca also had strong growth in the 1980s, averaging 4.8 percent annually. Recent population estimates for the first half of the 1990s indicates a minimal slowdown to an average annual growth rate of 3.4 percent (***Table 3-40***).

During the period from 1980 through 1990, Battle Mountain, in Lander County, had a modest population growth rate of 2.9 percent annually up to a 1990 population of 3,542. The only available population data for Golconda was the 1990 census indicating a population of 429 persons. No recent estimates were available for these two areas. Current projections for the region indicate strong growth through 1995, largely attributable to mining activity (Tri-County Development Authority 1994).

The 1990 U.S. Census data indicate that population density in Humboldt County is approximately 1.3 persons per square mile. According to U.S. Census standards, Humboldt County is considered a rural county. Winnemucca, which accounted for 47 percent of the county population in 1990, is the only U.S. Census designated "urban" area in the county.

There are currently 970 employees (including contractors) working at the Twin Creeks Mine. Of these, approximately 628 employees (65 percent) reside in Winnemucca, 228 employees (23 percent) reside in Battle Mountain, 57 (6 percent) in Golconda, and the remaining 57 (6 percent) in other areas, including Midas, Valmy, Imlay, and Lovelock. Given the most recent population estimates (***Table 3-40***), mine employees make up nearly 9 percent of Winnemucca's population (1994 estimate), 6 percent of the population of Battle Mountain (1990 estimate), and about 13 percent of Golconda's population (1990 estimate).

3.12.1.2 Economy and Employment

Historically, Humboldt County's economy has been directly influenced by the economic health of the mining industry. The development of the county began in the 1800s as a primary trading post for pioneers heading west. In 1869, the Central Pacific Railroad further bolstered the area's economic growth. In the early 1900s, the silver rush resulted in a significant influx of prospectors and related population growth. The first highway opened in 1920 and later became Interstate 80. Winnemucca became a favorite and logical rest stop, as it was halfway between Salt Lake City and San Francisco. In the 1930s, gambling was established and has continued to grow throughout the state.

Today, the Humboldt County economy is dominated by the mining sector and, to a somewhat lesser extent, the services industry, which has grown in response to tourism. According to the Overall Economic Development Plan Update for Humboldt County (Tri-County Development Authority 1994), while direct employment by the mining industry accounts for less than one-third of the total labor force, over 56 percent of the county's total economic activity is generated by the gold-mining sector, which also accounts for two-thirds of county total income and approximately one-third of county industrial employment.

The most recent available data on the number of firms in the Humboldt County mining sector dates to 1992 (Nevada Employment Security Department 1995). In that year, there were 28 mining-related firms. These firms accounted for less than 10 percent of total firms in the county. According to the Nevada Department of Taxation, there were 12

TABLE 3-40
Study Area Population

	1980[1]	1990[1]	1980-1990 Percent Change	1980-1990 Annual Average Growth Rate	1991[2]	1992[2]	1993[2]	1994[2]	1990-1994 % Change	1990-1994 Average Annual Growth Rate
Humboldt County	9,434	12,844	36%	3.6%	13,500	14,000	14,510	15,640	22%	4.4%
Winnemucca	4,140	6,134	48%	4.8%	6,580	6,640	6,910	7,170	17%	3.4%
Golconda	N/A	429	---	---	N/A	N/A	N/A	N/A	---	---
Battle Mountain	2,749	3,542	29%	2.9%	N/A	N/A	N/A	N/A	---	---

[1]U.S Department of Commerce 1991.
[2]Atkins 1995.
N/A - Not available.

producing mines in Humboldt County in 1994 (DiCianno 1995). The mining sector accounted for 29 percent of the county's 1994 total industrial employment (***Table 3-41***). The mining sector is the largest employment sector in Humboldt County followed by the services sector, which accounted for 23 percent of total non-agricultural employment. The trade and government sectors accounted for 19 and 18 percent, respectively. ***Table 3-41*** also indicates that the employment growth rate was the highest in the mining and services sectors between 1990 and 1994.

The economic reliance on the mining industry can be destabilizing to the economy as mining activity, and its resulting effect on the region, fluctuates with world metals demand and prices. This potential risk has been noted by local development authorities. In 1969, the Humboldt County General Plan was adopted setting up the first guidelines to direct growth, support existing businesses, and diversify economic activity. The 1994 Economic Development Plan Update also sites the need to economically diversify the region. The current plan identifies recreation, geothermal resources, agriculture, and industrial development as potential opportunities for diversifying action.

Sectors with potential risk-offsetting effects include agriculture, gaming, and tourism in general. Agricultural production in Humboldt County is one of the highest in the state (Tri-County Development Authority 1994). The tourism industry is centered around Winnemucca and includes gaming, historical education, outdoor recreation, and entertainment. Tourism and gaming has been growing in the area as is reflected by the growth in the services and trade sectors. However, these sectors, in general, require much lower skill levels for operation and, therefore, average wages are much lower in these sectors than in the mining sector. These sectors do, however, contribute to regional economic diversity.

General labor force information for Humboldt County is also shown in ***Table 3-41***. The data indicate that the labor force grew at an annual average rate of 4 percent from 1990 to 1994. The unemployment rate also remained steady at or near 5.8 percent of the labor force. This unemployment rate was the second lowest rate in the state in 1994 (Nevada Employment Security Department 1995).

Current employment at the Twin Creeks Mine numbers 970, accounting for approximately 46 percent of the mining sector employment in Humboldt County.

Per capita personal income in the county increased an average of 4.5 percent per year between 1990 and 1992. In 1992, per capita income was $19,335 compared to $18,498 estimated for 1990. These income estimates are lower than the non-metropolitan statewide averages of $19,267 in 1990 and $20,652 in 1992 (U.S. Department of Commerce 1994). The Nevada Employment Security Department reports that the average yearly income for a mine machine operator in Humboldt County ranged from $27,000 to $33,000 in 1992, with an average of $30,250. This is typically double the wages of the trade and service sectors (Nevada Employment Security Department 1992). Average annual income for workers at the Twin Creeks Mine is currently $32,500, 7.4 percent greater than the 1992 county average.

The average monthly payroll at the mine is approximately $55,850,000 (including contractor's wages). If one assumes that 70 percent of this is disposable income (based on an average income tax rate of 30 percent), then approximately $39,095,000 is spent in nearby communities on necessities, entertainment, and savings, with some leakage out of the study area. According to University of Nevada Economist John Dobra, disposable income spent would multiply through the state's economy, generating more spending, at a rate of 2.57 (Dobra 1989). This means that the initial $39,095,000 could generate an additional $61,379,000 in statewide spending.

3.12.1.3 Housing

In 1990, the U.S. Census Bureau reported that there were 2,923 housing units and 2,121 mobile homes in Humboldt County. Of these, 3,054 (69 percent) were owner-occupied and 1,404 (31 percent) were renter occupied. The Census also reported that the homeowner vacancy rate was 1.7 percent of the existing housing stock. In Battle Mountain there were 566 homes and 865 mobile homes for a total of 1,431. Of these, 816 (65 percent) were homeowner occupied and 449 (35 percent) were renter-occupied. The homeowner vacancy rate in Battle Mountain was 8.6 percent (U.S. Department of Commerce 1991).

According to the Overall Economic Development Plan Update for Humboldt County (Tri-County Development Authority 1994), the demand for

TABLE 3-41
Humboldt County
Non-Farm Labor Force Summary Data[1]

	1990	1991	1992	1993	1994	% of 1994 Total Industrial Employment	% Change 1990-1994[2]
Total Labor Force	6,780	7,420	7,650	7,880	7,870	----	16
Unemployment	370	330	430	480	460	----	.24
Unemployment Rate (%)	5.5	4.5	5.6	6.1	5.8	----	.24
Annual Average Employment by Sector							
Mining	1,530	1,760	2,000	2,090	2,090	29	37
Construction	520	490	360	370	380	5	(27)
Manufacturing	110	110	100	100	100	1	(9)
Transportation & Utilities	290	300	310	300	320	4	10
Trade	1,090	1,120	1,030	1,170	1,310	19	20
Finance, Insurance & Real Estate	90	90	90	100	110	1	2[illegible]
Services	1,210	1,500	1,470	1,520	1,650	23	36
Government	1,010	1,050	1,180	1,230	1,280	18	27
TOTAL NON-FARM INDUSTRIAL EMPLOYMENT	**5,840**	**6,420**	**6,540**	**6,890**	**7,250**	**100**	**24**

[1]Nevada Employment Security Department 1995.
[2]Parentheses indicate percentage decrease.

housing has been high over the previous 10 years. Also according to the Update, the cost for a single-family residence in Winnemucca ranges from $60,000 to $135,000, averaging close to $80,000.

Mobile home prices range from $40,000 to $65,000, averaging $55,000. The median price of a home in Battle Mountain was $58,700 in 1990. As of February 1, 1996, there were 34 homes and 24 mobile homes for sale in the Winnemucca/Golconda multiple listings publication (Hornbargar 1996), and 2 homes and 1 mobile home for sale in Battle Mountain (Campbell 1996). According to area realtors, listings are on the market from 60 to 120 days, depending on quality and price.

According to the 1990 Census information, there were approximately 1,404 rental units in Humboldt County and 449 rental units in Battle Mountain (U.S. Department of Commerce 1991). According to area realtors and property management personnel, the rental markets in the region are very limited. In the Winnemucca area, it was reported that there is a zero vacancy rate for rental units. In Battle Mountain, the vacancy rate was reported to be less than 1 percent. In many cases there are waiting lists for these units (Campbell 1995; Faber 1995; Ray 1995).

Rental housing consists of multi-family complexes and single-family residences. The U.S. 1990 Census reported that the median contract rent in 1990 was $272 per month in Battle Mountain, $364 per month in Winnemucca, and $263 per month in Golconda (U.S. Department of Commerce 1991). According to local realtors, the average monthly rent in the region for homes, apartments, or mobile homes in 1995 were:

$400 to $450	- one-bedroom
$450 to $500	- two-bedroom
$500 and up	- three-bedroom

Short-term, transient housing in Humboldt County is concentrated in Winnemucca. According to data provided by the Humboldt County Chamber of Commerce, there are approximately 1,200 units in 24 hotel/motels. In addition, there are approximately 280 units in Battle Mountain. Parking and hook-up services for recreational vehicles are available in Winnemucca and Battle Mountain. The busiest tourist season begins in June and ends in September. Weekend vacancy rates during this period are frequently near zero (Marden 1995).

The residency pattern of current employees at the Twin Creeks Mine results in the demand for a maximum (likely to be less as some workers might share housing) of 628 units in Winnemucca, 228 units in Battle Mountain, and approximately 57 units in Golconda. Housing demand for the Twin Creeks Mine employees consists of both temporary rentals and permanent sales. Although it appears current demand is being met by area housing, the supply of available housing is limited.

In order to aid new employees, SFPG conducts a housing program for salaried-exempt employees relocating from non-local areas. New salaried-exempt employees are provided with a furnished house or accommodations at a local motel for 90 days.

3.12.1.4 Community Facilities and Services

Water

According to the Overall Economic Development Plan Update, approximately 50 percent of Humboldt County residents are served by public or private water distribution services. The remaining county residents rely on private wells or developed springs. The City of Winnemucca provides water distribution to its municipal jurisdictions. The Golconda Water District provides water to the residents of Golconda, and Lander County provides water to the residents of Battle Mountain.

The City of Winnemucca serves 8,000 metered customers, with usage peaking during the summer months. The water is drawn from four wells and one developed spring and then is stored in tanks with a total capacity of 2.9 million gallons. Current use is approximately 22 percent of the projected build out of the service area. Current service is adequate for existing population levels and moderate growth. However, to accommodate total buildout of the service area, it would be necessary to install another 3.5 million gallons of storage facilities (Tri-County Development Authority 1994).

Water service to Golconda residents is provided from one spring and one well, with storage capacity of 150,000 gallons. The Golconda Water District currently has 82 customers. Current service is adequate for the existing customers. The district is in the process of drilling a new well and installing a second 150,000-gallon storage tank. This will allow for expansion and will supply the Golconda volunteer fire department with pressurized water (Collins 1995).

Water service in Battle Mountain is provided to approximately 1,200 residents from 3 community wells. The town has storage capacity of 2.3 million gallons. Within the year, a new water line will be installed to provide additional capacity and pressure. The new line would traverse Interstate 80 and connect to lines serving a planned school site. In addition, a new mainline and 1 million gallon storage tank will be constructed to increase capacity and provide for growth (Clap 1996). Current service is adequate for existing meters. Excess capacity exists for up to 400 additional residences.

Potable water at the Twin Creeks Mine is currently supplied from underground wells and distribution pipelines located on the site.

Wastewater Treatment

Approximately one third of the county households process wastewater through independent septic systems. The remaining two-thirds of the households are connected to a wastewater treatment facility. Winnemucca residents are connected to the City of Winnemucca wastewater treatment facility. This facility serves 8,000 persons and has a capacity of 1.5 million gallons per day. The average flow to the facility is 0.98 million gallons per day (approximately 65 percent of capacity) and peaks in the summer at 1.1 million gallons per day (approximately 73 percent of capacity). Any additions to the service area would require upgrades to the system (Tri-County Development Authority 1994).

There is no wastewater treatment facility in Golconda. Wastewater is handled through private septic systems (Collins 1995).

Battle Mountain residents are served by wastewater facilities operated by Lander County. The treatment facility has a capacity of 1.2 million gallons per day. Current usage consists of approximately 0.55 million gallons per day (approximately 46 percent of capacity). Once 80 percent of capacity is reached, the county must begin planning system expansion. The county already has $800,000 set aside for engineering this expansion (Clap 1995).

Facilities at the current mine site consist of septic systems constructed to meet the requirements of the Nevada Division of Consumer Heath Protection Services and Humboldt County.

Solid Waste Disposal

There are over 10 rural landfills in Humboldt County. Because of recent federal and state regulations, most of these will be closed within 18 months (McVey 1996). The City of Winnemucca and Humboldt County are currently operating the regional landfill located 5 miles north of Winnemucca. This landfill is currently being permitted as a non-hazardous municipal solid waste landfill. This landfill has adequate capacity for existing and future population growth (McVey 1996).

Non-hazardous solid waste generated by the current mining operations is disposed of at one of two on-site approved Class III landfills. Hazardous wastes generated at the site are currently transported to approved disposal facilities by approved waste transporters.

Schools

The Humboldt County School District total enrollment for 1995-96 was 3,516 students, an increase of 4.8 percent over the 1994-95 enrollment. The Battle Mountain School had a combined enrollment of 1,547 for the 1995-96 school year, an increase of 8.9 percent over the previous year's enrollment. ***Table 3-42*** presents the student population by school and indicates each school's capacity and the percentage of capacity currently allocated.

Winnemucca has three elementary schools, one intermediate school, one junior high school, and one high school. Children from Golconda attend Winnemucca schools, and children from Battle Mountain attend elementary school, middle school, and high school in Battle Mountain. There is one private school in Winnemucca.

When examining total enrollment in all area schools, 97 percent of available capacity has been allocated, indicating a need for new school construction. ***Table 3-42*** indicates that three schools in the Humboldt County School District are over 80 percent allocated. The high school, in particular, is approaching capacity indicating a need for capital-improvements planning. The district is currently building a new physical education facility at the high school as part of a 4-year expansion process that will eventually include administrative offices, media center, cafeteria, and 10 classrooms. This phased expansion would increase the capacity of the high

TABLE 3-42
School Enrollment and Capacity

School	Capacity[1]	Enrollment 1993 - 1994	Enrollment 1994 - 1995	Enrollment 1995 - 1996	Percent of Capacity (1995 - 1996)
Elementary					
Winnemucca Grammar	400	385	394	347	87
Grass Valley Elementary	600	537	600	527	88
Sonoma Heights	590	621	682	549	93
Battle Mountain Elementary #1	250	400	385	470	greater than 100
Battle Mountain Elementary #2	250	366	330	328	greater than 100
Junior High					
Winnemucca Junior High	750	727	754	555	74
French Ford Middle School	625	- - -	- - -	570	91
Battle Mountain Junior High	250	344	319	347	greater than 100
High School					
Albert Lowry High School	1000	822	923	968	97
Battle Mountain High School	500	390	387	402	80
TOTAL	**5,215**	**4,592**	**4,774**	**5,063**	**97**

[1]Indicates capacity of permanent school facilities; portable classrooms are not included.
Sources: Hensley 1995; Lords 1995.

school from 1,000 students to 1,200 students (Lords 1996).

Three schools in the Lander County School District, Eliza Pierce and Mary S. Black elementary schools and the Battle Mountain Junior High School, are in excess of fixed capacity. According to Leon Hensley, Superintendent for the Lander County School District, the elementary schools and junior high are currently using 26 portable classrooms to meet enrollment. The district has collected $3 million to build a new elementary school; however, because of the limitations of the Battle Mountain water system, the district cannot get approval for construction from the state fire marshal until upgrades to the water system are completed.

Upon this approval, construction of the elementary school would take 18 to 24 months. There are no current plans to expand the junior high school facilities at this time (Hensley 1995).

The Humboldt County School District employs 250 teachers and certified personnel. The average class size is approximately 22 pupils in elementary schools and 25 in junior and high schools. The district's per student expenditure was $5,176 for the 1994-95 school year. This expenditure encompasses total operating costs for K through 12th grades (Lords 1995).

The Lander County School District employs 103 teachers. The average class size varies from 17 to 22 pupils in elementary schools and from 23 to 26 pupils in the junior and high schools. Current expenditures per pupil total $4,300 (Hensley 1995).

Adult education classes are offered to assist area adults in earning a high school diploma or finishing their general equivalency diploma programs. In addition, the Great Basin Community college offers classes and associate degree programs. The college has moved into a new 11,400-square-foot facility that will provide a permanent home for the program. It is expected that this facility will allow for growth of the college. In addition, the college, assisted and supported by the county, is attempting to acquire funding for a telecommunications facility and vocational skills training (Tenney 1995).

Fire Protection

Fire protection in Humboldt County is provided by local, state, and federal agencies, with extensive co-ordination from a county fire protection officer. There are local volunteer fire departments in the City of Winnemucca and in Golconda in Humboldt County, and in Battle Mountain in Lander County. The types, numbers, and quality of fire fighting equipment vary for each location as does the level of training of the volunteers (Johnstone 1995; Wright 1995).

The Nevada Department of Forestry is self-equipped to fight both structure and wildland fires. It is directly responsible for fighting fires on state lands and assists local and federal agencies under mutual assistance agreements. Both the U.S. Forest Service and BLM provide fire fighting capabilities on federal lands in Humboldt County.

Hazardous Material (HazMat) responses are currently coordinated by the Local Emergency Planning Committee. The Committee coordinates responses to emergencies and provides training to rural and city department volunteers (Johnstone 1995).

Law Enforcement

The Humboldt County Sheriff's Department provides police protection throughout the county. The sheriff's staff includes 13 deputies and 4 reservists. The county's law enforcement officers are supplemented by Nevada Department of Investigations officers. In addition to law enforcement, the sheriff's department is assigned responsibility for Humboldt County's jail, civil process, and county-wide emergency communications. The jail currently has capacity for 61 men and women (Nelms 1995).

The Winnemucca Police Department provides protection within the municipal boundaries and in cooperation with the Sheriff's Department, as necessary. The Department has 14 officers and 2 reservists. The department has applied for a federal grant to create two additional officer positions (Johnstone 1995). Current appraisal of service is that the department is short-handed and in need of at least two additional officers to provide adequate urban protection

The Lander County Sheriff's Department provides law enforcement to Battle Mountain. The department has 13 deputies and 1 reservist. Current services are considered adequate for existing population levels (Kranovich 1996).

Health Care

Health care facilities in Humboldt County include the Humboldt General Hospital in Winnemucca. This facility has 18 acute care beds, 12 long-term beds, an intensive care unit, and an obstetrics unit. Mobile services are also available. Humboldt General Hospital has 5 family practitioners, 5 surgeons, 1 internist, and 33 nurses. Specialists visit the county regularly to provide additional services as needed. Emergency transportation services are provided by the Humboldt County Volunteer Ambulance Corps under the jurisdiction of the hospital. Other services include physical therapy, dentistry, and mental health services. The hospital's 1994 occupancy rate was approximately 40 percent for general services and 97 percent for nursing home services. There are no current plans to expand operations, only to enhance existing services (Quinton 1995).

Battle Mountain General Hospital serves largely as an emergency facility. Treatment consists of emergency procedures aimed at patient stabilization. There is also a clinic providing the services of two family doctors. Emergency transportation is provided by the Lander County Sheriff's Department. There are current plans to expand the hospital, adding in-patient facilities (Lee 1995).

The existing Medical Emergency Plan in effect at the Twin Creeks Mine requires that a qualified volunteer medical response team be on site at all times. This team is trained as first responders to medical emergencies on site and coordinates with the Humboldt General Hospital Ambulance, as necessary. Personnel at the mine are also trained in first-aid, rescue, and fire suppression. Equipment maintained on site includes: two emergency vehicles with Humboldt County Sheriff radios, trauma kits, and first-aid kits.

3.12.1.5 Government Administration and Public Finances

Humboldt County has a commissioner form of government, with three elected commissioners serving 4-year terms. The county administers many services, including fire protection, roads, recreation facilities, library, water, sewer, and planning.

The City of Winnemucca was incorporated in 1917 and operates by a mayor-council form of government. The mayor and five council members are elected to 4-year terms. Administrative duties performed by the city include animal control, fire protection, golf course maintenance, mosquito and weed abatement, police, prosecutor, public works, recreation, landfill, and street maintenance services.

Golconda and Battle Mountain are not incorporated communities; therefore, they are under county jurisdiction. The Humboldt County government is primarily supported by ad valorem/property taxes, sales taxes, and net proceeds taxes. Net proceeds of mines (gross proceeds less allowable expenditures) are taxed by the state's centrally assessed property tax division. This tax, currently $5 per $100 (if net is over $4 million), is assessed on net proceeds or net profit. The county receives revenues equal to its ad valorem rate applied to the net proceeds, and the State of Nevada receives the balance of the generated revenues. For example, Humboldt County's ad valorem tax rate is 2.4948 per $100 (Gillespie 1995). Therefore, the county will receive $2.50 for every $100 of net mining proceeds generated in the county. The State of Nevada will receive the remaining $2.50 on every $100 of net mining proceeds generated in Humboldt County. The net proceeds from mines in Humboldt County showed a slight decrease from 1992 to 1994, although a reversal in this trend is expected (DiCianno 1995). ***Table 3-43*** indicates net proceeds tax revenue for Humboldt County for the years 1992 to 1994. The Humboldt County portion of this tax is distributed within the county in the same manner as the ad valorem tax revenues.

Table 3-43 also shows ad valorem/property tax and sales tax revenues for Humboldt County. Both of these taxes have generated increasing tax revenues over the 3-year period. Property tax and intergovernmental transfers, of which sales tax and net proceeds tax are included, account for nearly 80 percent of county operating revenue (Tri-County Development Authority 1994).

The sales and use tax rate in Humboldt County for all transactions is 6.5 percent, broken down as follows:

Local School Support Tax	2.25 percent
Basic City-County Relief Tax	.50 percent
Supplemental City-County Relief Tax	1.75 percent
State of Nevada Sales/Use Tax	2.00 percent
Total Tax Rate	6.50 percent

Local school support tax revenues are collected by the state and redistributed to school districts based on enrollment and the per student cost of education.

A large percentage of the State of Nevada's revenue is derived from the collection on gaming winnings. Nongaming tax revenues consist of sales

TABLE 3-43
Humboldt County Tax Revenue

Revenue Source	1991 - 1992	1992 - 1993	1993 - 1994
Property Tax Collected	$10,114,701	$9,947,151	$11,354,573
Sales Tax[1,2] Collected	$6,178,797	$6,961,783	$8,029,878
Net Proceeds[3]	$2,355,158	$2,348,888	$2,052,099[4]
TOTAL	**$18,648,656**	**$19,257,822**	**$21,436,550**

[1]Harmon 1995, based on fiscal year.
[2]Based on taxable sales as reported and a county sales tax rate of 6.5 percent (2.0 percent accrues to the state; therefore, the effective county sales tax rate is 4.5 percent).
[3]DiCianno 1995, based on calendar year and county property tax rate of 2.4948.
[4]Estimated.

tax, the statewide gas tax, cigarette and liquor tax, the drug manufacturer's tax, the estate and lodging tax, and the net proceeds from mines tax.

The assessed valuation of properties in Humboldt County has increased by 12.6 percent from fiscal year 1991-92 to 1995-96, or from $152,491,006 to $171,759,449 (Fetters 1995). This reflects not only reappraisals, but also a general increase in property value and property improvements. Increases in assessed valuation typically generate increases in property tax revenue, and are partially reflected in ***Table 3-43***. Property tax revenue is generated by assessing a 2.4948 tax rate on every $100 of assessed valuation.

SFPG contributes to Humboldt County revenues through the payment of property tax, sales tax, and net proceeds tax. In 1994, SFPG paid $1.3 million in county property taxes and approximately $2.4 million in net proceeds tax (***Table 3-44***). As net proceeds taxes are split by the county and state, the total 1994 county revenue from property and net proceeds taxes amounted to $2.5 million, to be allocated according to the county formula. Sales tax revenue is also split by county, municipalities, and state depending on the location of sales. Estimated sales and use taxes paid by SFPG in 1994 was $3,800,000, of which $1,178,000 went to the state and $2,622,000 went to counties and municipalities. Comparing ***Tables 3-43*** and ***3-44*** indicates that SFPG accounted for approximately 11.4 percent of the county's property tax revenue and approximately 58 percent of the county's net proceeds tax revenue in 1994.

3.12.2 Environmental Consequences

This section describes potential impacts to population; economy and employment; housing; and community facilities and services, which include water supply, wastewater treatment, solid waste disposal, schools, fire protection, law enforcement, health care, and social services. Also discussed are potential impacts to government administration and public finances.

The No Action alternative and Proposed Action were evaluated for issues relating to the social, cultural, and economic well-being and health of minorities and low income groups. Such issues are termed environmental justice issues, and none were identified for the Twin Creeks Mine project. Social and economic impacts of the No Action alternative and Proposed Action would not affect minority or low income groups disproportionately. Potential effects to Native American groups are presented in Section 3.8, Cultural Resources.

The following workforce numbers were used to conduct the socioeconomic impact analysis:

- No Action Alternative
  - Construction phase: 300 employees over 12 months
  - Operations phase: no additional workers would be needed above the current operations work force of 970 employees

TABLE 3-44
Taxes Paid by Santa Fe Pacific Gold Corporation

Taxes Paid	1993	1994
Property Tax	$1,300,000	$1,300,000
Net Proceeds Tax[1]	2,500,000	2,400,000
County Portion	1,250,000	1,200,000
State Portion	1,250,000	1,200,000
Estimated Sales Tax	2,600,000	3,800,000
TOTAL TAX	**6,400,000**	**7,500,000**

[1] Net Proceeds Tax paid for operations in Humboldt County are equally split between county and state due to county mill levy of 2.4948.
Sources: Maley 1995; Guthrie 1996.

- Proposed Action
  - Construction phase: 150 employees over 12 months
  - Operations phase: same as the No Action alternative

__Construction Phase Assumptions__

- The construction workforce is assumed to be 15 percent local. That is, 85 percent of the construction workforce would enter the area from non-local origins (Maley 1995).

  The indirect construction employment (secondary or induced employment) is calculated using a construction employment multiplier of 1.2 based on *The Economic Impacts of Nevada's Mineral Industry*, by University of Nevada Economist John Dobra (1989).

- Based on previous EISs prepared for similar gold mining projects in northern Nevada, it is assumed that 70 percent of the indirect labor force would be second persons in a direct labor household or current residents of the Winnemucca, Golconda, and Battle Mountain areas.

- Based on previous EISs prepared for similar gold mining projects in northern Nevada, the construction workforce composition is estimated to be 80 percent single (including married without family present) and 20 percent married with families. The population estimates are based on 1 person per single household and an average of 3.5 persons per married household.

Significance criteria that were used to analyze socioeconomic impacts of the No Action alternative and the Proposed Action are listed below. Impacts are considered significant if these criteria are met or exceeded. Both beneficial and adverse impacts are evaluated and disclosed.

- The population change associated with workforce requirements is 10 percent greater than current levels.
- The long-term employment increases by more than 10 percent in Humboldt County.
- The demand for housing exceeds the existing supply when project-related needs are considered.
- The permanent demand on infrastructure is greater than 10 percent of current levels.
- The change in local tax bases (property, net proceeds, or sales taxes) is greater than 10 percent over current levels.

3.12.2.1 No Action Alternative

The No Action alternative would allow for the currently permitted project to continue as planned. Construction of the No Action alternative facilities is anticipated to take approximately 12 months and would require a peak construction workforce of 300 workers. The operations component of the No Action alternative would result in a continuation of current mining operations and continued employment for the life of the project estimated to conclude in the year 2000. Without any further expansion plans and/or permits, the Twin Creeks Mine would close at this time.

This analysis is based on the assumption that the current total of 970 employees (Maley 1995; Schielke 1995) would remain employed at the mine until 1998 when the mine labor force would start to be phased down until the final shutdown, estimated to be in the year 2000.

Population and Demography

Winnemucca, Battle Mountain, and Golconda would continue to host the majority of employees associated with the Twin Creeks Mine as described in Section 3.12.1. Anticipated population increases resulting from construction of the No Action alternative are presented in ***Figure 3-54***. This figure presents impacts related to peak construction employment of 300 temporary employees. The figure also includes anticipated indirect or secondary employment as calculated through the multiplier analysis.

Construction. The effect on area population would depend largely on the number of in-migrating workers and the characteristics of their families. SFPG predicts that 85 percent, or 255 construction workers would be hired from non-local origins (Maley 1995) (***Figure 3-54***). In addition, it is anticipated that the construction phase would induce another 18 in-migrants into the area. Given the previously stated assumptions, in-migrating workers and their families would number approximately 410 persons.

Assuming that in-migrants follow a similar residency pattern as currently established by the existing workforce at the mine, approximately 65 percent (267 persons) would seek to reside in or near Winnemucca and 24 percent (98 persons) would seek accommodations near Battle Mountain. The remaining 45 people would spread out in the region. Therefore, it is estimated that the population of Winnemucca would increase by 3.7 percent (using 1994 population estimates), Battle Mountain would increase by 2.8 percent, and the Humboldt County population would increase by almost 2 percent. Currently, 13 percent of existing mine employees reside in Golconda, however, due to limited infrastructure and available housing, it is unlikely that many construction workers and their families could relocate to this community.

These numbers represent the No Action alternative peak construction workforce which would be on the site for only part of the construction phase. Typical construction involves fluctuating workforces as special crews may only be employed for certain projects lasting only several weeks. These population increases would not be significant as they would be temporary (12 months or less) and are under the 10 percent significant impact threshold.

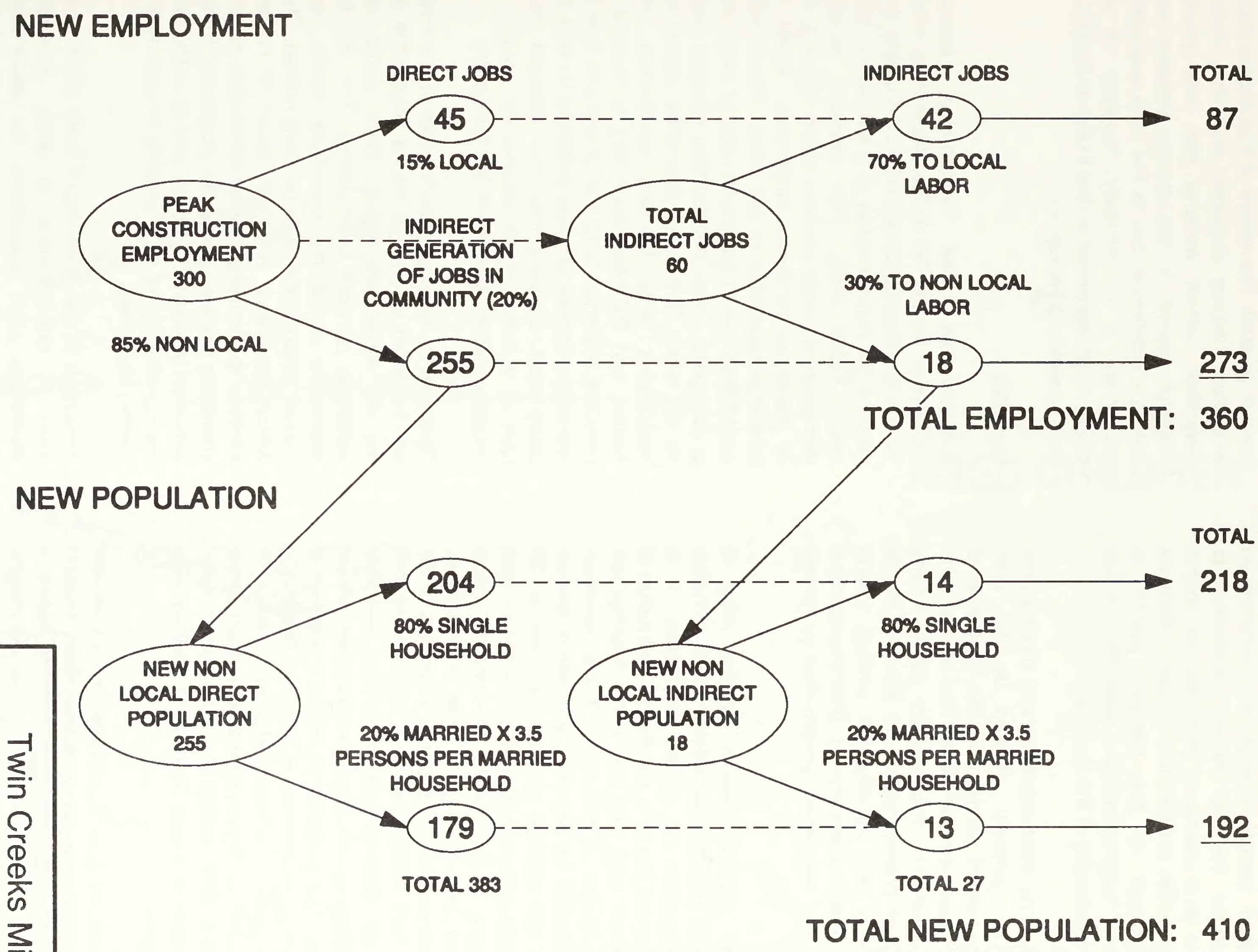
Operations. Continued operation of the Twin Creeks Mine, as permitted under the No Action alternative, would result in the stabilization of the area's population until 1998 when lay-offs would begin. Given a phased downsizing, the regional economy should be able to assimilate a portion of those laid-off from the mine, thereby maintaining the current population. However, determining the exact extent of assimilation and out-migration is not possible at this time as the assimilative potential of the region is dependent on prevailing economic conditions and the timing of the layoffs.

Economy and Employment

The principal economic effects of the No Action alternative would be a temporary increase in the construction employment in Humboldt County and a continuation of the current mining employment through the year 2000.

Construction. It is estimated that a total of 87 jobs (direct and indirect) would be created for local persons, and a total of 273 jobs for non local in-migrants (***Figure 3-54***). These 360 total direct and indirect jobs, created during the construction phase, would represent an increase of approximately 4.5 percent over current employment levels. This impact would not be significant, but would be a n economic benefit to individuals and to the regional economy.

An additional 300 construction positions would temporarily increase employment in the construction sector by approximately 12 percent (using 1994 data). An additional 60 secondary positions would increase employment primarily in the services and trade sectors by approximately 2 percent. Indirect employment was estimated using a multiplier of 1.20 (Dobra 1989). The Dobra study indicates that rural areas experience an increase of 0.20 workers for each new mine worker. The model represents an aggregation of rural counties in Nevada. This increase would be a beneficial impact, but not significant.



Twin Creeks Mine

Figure 3-54

No Action Alternative New Employment and Population - Construction Phase

The expected annual payroll for construction activities under the No Action alternative is estimated at $6.8 million, or $566,666 per month for the 12-month construction phase. Assuming that 70 percent of the monthly payroll is discretionary, approximately $396,666 would available for spending in the local economy.

Operations. The local economy and employment conditions as currently affected by the Twin Creeks Mine would persist until the beginning of the phased downsizing in 1998. That is, the mine would continue to account for 970 mining employees, or approximately 40 percent of the county mining and construction sectors (using 1994 sector employment levels). This is currently a substantial and significant contribution to county employment.

The current monthly payroll at the mine is approximately $55,850,000 (Maley 1995; Schielke 1995). Under the No Action alternative, it is assumed that this figure is a sufficient estimation of monthly payroll until that time when employment downsizing begins at the mine. If one assumes that 70 percent of the payroll is disposable income (based on an average income tax rate of 30 percent), then approximately $39,095,000 in 1995 dollars would be available annually for local expenditures and savings. These expenditures would decrease with the eventual shutdown of the mine. With mine closure, workers would eventually be let go. The salaries from these jobs, and their multiplier effect in the local communities, would also be lost. The workers would likely attempt to acquire work at other mines in the area, depending on the availability of jobs at that time. If jobs were unavailable, the unemployed workers would either remain in the area, continuing their demands on social services, or would relocate to another area for employment.

Projecting precise quantity impacts to the local and regional economy is not possible. Such impacts would depend on the personal spending habits of employees. It is sufficient to say that the magnitude of employment at the Twin Creeks Mine does generate economic activity in all sectors. Winnemucca, the regional urban center, would continue to benefit the most from the continuing operations and expenditures, however, some leakage outside Winnemucca and the region is likely.

The eventual loss of 970 positions would have an adverse effect on economic activity and employment in general. The extent of this impact depends on future mining projects and the ability to assimilate laid-off workers into new positions. Although growth in the mining industry cannot continue indefinitely due to the finite availability of resources, it is currently capable of some employment assimilation due to the strength of the mining sector in the region.

Housing

Construction. The construction population projections for the No Action alternative, over the 12-month construction period, could create a peak demand for approximately 273 temporary housing units (***Table 3-45***). This demand would be decreased if single workers share housing. Many of these construction employees would have limited assignments at the mine. These workers would likely seek hotel/motel units of which supply is adequate. Other construction workers required for the entire 12-month construction period would likely seek rental houses, apartments, mobile homes, and RV sites. According to housing data provided in Section 3.12.1.3, at any one time there are approximately 20 units available for rent in the study area. Consequently, the demand for this type of housing would exceed the supply. This impact would be significant, but temporary.

Operations. As employment levels at the mine are not expected to change during operations under the No Action alternative, there would be no additional demand for housing. The No Action alternative would not contribute further to the current strain in the local housing market. The No Action alternative, however, would do nothing to alleviate the housing market constraints other than stabilizing the area economy, potentially improving expected investment returns, and possibly causing the construction of new housing through improved market incentives.

Shutdown of the mine would likely result in some level of out-migration. If such out-migration decreases area population, the accompanying decrease in demand for housing would relieve some of the strain in the housing market.

Community Facilities and Services

It is estimated that the construction phase under the No Action alternative would result in a total of approximately 77 children entering the region. ***Figure 3-55*** depicts the student enrollment

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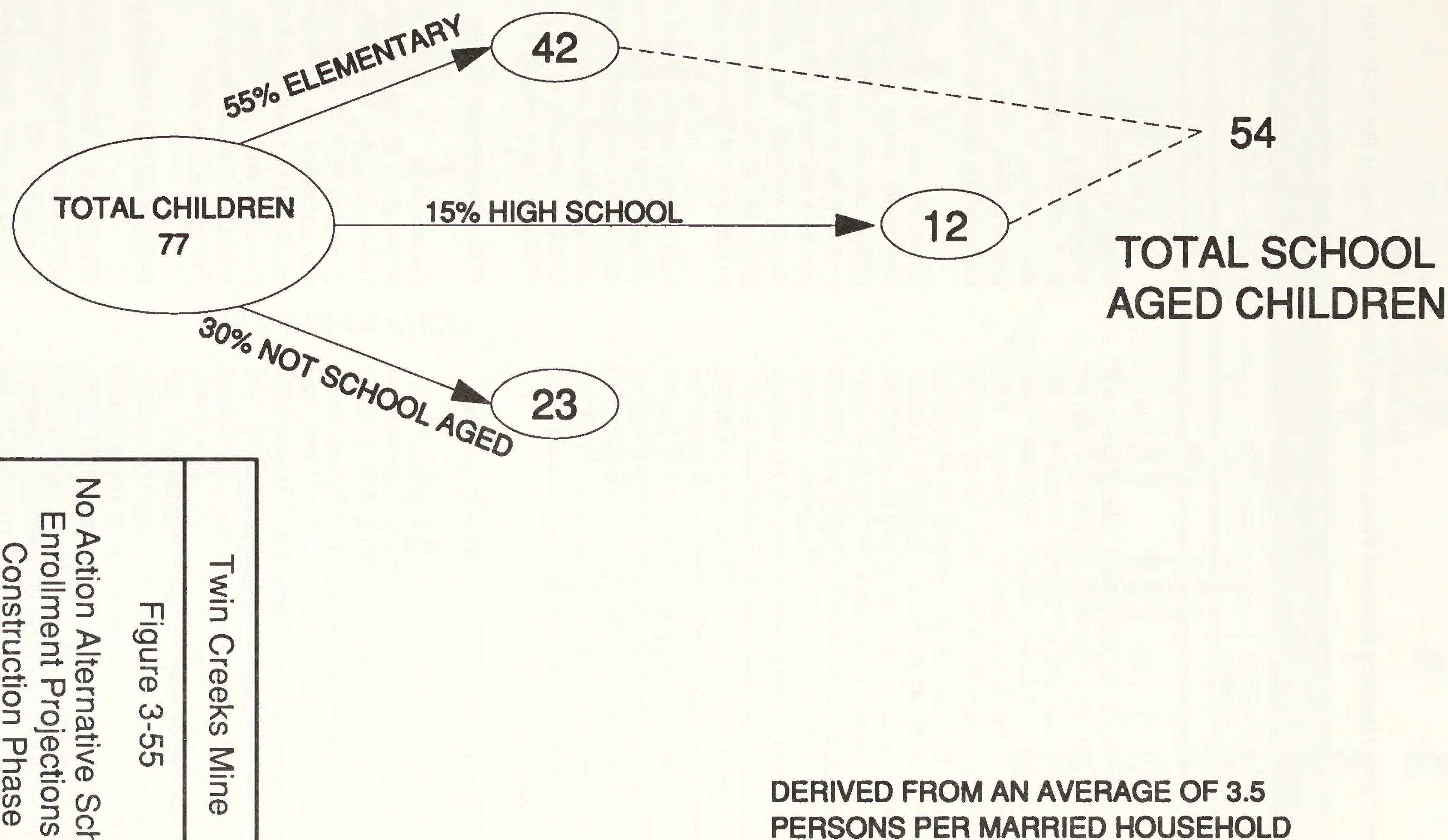

Twin Creeks Mine

Figure 3-55

No Action Alternative School Enrollment Projections - Construction Phase

TABLE 3-45
No Action Alternative
Short-Term Housing Demand From In-Migrant Households During the 12-Month Construction Phase

Household Type	Direct Labor-Related Households	Indirect Labor-Related Households	Total Households
Single-Status Workers	204	14	218
Married-Status Workers	51	4	55
TOTAL	**255**	**18**	**273**

projections based on the stated assumptions. Of the 77 children, 54 would be of school age, with 42 of elementary age and 12 of high school age. An influx of 54 children would increase total enrollment in the study area by 1 percent. This would be a temporary impact and would not be significant. The No Action alternative would not result in a significant increase in demand for other community facilities and services. No additional adverse impacts to community facilities and services would be expected. During the phased closing of the No Action alternative, laid-off workers would, to some extent, impact job service centers and would likely result in increases in unemployment compensation and worker retraining programs. The total effect on these social services would be determined by the prevailing economic conditions, the employment assimilation potential of the region, and the ***Figure 3-55*** availability of suitable substitute employment. Depending on the existing conditions at the time of closure, this impact could be significant.

<u>Government Administration/Public Finances</u>

The No Action alternative would result in the continuation of production and processing activities at the Twin Creeks Mine until 2000. SFPG would continue to pay property taxes, payroll taxes, sales taxes, and net-proceeds taxes to local, state, and federal taxing entities. ***Table 3-44*** indicates the level of property taxes, net-proceeds taxes, and estimated sales taxes paid by the Twin Creeks Mine in 1993 and 1994. The property taxes SFPG paid to Humboldt County accounted for approximately 11 percent of the total tax revenue collected in 1994. The net-proceeds tax is shared by the state and county as indicated on the table. Net-proceeds taxes associated with existing mine operations accounted for approximately 58 percent of the net-proceeds tax revenue collected by the county in 1994. The sales tax contributions were estimated by SFPG and indicate that as much as $3.8 million in sales tax revenue was collected by the county in 1994. Contributions to county property tax, sales tax, and net-proceeds tax revenue are, and would continue to be, significant.

Given this data, it is anticipated that the No Action alternative would contribute approximately $6.3 million annually in 1994 dollars to the county in property, sales, and net-proceeds tax. These taxes are then allotted to the government general funds, school districts, and other taxing districts. The state also would collect approximately $1.2 million annually in net proceeds taxes.

During the phase down of operations, the tax contributions by the mine would begin to decrease, lagging by one year in most cases. The year following shutdown would be the last year of tax contribution, resulting in an overall decrease of $7.5 million (in 1994 dollars) in annual tax contributions.

3.12.2.2 Proposed Action

Construction of the proposed facilities is anticipated to take approximately 12 months. During that time, the construction workforce would grow to a peak of 300 workers. Current employees are expected to continue working through the construction phase, and transition into the new facilities and operations as permitted. It is expected that the life of the project would extend through the year 2011.

<u>Population and Demography</u>

Anticipated population increases resulting from construction of the Proposed Action are presented in ***Figure 3-56.*** This figure presents impacts related to peak construction employment of 150

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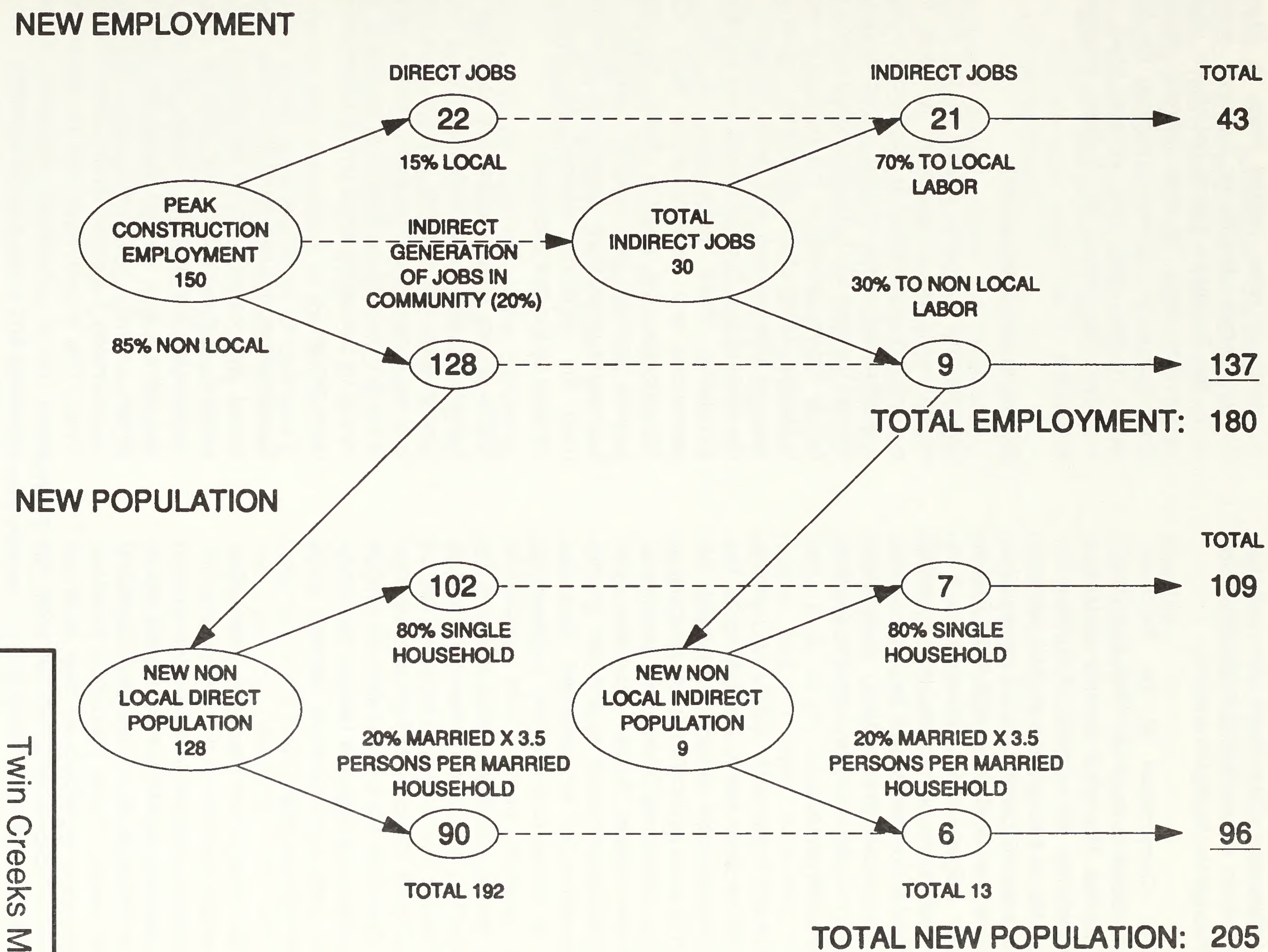

Twin Creeks Mine

Figure 3-56

Proposed Action New Employment and Population - Construction Phase temporary employees. The figure also includes anticipated indirect or secondary employment as calculated through the multiplier analysis.

Construction. Construction of the Proposed Action is scheduled to begin in 1996 and would require 12 months. The effect on area population depends largely on the number of in-migrating workers and the characteristics of their families. SFPG predicts that 85 percent, or 128 construction workers would be hired from non-local origins (Maley 1995) (***Figure 3-56***). In addition, it is anticipated that the construction phase would induce another 9 in-migrants into the area. Given the previously stated assumptions, in-migrating workers and their families would number approximately 205 persons.

Assuming that in-migrants follow a similar residency pattern as currently established by the existing workforce at the mine, approximately 65 percent, or 133 persons, would seek to reside in or near Winnemucca and 49 (24 percent) would seek accommodations near Battle Mountain. The remaining 23 people would spread out in the region. Therefore, it is estimated that the population of Winnemucca would increase by almost 2 percent (using 1994 population estimates), Battle Mountain would increase by approximately 1 percent, and the Humboldt County population would increase by approximately 1 percent. Currently, 13 percent of mine employees reside in Golconda, however, due to limited infrastructure and housing, it is unlikely that many construction workers and their families could relocate to this community.

These numbers represent the peak construction workforce which would be on the site for only part of the construction phase. Typical construction involves fluctuating workforces as special crews may only be employed for certain projects lasting only several weeks. These population increases are not considered significant as they would be temporary (12 months or less) and are under the 10 percent significant impact threshold.

Operations. Operations under the Proposed Action are anticipated to require no additional mining personnel over the current level and are projected to continue through the year 2011. Assuming the mine life is not extended, operations personnel would gradually be phased out. At that time, if no additional economic activity is occurring in mining or other related fields in Humboldt County, people directly or indirectly employed under the Proposed Action operations could be expected to leave the area, thereby decreasing population levels. However, phasing the closure period of the mine over several years would minimize the effect of sudden changes in population.

<u>Economy and Employment</u>

The principal economic effects of the Proposed Action would be a temporary increase in the construction employment in Humboldt County and a continuation of the current mining employment through the year 2011. The Proposed Action would further induce growth in the retail and services industries. Most of the economic impact would occur in Winnemucca and Battle Mountain with the influx of new population and new employment stimulating these economies. A few new businesses and services would likely start in Winnemucca and possibly Battle Mountain to provide services not currently available. Other businesses would likely expand their operations to meet the additional demand for goods and services by the new population.

SFPG is an equal opportunity employer with women and minority workers employed at the Twin Creeks Mine and at other projects. It is possible that the Proposed Action would have a beneficial affect on minority or female employment in the county by increasing employment opportunities for these groups.

Construction. It is estimated that a total of 43 jobs (direct and indirect) would be created for local persons, and a total of 137 jobs for non local immigrants (***Figure 3-56***). These 180 total direct and indirect jobs, created during the construction phase, would represent an increase of approximately 2 percent over current employment levels. This impact would not be significant, but would be a substantial economic benefit to individuals and to the regional economy.

In addition, the construction phase of the Proposed Action could decrease the unemployment rate of 5.8 percent (1994) by approximately one point. The actual impact would likely be less than this as it is assumed that a portion of the 43 created jobs would be filled by those transferring from other employment within the area.

An additional 150 construction positions would increase the employment in the construction sector by 6 percent (using 1994 data). This impact would be temporary based on the duration of peak construction employment. An additional 30 secondary positions would increase employment in the services and trade sectors by approximately 1 percent. This increase would be a beneficial impact, but not significant.

The expected annual payroll for construction activities is estimated at $3.4 million, or $283,333 per month for the 12-month construction phase. Assuming that 70 percent of the monthly payroll is discretionary, approximately $198,333 would be available for local spending on housing, food, clothing, entertainment, and savings. Such spending would stimulate the local economy; however, due to the non-local origin of the majority of construction workers, the leakage's from the area also would be substantial.

The employment and income effects associated with construction of the Proposed Action are beneficial, but temporary. The impacts are not considered significant.

Operations. As no new operations personnel would be hired under the Proposed Action, the primary economic and employment impact associated with the Proposed Action would be the continuation of 970 mining sector jobs and the income these generate (see Section 3.12.1.2).

Mine closure and downsizing at the end of the project life would have the effect of decreasing employment at the mine.Depending on the assimilative potential of the economy at the end of the project life, a portion of laid-off persons would become unemployed. Employment in the mining sector would decrease, having negative impacts on secondary employment as economic activity is depressed. Income impacts associated with the mine also would decrease.

__**Housing**__

Construction. The construction population projections for the Proposed Action, over the 12-month construction period, could create a peak demand for approximately 137 temporary housing units (***Table 3-46***). This demand would be decreased if single workers share housing. Many of these construction employees would have limited assignments at the mine. These workers would likely seek hotel/motel units of which supply is adequate. Other construction workers required for the entire 12-month construction period would likely seek rental houses, apartments, mobile homes, and RV sites. According to housing data provided by the U.S. Census Bureau and local realtors (see Section 3.12.1.3), at any one time there are approximately 20 units available for rent in the study area. The demand for housing during the construction phase of the Proposed Action would exceed the supply of housing. This impact, though temporary due to the short-term construction period, would be significant.

Given the possibility of excess demand for housing and prior to increases in the available housing stock, housing and rental prices could increase to capture higher profit potential. Such an increase may not be a detriment to the mine workers (where wages are above average), but may adversely affect persons in other employment sectors or those not in the labor force (e.g., retired persons and persons employed in lower paying employment sectors).

Housing costs should not be a problem for the construction workers. Construction worker wages in Nevada average about $29,000 per year, or

TABLE 3-46
Proposed Action
Short-Term Housing Demand From In-Migrant Households
During the 12-Month Construction Phase

Household Type	Direct Labor-Related Households	Indirect Labor-Related Households	Total Households
Single-Status Workers	102	7	109
Married-Status Workers	26	2	28
TOTAL	**128**	**9**	**137**

slightly over $2,400 per month (Nevada Employment Security Department 1990). Assuming that 25 percent of a worker's wages would be spent for housing, the average worker could afford a gross housing cost of $600 per month. This would be a reasonably competitive amount in the local rental housing market.

Operations. As no new operations personnel would be hired under the Proposed Action, there would be no additional demand for housing. Operations under the Proposed Action would not contribute further to the current strain in the local housing market.

Community Facilities and Services

Water Supply. Winnemucca, Battle Mountain, and Golconda have recently or are currently expanding their water supply systems, which would adequately serve additional demand in the area. As the population increases associated with the Proposed Action are not anticipated to exceed 10 percent in any area, the increases in infrastructure demand are not considered significant.

Wastewater Treatment. The current municipal wastewater treatment system in Winnemucca is in need of upgrade prior to expanding to new subdivisions. The treatment system in Battle Mountain is not yet at 80 percent and could adequately serve moderate levels of new construction. As mentioned previously, Golconda does not have a municipal treatment system. The construction phase of the Proposed Action would strain the existing system in Winnemucca. This would not be a significant strain as it is limited by the current number of meters. If the operations phase causes new residential or commercial construction within the municipal boundaries by improving or expanding current economic conditions, provisions would be necessary to upgrade this municipal system.

Solid Waste Disposal. Plans to permit the Humboldt County landfill would proceed with or without the Proposed Action. No significant impacts to solid waste disposal facilities are anticipated.

Schools. Estimated student enrollment generated during construction of the Proposed Action was calculated using an average of 3.5 persons per married household (2 adults and 1.5 children). It is estimated that the construction phase would result in a total of approximately 39 children entering the region. ***Figure 3-57*** depicts the student enrollment projections based on the stated assumptions. Of the 39 children, 27 would be of school age, with 21 of elementary age and 6 of high school age. An influx of 27 children would increase total enrollment in the study area by less than 1 percent. This would be a temporary impact and would not be significant.

The above assessment considers growth in total regional school enrollment, including the Humboldt County and Lander County School Districts. Depending on the dispersion of incoming students, it may occur that one or more schools would be significantly impacted by the Proposed Action. If increased student enrollment generated by the mine expansion results in further overcrowding or excess capacity at certain schools, then a significant impact would occur.

In addition, during construction there would be an increase in school expenditures in Humboldt County to address the increased enrollment. Due to the one-year lag of property tax collection, Humboldt County school revenues would not immediately increase to fund these expenditure increases. It is important to note that schools in Lander County would not benefit from increased property tax revenue generated by the Twin Creeks Mine, as the mine is located wholly in Humboldt County.

Fire Protection. The Proposed Action would generate only minor increases in the need for fire protection services in developed areas of Humboldt County and Battle Mountain. Fire danger would increase somewhat in the vicinity of the proposed project because of increased activity; however, the manpower, equipment, and water sources on the site would increase the opportunity to suppress wildland fires in the area before they became large and difficult to control.

The Proposed Action would have no adverse impacts on hazardous spill response capabilities in Humboldt County.

Law Enforcement. The concern associated with the Proposed Action would be the influx of construction workers and their potential for disproportionate effects on law enforcement work loads (Kranovich 1996). There are no precise

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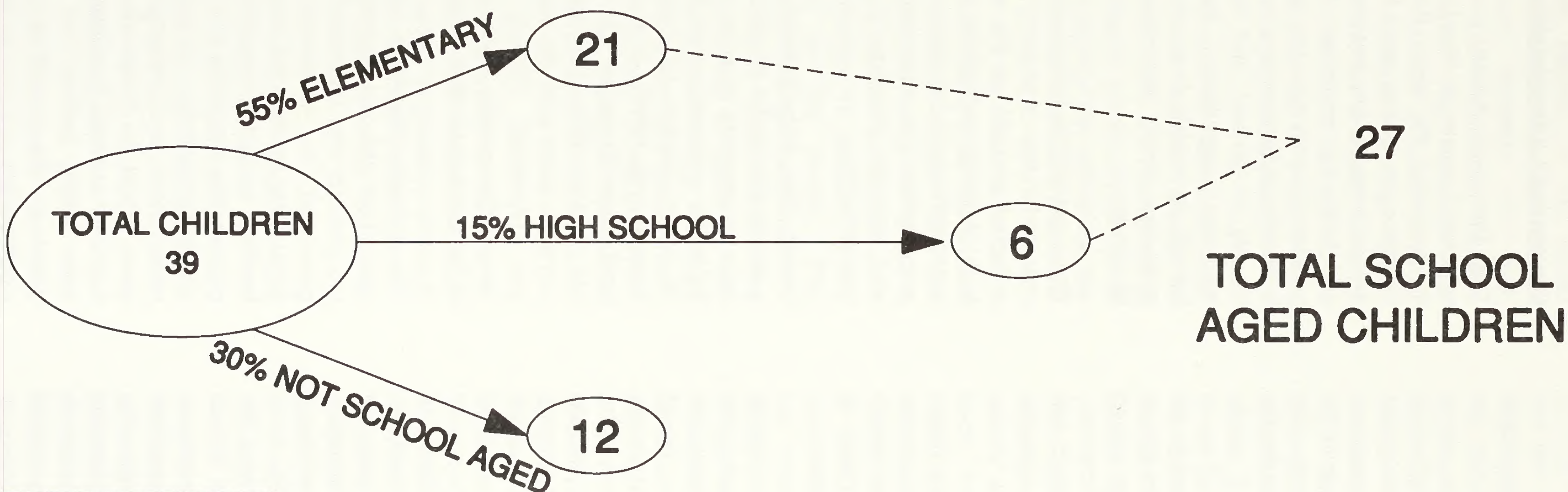

DERIVED FROM AN AVERAGE OF 3.5 PERSONS PER MARRIED HOUSEHOLD

Twin Creeks Mine

Figure 3-57

Proposed Action School Enrollment Projections - Construction Phase means of predicting this effect; however, the net effect would be an increase in law enforcement work loads compared with current levels. As population increases resulting from the mine expansion would not exceed 10 percent and would be temporary, the impact on law enforcement workload would not be expected to increase permanently by 10 percent. Again, this would be difficult to monitor. As stated previously, the Winnemucca Police Department is currently considered shorthanded.

The local judicial system is also anticipated to be impacted to a minor degree. The projected rise in population during the construction phase would increase work loads from current levels; however, this increase would be temporary and would not interfere with the efficiency of the courts' operations.

Health Care. Construction-related population increases would increase demands temporarily on the Humboldt County and Battle Mountain health care systems to a small degree. The capacity of the system is sufficient to handle the increase.

Social Services. The Proposed Action would have small and offsetting effects on the local social services system. Temporary increased population levels during the construction phase would increase demand slightly for such services as counseling and day care. However, new jobs created by the Proposed Action would reduce unemployment and increase financial opportunity, which could reduce the need for public welfare assistance.

Workers associated with the construction phase of the Proposed Action are expected to be mostly in-migrants. It is anticipated that they would leave the area as their work is finished. This should minimize any long-term impact on local social services. Operations workers and their families may have the greatest impact on social services during the phase down and shutdown period. This impact would be dependent on the prevailing economic conditions and the ability of the region to assimilate laid-off workers. Due to the project life extending through the year 2011 and the uncertainty involved, it is not possible at this time to estimate the impact of mine closure on social services.

Government Administration/Public Finances

The Proposed Action would contribute a net revenue increase to Humboldt County throughout its projected life span through the year 2011. Revenue increases would result primarily from greater property tax, net-proceeds-from-mines tax, and sales tax revenues. Property tax and net-proceeds-from-mines tax revenues would accrue to Humboldt County and the state, but not Lander County, in general, and the community of Battle Mountain, specifically. Battle Mountain would benefit somewhat from an increase in sales tax revenues from employees residing in Battle Mountain.

The net-proceeds-from-mines tax, which is collected in lieu of property tax on the ore body, is collected annually on the estimated net revenues from mineral extraction. The balance of the improvements to the mine property would generate property tax. The mine would also generate sales and use tax revenue to the state and local governments.

During the construction phase, the principal revenue change for Humboldt County would result from an increase in sales and use tax revenues. Sales tax revenues would lag approximately 45 to 75 days behind the actual purchase dates. According to SFPG, it is estimated that monthly local expenditures by the mine would amount to $10 million. This could generate $650,000 per month in sales and use tax revenue for the state and Humboldt County for the 12-month construction period. There would likely be leakage of tax revenue to other counties.

The primary long-term revenue change would come from the net-proceeds-from-mines tax and the property tax. Increased property tax would be generated by increased assessed valuation attributable to the mine improvements, processing facilities, and other support facilities. Receipt of the property tax would lag one year behind installation of improvements because of conventional assessment and collection practices. Property taxes would be determined through the property appraisal process as conducted by the county and state taxing entities, but are not expected to increase the existing property tax base significantly.

Net-proceeds tax would depend on the actual production rates at the mine. It is important to note that actual production depends on both technological factors and economic factors; therefore, production rates may fluctuate. The primary impact here is that SFPG would continue to be a substantial contributor to the county treasury; however, contribution changes resulting from the implementation of the Proposed Action are not expected to increase by 10 percent and, therefore, would not be a significant impact.

In addition to project construction activities, other commercial and residential activity would be occurring in Winnemucca and the surrounding areas. These developments would contribute to the tax base and add property tax and sales tax revenues to the City of Winnemucca and Humboldt County's treasuries.

The most substantial financial impact associated with the Proposed Action would be the continuation of the tax contribution by SFPG to the taxing jurisdictions. As indicated in ***Tables 3-43*** and ***3-44***, SFPG contributes 11 percent of the property tax revenue to the county. This contribution would stabilize through the year 2011. The tables referenced above also indicate that SFPG contributes approximately 58 percent of the net-proceeds-tax collected by the county. Although fluctuating with gold production and gold prices, this contribution would continue through the year 2011. Estimated sales tax indicates that SFPG could contribute up to 30 percent of the sales tax collected by the county.

In addition to the benefits accruing to the county, the state receives a portion of the net-proceeds-tax and sales taxes. This benefit is positive, although not significant (i.e., less than 10 percent) when considering the state's total revenue from net-proceeds-tax.

Upon project closure, Humboldt County would experience reductions in property, sales, and net-proceeds tax revenues in the proportion described above. This impact would be significant given the current tax contribution by SFPG.

3.12.2.3 Other Project Alternatives

The social and economic impacts of the other project alternatives would be similar to the Proposed Action.

3.12.3 Cumulative Impacts

The socioeconomics cumulative impacts area for the Twin Creeks Mine EIS encompasses those communities and the counties wherein the impact from regional development would be expected to occur. Given geographical and demographic characteristics, impacts from the Twin Creeks Mine would impact Humboldt County, Lander County, Winnemucca, Battle Mountain, and the smaller communities of Golconda, Valmy, and Midas. It is unlikely that noticeable impacts would be as far reaching as Elko or Lovelock. Therefore, the cumulative impact area is concentrated in eastern Humboldt County, and Battle Mountain in Lander County.

The cumulative impacts area has long been dependent on the mining sector for economic activity and employment. Likewise, it is the mining sector that has done much to define this region. Rapid growth over the last 15 years is largely attributable to the increased mining in the area. Cumulative impacts from mining, therefore, are not a new phenomena. The impacts include a substantial infusion of economic resources, which has been beneficial. However, with the growth, development pressures are also apparent. That is, infrastructure and services are increasingly impacted, sometimes excessively. Section 3.12.2 identified several issues related to overuse and rapid growth. The cumulative impacts are evident in the case of the limited housing market, overcrowding in area schools, and excess demand on some components of the infrastructure.

Socioeconomic impacts resulting from reasonably foreseeable future actions would depend on the schedule and scope of the potential new mining activities and any other large-scale development projects. Exploration activities do not require large numbers of workers, whereas, continued mining operations and expansions may extend the types of beneficial and negative impacts similar to those discussed for the Proposed Action.

Several socioeconomic resources identified in this EIS are near their current capacities and may be affected by increases in the local population. Specifically, (1) a housing shortage currently exists in the area; (2) the water delivery system in Winnemucca is in need of upgrade to accommodate new growth; and (3) many of the area schools are at or near capacity.

Socioeconomic impacts in an area depend on the relationship between the amount and timing of the service demand and the amount and timing of the tax revenues that could fund needed capital improvements. The reasonably foreseeable future actions would produce public revenue surpluses, but there would be an initial lag of 1 to 2 years when public tax revenues (tax base) might experience deficits. All tax revenues would be generated both directly and indirectly through increased economic activity, jobs, and payrolls. Actual start dates for most of the gold operations would depend on favorable conditions in the gold market and are, therefore, very difficult to predict with any certainty.

Current mining in the project area is centered around the Twin Creeks, Getchell, and Pinson-Mag mining districts. These areas generate social and economic impacts, and contribute to the capacity constraints identified above. In the Twin Creeks Mine cumulative impacts area, there are approximately 2,000 persons employed at other mines, not including contract personnel ***Table 2-11***. Currently proposed new and expanded mining projects would create an additional 815 employment positions over the next several years (***Table 2-11***).

The cumulative impacts of mining are a substantial mining employment sector and its resulting impact on the regional economy and financial resources. Given the history of the area, this impact has persisted to some degree for nearly a century. Indirect cumulative impacts include stabilization of the regional employment base and economy. An active mining sector provides jobs and can assimilate out-of-work mine workers. In addition, the high wages earned in the mining sector can boost relative economic profiles which may enhance investment attraction.

The housing impacts would include competition with tourists for temporary housing in hotel/motels, camping areas, and RV sites. The final outcome on the phasing of projects requiring construction or temporary special crews would determine the impact of such competition.

One of the primary concerns in the region is the shortage of more permanent rental housing as well as new construction. Housing shortages exist and could worsen given the projected new projects. The total new household demand would be greater than the currently available supply.

Total school enrollment increases under the Proposed Action may be below the significance criteria, however, the actual impact on schools would depend on the dispersion of new students. As indicated in ***Table 3-42***, all but one of the 10 regional schools is at or above 80 percent capacity. Much of the over-capacity is currently accommodated with mobile classrooms. It may be that several of the schools would be forced to add more of these mobile classrooms until new capital construction funds become available. Nevertheless, cumulative increases in school-aged children could overload the school districts' current capacities and create an overcrowding problem.

3.12.4 Monitoring and Mitigation Measures

The most serious potential impact identified is the possibility of inadequate temporary housing for the construction workforce. Other areas of concern identified are the potential for overcrowding of certain schools and insufficient staffing for law enforcement during the project's 12-month construction phase. These potential impacts might properly be monitored and considered for appropriate mitigation measures. No specific mitigation measures are proposed here because the BLM is without legal authority to compel or enforce private or community action in regard to housing, schools, and other local community resources.

The BLM can and does encourage local, county, and state governments or agencies to initiate discussions with the project proponent on the basis of the analysis presented in the EIS. The establishment of a dialogue based on mutual advantage and understanding, and a commitment to a shared responsibility for resolution of the potential impacts associated with project development, could lead to the preparation and implementation of mitigation measures which are advantageous to all parties.

3.12.5 Residual Adverse Effects

There would be no residual adverse effects associated with socioeconomic resources.

3.13 Visual Resources

3.13.1 Affected Environment

The visual resources study area includes lands that contain sensitive viewpoints in view of proposed project elements out to a distance of approximately 15 miles (outer limit of the Background Distance Zone). This zone is restricted on the east and west by the presence of mountain ranges (the Snowstorm and Osgood/Dry Hills respectively), which limit the extent of visibility of the mine expansion area.

Sensitive viewpoints within the visually affected area include two residences, two county roads, and a county recreation area. One of the residences is a ranch house located approximately 6 miles south of the existing Twin Creeks Mine and approximately 2 miles southeast of the existing Pinson Mine. The second residence is a ranch house located along Julian Creek, approximately 5 miles southwest of the existing Twin Creeks Mine. (A third ranch house is located on Jake Creek within 6 miles east/southeast of the mine but is not visually affected due to intervening topography.) Kelly Creek Road runs generally north to south along Kelly Creek within close proximity to the existing Twin Creeks Mine. It carries a low volume of traffic, primarily mining related, but with occasional ranch and hunter traffic (Russum 1996). A second county road, Midas Road, enters the project area from the southwest and then transects the southern portion of the project area from west to east. Within the potentially visible area, this road is graveled and carries a relatively low volume of primarily mining related traffic. The Chimney Reservoir recreation area, which is maintained by Humboldt County, is located approximately 7 miles north of the Twin Creeks Mine at the confluence of the North and South Forks of the Humboldt River. Developments at this site include a boat ramp and camping area. Access to this area is primarily via county roads through Paradise Valley to the west.

The lands within the project area are typical of Basin and Range province landscapes with broad, open, sage-dominated basins bounded by prominent, isolated mountain ranges. The Twin Creeks Mine is located along the eastern side of a small mountain range known as the Dry Hills, which transitions into the Osgood Mountains to the south. While a portion of the existing mine encroaches into the Dry Hills, most of the existing development is located within an unnamed valley between the footslopes of the Dry Hills and Kelly Creek, an intermittent steam which cuts from north to south through the center of the valley.

The region is relatively remote and, with the exception of existing mines, is very sparsely developed. The existing mines are therefore visually dominant features in this setting. The Pinson Mine is located at the base of the Osgood Mountains and extends approximately 2 miles from north to south. Approximately 3 miles to the north of the Pinson Mine is the Getchell Mine, which is located in part within the Osgood Mountains and in part along the eastern edge, extending into the Kelly Creek valley. It is therefore somewhat elevated. Approximately 2 miles to the east of the Getchell Mine is the existing Twin Creeks Mine. This mine currently covers one-half to two-thirds of the land within a 2-mile (east-west) by 6-mile (north-south) rectangle.

The lands within the project area have been inventoried and classified by the BLM for visual resources. The inventory process considers the scenic value of the land, the volume and sensitivity of the viewers who see the land, and the distance from which the lands are commonly seen. The results of these three independent investigations are combined to determine one of four visual resource management classifications. Management guidelines for each of the four visual resource management classes are briefly described as follows:

<u>Class I</u>: The level of change to the characteristic landscape should be very low and must not attract attention.

<u>Class II</u>: 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.

<u>Class III</u>: 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.

<u>Class IV</u>: 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 (landscape) elements.

All BLM lands within the study area have been classified as Visual Resource Management Class IV.

3.13.2 Environmental Consequences

Visual impacts have been assessed in accordance with BLM Visual Resource Management Contrast Rating principles (BLM 1986b). The contrast rating process is used to systematically identify the nature and degree of modification to the landscape that would be visible from sensitive viewpoints (key observation points). The degree of contrast is then compared to visual resource management class guidelines for the area to determine the level of impact or compatibility. To facilitate this evaluation and best ensure consistency, application of the contrast rating process has been divided into three distinct steps. The first step is to accurately characterize the nature and extent of the on-site disturbance to the landform and vegetation, and through the addition of structures. Second, the level of visibility is determined from each potentially affected viewpoint, through consideration of variables such as distance, duration, orientation, screening, backdrop, angle of view, and scale. Third, the level of on-site contrast, modified by the level of visibility from each viewpoint, is used as the basis to determine the level of visual contrast (i.e., the nature and degree of contrast that is seen by the viewer). As stated above, visual impacts are then determined based on the compatibility of the predicted levels of visual contrast with the visual resource management class guidelines (see Section 3.13.1).

Impacts to visual resources would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Degree of visual contrast exceeds the BLM visual management guidelines for the area

For this analysis, the No Action alternative was contrasted against the existing conditions (as of December 31, 1994), and the Proposed Action was contrasted against the No Action alternative. As indicated in Section 3.13.1 above, there are five sensitive viewpoints which are located in the visually affected area: two residences, Chimney Reservoir, and two county roads (Kelly Creek Road and Midas Road). Contrast ratings and impact assessments were conducted on each of these.

3.13.2.1 No Action Alternative

Chimney Reservoir is approximately 8 miles north of the northern most portion of the mine (overburden and interburden storage area J). From the campground at the southern end of the reservoir, a small portion of a ridge is currently visible on the horizon at the mine site. This ridge is being cut away from view and would eventually disappear as a result of the construction and expansion of storage area J. Another minor ridge would later appear in the same vicinity which would be the top portion of storage area J as it is developed. The light color of this unvegetated landform would cause the primary contrast. While the context of view from this viewpoint is of a naturally appearing landscape, the degree of contrast is substantially reduced because of the small amount of disturbance in view, the distance, and the strong orientation toward the reservoir and away from the mine. The low visual contrast in a Class IV area would result in a low impact.

Residents of a ranch house located on Julian Creek have a view of the developing infiltration basins from a distance of approximately 5 miles. The level of disturbance is moderate to low in the context of their view. With visibility modified by distance, visual contrast and impacts would be low in this Class IV area.

A second residence north of Midas Road, approximately 6 miles south of the mine, currently has visibility of the tops of portions of the storage and tailings areas. Between the portions of the Twin Creeks Mine in view and the full visibility of the Pinson Mine approximately 2 miles to the west, the context of their view is of an already strongly modified landscape. The additional disturbance which would develop under the No Action alternative would result in a moderate to low incremental degree of visual contrast and therefore a low visual impact in this Class IV area.

Two county roads are also affected by the project. Midas Road runs generally east-west across the southern portion of the study area at distances of 6 to over 9 miles from the project area, with intermittent visibility of the mine. The context of views from this road is strongly influenced by existing mining disturbance, among which is the Twin Creeks and Pinson Mines. Visual contrast is expected to be moderate to low in this context with resulting low levels of visual impact. The second road is Kelly Creek Road which runs generally north to south between Kelly Creek and the Twin Creeks Mine (between a few hundred feet to approximately a mile from the mine). Visibility of the mine is therefore high. The visual contrast of the No Action alternative in the context of the existing mine (approximately 6 miles of disturbance from north to south) is moderate. Visual impacts in the Class IV area would be low.

In summary, the No Action alternative would result in low visual impacts as seen from any affected viewpoint, primarily because of the already extensively modified landscape, the long viewing distances in some cases, and the Class IV visual management guidelines. Visual contrasts under the No Action alternative would not exceed the Class IV guidelines and would not be a significant impact.

3.13.2.2 Proposed Action

From Chimney Reservoir, no changes attributable to the Proposed Action would be visible. The only noticeable change to the landscape would be the gradual reduction in visual contrast over time as a result of the revegetation of the portion of storage area J that would remain in view.

From the ranch on Julian Creek, the upper portions of storage areas I and E may be visible (the angle of view cannot be precisely determined with the information available so a reasonable conservative scenario has been assumed for the purposes of assessing impacts). The contrast of this modification in the context of their view, which excludes the great majority of the existing mining disturbance, would result in a moderate level of visual contrast. In a Class IV area this would result in low short-term visual impacts. With effective reclamation of the disturbance, long-term visual impacts would improve over time as structures are removed and vegetation becomes established. However, substantial landform modifications would remain indefinitely.

From the ranch along Midas Road south of the mine, the apparent east-west extent of the mine would be increased. As with the No Action alternative, it would be the tops of various storage and tailings areas that would be visible. Because of the extensive modifications already visible from both the Twin Creeks Mine and the closer Pinson Mine, the degree of visual contrast created by the Proposed Action would be moderate to low. Short-term visual impacts would be low. As indicated above, the degree of visual contrast would be reduced over time, however, major unnatural appearing landform modifications would remain.

Similar conditions would exist from Midas Road. The primary differences are that the orientation of view would not be as focused, and distances would be greater in some cases. The level of visual contrast would be low, and short-term visual impacts would also be low as a result. Long-term conditions would be as discussed above.

From Kelly Creek Road, landscape modifications would be seen from a much closer distance. In addition, Kelly Creek Road parallels the Twin Creeks Mine for approximately 6 miles; consequently, the duration of the view would be longer. Visibility would be high, and the level of visual contrast would be moderate compared to the nature and extent of modifications that would already exist at that time. In a Class IV area, this would result in low short-term visual impacts, with long-term impacts as discussed above. Visual contrasts under the Proposed Action would not exceed the Class IV management guidelines and would not be a significant impact.

3.13.2.3 Other Project Alternatives

Partial Vista Pit Backfill Alternative

The Vista Pit would not be visible from any sensitive viewpoint due to screening by natural or mining-related topographic features. The amount of material utilized in the partial pit backfill would not be substantial enough to result in any perceptible difference in the height or extent of any of the overburden and interburden storage areas. For these reasons, the Partial Vista Pit Backfill alternative would result in the same impacts to visual resources as described for the Proposed Action.

Selective Handling of Overburden and Interburden Alternative

Because the height and extent of the overburden and interburden storage areas would not be noticeably affected under the Selective Handling of Overburden and Interburden alternative, visual impacts would be the same as described for the Proposed Action.

Overburden and Interburden Storage Area Reclamation Alternatives

Because the storage areas' height (maximum of 400 feet), extent (approximately 6 square miles for the reclaimed footprint of storage area B), and setting (extensive other postmining related disturbances), it is not expected that either alternative 1 or alternative 2 would significantly change the overall visual appearance of the mine. Of the two alternative configurations, alternative 2 would have the most visual benefit. The rounding of corners, as proposed in alternative 1, would have little noticeable effect on a landform of this size and scale. While there would be some noticeable level of improvement from the configuration proposed in alternative 2, it would have little effect on the overall postmining landscape, and impacts would be similar to those described for the Proposed Action. Alternative 2 would encroach on private lands not owned by SFPG.

3.13.3 Cumulative Impacts

The cumulative impact area for visual resources includes the lands within view of the reasonably foreseeable future actions out to a distance of approximately 15 miles. Of most significance in this regard is the potential for exploration and mining to extend northward into the Humboldt River drainage as far as the Little Humboldt River and Chimney Reservoir. This is an area which is generally free of the influence of large-scale landscape modifications such as mining. A public campground run by Humboldt County is located at the southern end of the reservoir. Viewer sensitivity in this area could therefore be expected to be high. Visual contrast would be high. Because this area has been designated as a Class IV area, visual impacts would be moderate.

Long-term modifications to this region (in both the Kelly Creek and the Little Humboldt River drainages) would be significant because, despite the revegetation efforts and removal of structures, the extent and scale of landform modifications would remain.

3.13.4 Monitoring and Mitigation Measures

During active mining, little can be done to reduce the form and color contrasts of disturbed lands without unduly interfering with mine operations. Because of the size and extent of the tailings and storage areas, it is not realistic to assume that creative land form modifications following mining would have any meaningful effect in reducing the unnatural character of these mine features. Measures to control dust are discussed in Section 3.9.4, Air Quality.

Other possible mitigation measures for reducing visual impacts include the following:

VR-1: Colors for buildings and field facilities would be selected to blend with the surroundings and to reduce reflectivity to the greatest degree possible. Specifications would be submitted to the BLM for review.

VR-2: Night-lighting would be shielded and directed downward to avoid night light spill and glare.

VR-3: Incremental reclamation and revegetation would be initiated as soon as it is feasible on completed portions of the mine workings so that the process of revegetation can begin as early as possible.

3.13.5 Residual Adverse Effects

Residual adverse visual effects during the active life of the mine would include the expansion of unnatural forms, lines, colors, and textures to the landform and vegetation. Extensive areas of unnatural landforms would persist indefinitely beyond the active life of the mine. Successful revegetation is assumed, but may realistically take many years before it achieves the degree of cover of the adjacent undisturbed landscape.

3.14 Noise

3.14.1 Affected Environment

Human perception of noise is affected by intensity, pitch, and duration. "Loudness" is measured in decibels. The A-weighted sound scale (dBA) was developed for weighting the frequency spectrum to mimic the human ear. The A-weighted sound scale represents environmental noise. The U.S. Environmental Protection Agency recommends the A-weighted sound scale to describe environmental noise because it is accurate, convenient, and used internationally (U.S. Environmental Protection Agency 1978). All activities at the Twin Creeks Mine are subject to noise regulations and guidelines imposed by the Mine Safety and Health Administration.

Table 3-47 shows average noise levels generated by typical mining equipment and operations as determined by various noise researchers. As indicated in the table, noise generated by trucks, bulldozers, and other equipment typically ranges from 90 to 100 dBA at the source. Sound levels from blasting range from 115 to 125 dBA at 900 feet. ***Table 3-48*** contains a list of noise levels frequently experienced in daily activities.

Certain human activities are commonly more susceptible than others to noise interference. Such activities or land uses, termed sensitive receptors, include residential areas, schools, hospitals, libraries, and certain outdoor gathering places, such as parks and recreation areas. The nearest potential noise-sensitive receptors where noise from mining activity may be heard include (1) a ranch house located approximately six miles south of the existing Twin Creeks Mine, (2) a ranch house located along Julian Creek approximately five miles southwest of the mine, (3) a ranch house located along Jake Creek approximately six miles east/southeast of the mine, and (4) the Chimney Reservoir recreation area located approximately seven miles north of the existing Twin Creeks Mine. Existing noise measurement data for these sites are not available; however, all four of these receptors are currently affected by noise levels generated from the existing mining operations.

Using the information provided in ***Table 3-47***, levels of existing mine-generated noise (excluding blasting) at the Twin Creeks Mine were estimated to provide a baseline noise level of approximately 105 dBA at a distance of 50 feet. Excluding blasting, existing noise levels from the ongoing mining operations at the four receptors are estimated at (1) 55 dBA, (2) 57 dBA, (3) 55 dBA, and (4) 54 dBA. These noise levels are equivalent to activities in a large business office ***(Table 3-48)***.

Blasting at the Twin Creeks Mine generally occurs one to three times a day, with the first blast at 11:30 a.m., the second blast at 12:00 noon (if necessary), and the third blast at 12:30 p.m. (if necessary). Average noise levels from blasting are 115 to 125 dBA at 900 feet ***(Table 3-47)***. Estimated blasting noise from the mine at the four receptors is estimated at (1) 90 to 100 dBA, (2) 92 to 102 dBA, (3) 90 to 100 dBA, and (4) 89 to 99 dBA. These noise levels are equivalent standing next to a gas lawn mower ***(Table 3-48)***.

3.14.2 Environmental Consequences

Noise impacts are commonly evaluated according to two general criteria: the extent to which a project would exceed federal, state, or local noise regulations, and the estimated degree of disturbance to people; in this case, disturbance to the residents of the three ranch houses and recreationists at the Chimney Reservoir recreation area.

Noise impacts would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- Project-related noise levels at the four receptors exceed the U.S. Department of Housing and Urban Development acceptable noise standard of 65 dBA in residences

3.14.2.1 No Action Alternative

The primary sources of noise at the Twin Creeks Mine under the No Action alternative would continue to be the same sources as the existing operations: rock drilling, blasting, loading and unloading of overburden and interburden, truck hauling, ore crushing, and milling. The same numbers and types of equipment used in the existing operations also would be used under the No Action alternative. Therefore, noise levels at the four receptors are not expected to increase over existing levels. Because existing noise levels, exclusive of blasting, at the four receptors are well below the U.S. Department of Housing and Urban Development's acceptable noise standard of 65

TABLE 3-47
Average Sound Levels for Equipment and Mine Operations

Equipment/Operation	Noise Level (dBA)[1]	Source of Information
Blasting	115-125 dBA at 900 feet	U.S. Bureau of Mines and Geology 1976
Crusher	95 dBA at source	CMC Inc. 1989
Haul trucks	90 dBA at 50 feet	U.S. Environmental Protection Agency 1978
Loaders	87 dBA at 50 feet	Reagan and Grant 1977
Blasthole drilling	86 dBA at 50 feet	Reagan and Grant 1977
Bulldozers	85 dBA at 50 feet	Reagan and Grant 1977

[1] A-weighted decibel sound scale.

TABLE 3-48
Relative Scale of Various Noise Sources

Noise Level (dBA)[1]	Common Indoor Noise Levels	Common Outdoor Noise Levels
100	Rock band	
105		Jet flyover at 1,000 feet
100	Inside New York subway train	
95		Gas lawn mower at 3 feet
90	Food blender at 3 feet	
80	Garbage disposal at 3 feet, shouting at 3 feet	Noisy urban daytime
80	Vacuum cleaner at 10 feet	Gas lawn mower at 100 feet
65	Normal speech at 3 feet	Commercial area, heavy traffic at 300 feet
60	Large business office	
50	Dishwasher in next room	Quiet urban daytime
40	Small theater, large conference room	Quiet urban nighttime
95		Quite suburban nighttime
33	Library	
28	Bedroom at night	
25	Concert hall (background)	Quiet rural nighttime
15	Broadcast and recording studio	
5	Threshold of hearing	

[1]A-weighted decibel sound scale.
Source: Hatano 1980.

dBA, no significant noise impacts are anticipated under the No Action alternative.

Blasting in the South Pit would continue at a frequency of one to three blasts per day through the year 2000. Estimated blasting-related noise levels under the No Action alternative would be similar to existing levels, and would exceed the acceptable noise standard of 65 dBA at the four sensitive receptor sites. Even though this would be a significant impact, there are several factors to consider that would substantially reduce the noise effects from blasting, including (1) blasting-related noise levels would decrease as pit depth increases, (2) blasting would only occur one to three times per day, (3) blasting would occur between the hours of 11:30 a.m. and 1:00 p.m. (i.e., mid-day), and (4) noise effects from blasting would exist for a short duration per blast (less than 15 seconds).

3.14.2.2 Proposed Action

Mining-related noise impacts under the Proposed Action (including blasting) would be the same as described for the No Action alternative, except operations under the Proposed Action would continue through the year 2011. In addition, blasting-related noise impacts under the Proposed Action would be reduced from impacts described under the No Action alternative because the depth of the South Pit would continue to increase, thereby muffling the blasting noise. Therefore, no significant noise impacts are anticipated during operations under the Proposed Action.

3.14.2.3 Other Project Alternatives

Noise impacts under the other project alternatives would be the same as described for the Proposed Action. There would be no significant noise impacts under the other project alternatives.

3.14.3 Cumulative Impacts

Reasonably foreseeable future actions that are near enough to the proposed project to potentially generate interactive noise effects are the potential future mining activities at the Twin Creeks Mine (see Section 2.6.2.1). Other mines in the immediate area that could potentially generate interactive noise effects include the Getchell and Pinson Mines. At the present time, there are no known plans to expand mining activities at these mines ***(Table 2-11)***.

Available data are not sufficiently detailed to permit a quantitative noise evaluation of potential future activities at the Twin Creeks Mine. It is reasonable to assume that noise generated from the activities outlined in Section 2.6.2.1 would replace similar activities currently occurring in the area. Under this assumption, potential future activities at the Twin Creeks Mine would not increase noise effects over current levels and would have essentially no cumulative effects on noise levels at the four sensitive receptors.

3.14.4 Monitoring and Mitigation Measures

No monitoring or mitigation measures for noise are recommended.

3.14.5 Residual Adverse Effects

There would be no residual adverse effects on the environment from noise generated during mining and ore-processing operations. Very few observers would be able to discern the difference between noise levels from the existing operations and those produced by the proposed project. Once mining, processing, and reclamation activities cease, noise would be reduced to premining levels.

3.15 Hazardous Materials

3.15.1 Affected Environment

The affected environment includes air, water, soil, and biological resources that could potentially be affected by an accidental release of hazardous materials during transportation to and from the project site, and during storage and use on the project site.

The current mining and ore processing operations at the Twin Creeks Mine require the use of the following materials classified as hazardous: (1) diesel fuel, gasoline, oils, greases, anti-freeze, and solvents used for equipment operation and maintenance; (2) sodium cyanide, sodium hydroxide, nitric acid, sulfuric acid, hydrochloric acid, flocculants, and antiscalants used in the gold extraction processes; (3) ammonium nitrate and high explosives used for blasting in the open pit; and (4) various by-products, classified as hazardous waste, and chemicals from the assay laboratory.

Pursuant to regulations promulgated under Section 102 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, release of a reportable quantity of a hazardous substance to the environment in a 24-hour period must be reported to the National Response Center (40 Code of Federal Regulations Part 302). A release of a reportable quantity on public land must also be reported to the BLM. The Nevada Administrative Code (445.240) also requires immediate reporting of a release of a reportable quantity of a hazardous substance to the Nevada Division of Emergency Management. ***Table 3-49*** identifies the hazardous materials and reportable quantities that are stored and used at the Twin Creeks Mine.

Minor spills of cyanide solutions or petroleum products have occurred at the project site during previous mining and ore processing operations. Upsets in the leaching process have caused releases of cyanide solutions that were generally confined to the leaching facilities. Spills of diesel fuel have occurred during equipment fueling procedures or during the filling of diesel fuel storage tanks. Other releases of various types of petroleum products, such as hydraulic fluid, have occurred on the site as a result of mining equipment or machinery failure.

As stated in SFPG's 1995 Water Pollution Control Permits NEV86018 and NEV89035, the Twin Creeks Mine has mitigated all previous releases of hazardous materials on the project site by following accepted state, federal, and manufacturer's methods. All reported spills have been, or are in the process of, being cleaned up, and contaminated materials have been disposed of according to federal and state guidelines.

Non-hazardous solid waste generated at the Twin Creeks Mine is presently disposed of in one of two approved Class III landfills located at the mine. Non-hazardous solid waste is disposed of in accordance with federal and state regulations and as specified in the Twin Creeks Mine Class III landfill operational plan.

Hazardous wastes generated at the Twin Creeks Mine are currently transported to approved disposal facilities by approved waste transporters. When practicable, these waste streams are sent to recycling facilities. All hazardous wastes are stored, packaged, and manifested in compliance with applicable federal and state regulations.

3.15.2 Environmental Consequences

Impacts from the transportation, storage, or use of hazardous materials would be significant if the Proposed Action, No Action alternative, or other project alternatives result in the following:

- One or more accidents occur during transport which result in the release of a reportable quantity of a hazardous material
- Release of a hazardous material on the site exceeds the storage volume of the containment structure

Project-Related Hazardous Materials

Operation of the Twin Creeks Mine would involve the transportation, handling, storage, use, and disposal of additional hazardous materials. A description of reagent use is provided in ***Table 3-50***. The delivery volumes and intervals, and storage volumes of these substances are listed in ***Tables 3-51*** and ***3-52***.

In addition to the reagents, SFPG requires various types of petroleum products such as diesel, gasoline, antifreeze, and oils and lubricants to operate the facility. ***Table 3-53*** lists the product

TABLE 3-49
CERCLA[1] Reportable Quantities For Hazardous Substances

Chemical or Solution	Limiting Compound	CAS[2] Registry Number	Typical CERCLA Reportable Quantity[3]
Pregnant Solution	10 lb NaCN	143-33-9	Note[4]
Barren Solution	10 lb NaCN	143-33-9	Note[4]
Tailings Slurry	10 lb NaCN	143-33-9	Note[4]
Reclaim Water	10 lb NaCN	143-33-9	Note[4]
Sodium Cyanide (as received)	10 lb NaCN	143-33-9	Note[4]
Nitric Acid (as received and stored)	1,000 lb HNO_3	7697-93-9	260 gal
Sulfuric Acid (as received and stored)	1,000 lb H_2SO_4	7664-93-9	76 gal
Hydrochloric Acid (as received and stored)	5,000 lb HCl	7647-01-0	1,500 gal
Calcium Hypochlorite	10 lb $Ca(ClO_3)$	7778-54-3	10 lb
Elemental Mercury	1 lb Hg	7439-97-6	1 lb
Petroleum Products	25 gal		25 gal[5]
Ferric Sulfate	1,000 lb $FeSO_4$	7720-78-7	1,000 lb
Caustic	1,000 lb NaOH	1310-73-2	500 gal
Ethylene Glycol	1 lb	107-21-1	1 lb[6]

[1]Comprehensive Environmental Response, Compensation, and Liability Act.
[2]Chemical Abstract Service.
[3]These values represent the quantity of solution or chemical at which a reportable quantity of a hazardous substance would be released based on historical solution concentrations at the Twin Creeks Mine. The limited compound quantities presented in column two are the regulated reportable quantities tabulated in 40 Code of Federal Regulations Part 302.
[4]Releases of cyanide-bearing solutions equal to or exceeding 500 gallons must be reported to the Nevada Division of Environmental Protection. For spills of process solutions, the amount of cyanide released may be calculated from the estimated volume of the spill and the concentration of the cyanide in the solution as follows:

$$\frac{\text{Gallons of Solution Spilled}}{240 \text{ gallons/ton}} = \text{Tons of Solution Spilled}$$

[Tons of Solution] x [Concentration of Sodium Cyanide (pound/ton)] = Pounds of Sodium Cyanide Spilled

Concentrations of sodium cyanide in process solutions may vary from 0.1 pound per ton of solution (pound/ton) to 2.0 pounds/ton in the several types of solution present at the Twin Creeks Mine. In addition, the concentration of liquid sodium cyanide as received from the supplier in 600 pounds/ton.
[5]State of Nevada reportable quantity pursuant to Nevada Administrative Code 445.240. Nevada Division of Environmental Protection specifies a reportable quantity for petroleum products of 100 gallons.
[6]Nevada Division of Environmental Protection specifies a reportable quantity for ethylene glycol of 25 gallons.

TABLE 3-50
Reagent Operational Use

Substance	Operational Use
Cyanide	Leaching of gold; leach pads, mill sites
Lime	pH adjustment: leach pads, mill sites
Antiscalant	Prevention of scale formation; leach pads, mill sites
Flocculant	Enhance settling of solids; mill sites
Nitric Acid	For acid wash of carbon and equipment; mill site
Caustic	For use in the strip circuit; mill sites
Sulfuric Acid	To aid in the oxidizing of sulfide ore; mill site
Ferric Sulfate	Precipitate arsenic from pit water
Hydrogen Peroxide	Break down cyanide in tailings discharge
WT Flocculant	Settles particulates in dewatering lamella; sky pond
Hydrochloric Acid	For acid wash of carbon and equipment; mill site
Salt	Water softeners, both mills and boiler room
Diatomaceous Earth	Precoat filters; mill sites
Zinc	Precipitate gold from strip solution; mill sites
Fuel Oil	Operation of mining equipment, support equipment and buses
Gasoline	Operation of small vehicles, i.e. cars, pickups, and vans

Source: Gillespie 1996.

type, storage location, and storage volume of the petroleum products currently stored at the mine site. Although storage volumes and storage locations of petroleum products may vary during the life of the mine, it is expected that the information provided in ***Table 3-53*** is a close approximation of what would be at the mine site at any given time. Mobile units, consisting of trailers and “lube” trucks, store miscellaneous types of oil and are used to service other vehicles and equipment at various locations at the mine site. The mobile tank inventory (***Table 3-54***) provides additional information concerning these mobile units.

Transportation

Trucks would be used to transport a variety of non-hazardous and hazardous materials to and from the Twin Creeks Mine. The transportation route would be via Interstate 80 to State Route 789 to County Road 513 (see ***Figure 1-1***). Based on the quantity of material and number of deliveries, the materials of greatest concern would be cyanide solutions, acid solutions, and fuel oil (diesel).

Potentially, the most hazardous deliveries to the mine would be sodium cyanide solutions, acid solutions (which include hydrochloric, nitric, and sulfuric acid solutions), and fuel oil (diesel). Sodium cyanide would be shipped as a liquid in 55,000-pound tanker trucks. Acids would be shipped in 47,000- or 48,000-pound tanker trucks. Diesel would be delivered in tanker trucks with a 10,200-gallon capacity (***Table 3-51***).

Sodium cyanide solutions would be supplied from Winnemucca, Nevada (located approximately 50 miles from the mine), or Battle Mountain, Nevada (located approximately 70 miles from the mine). For this analysis, the transportation route for the sodium cyanide solutions and diesel was assumed to be west from Battle Mountain on Interstate 80 to the Golconda exit, then north on State Route 789 (Midas Road) to Humboldt County Road 513 (Kelly Creek Road) to the Twin Creeks Mine. The route for sodium cyanide solutions and diesel goes through the communities of Battle Mountain and Golconda and crosses the Humboldt River. Acid solutions would be purchased in Carlin, Nevada. The haul route for the acid solutions, which is approximately 125 miles, would also go through the communities of Carlin, Beowawe, and Dunphy.

Impact Analysis

Important issues related to the presence of hazardous materials are the potential impacts to the environment from an accidental release of

TABLE 3-51
Substance/Reagent Deliveries and Nominal Use

Substances	Nominal Delivery Size[1]	Approximate Frequency: Existing and No Action Alternative	Approximate Frequency: Proposed Action	Approximate Maximum Usage: Existing and No Action Alternative	Units	Approximate Maximum Usage: Proposed Action
Sodium Cyanide (30% NaCN)	50,000 lbs	36 trucks/month	55 trucks/month	6.5 million	lbs/yr	10 million
Lime (96% CaO)	70,000 lbs	34 trucks/month	678 trucks/month	28.5 million	lbs/yr	569.5 million
Antiscalant (>10% Active)	45,000 lbs	2 trucks/month	2 trucks/month	0.907 million	lbs/yr	1.1 million
Flocculant	19,800 lbs	1 truck/3 months	1 truck/month	0.097 million	lbs/yr	0.324 million
Nitric Acid (>55%)	48,000 lbs	1 truck/month	6-8 trucks/month	0.554 million	lbs/yr	2.0 million
Caustic (49% NaOH)	48,000 lbs	1 truck/month	4 trucks/month	0.436 million	lbs/yr	1.2 million
Sulfuric Acid (93%)	48,000 lbs	N/A	17 trucks/month	N/A	lbs/yr	9.9 million
Ferric Sulfate (10% Iron)	48,000 lbs	5 trucks/month	6 trucks/month	3.1 million	lbs/yr	9.9 million
Hydrogen Peroxide (70% H_2O_2)	40,000 lbs	N/A	5 trucks/month	N/A	lbs/yr	1.8 million
WT Flocculant	7,200 lbs	1 Delivery/6 months	1 delivery/6 months	14,400 million	lbs/yr	0.0144 million
Hydrochloric Acid (30% HCl)	47,000 lbs	1 truck/month	1 truck/month	0.192 million	lbs/yr	N/A
Salt (NaCl)	34,300 lbs	1 Delivery/year	0 Deliveries	68,600	lbs/yr	N/A
Diatomaceous Earth (FW 18)	4,350 lbs	1 Delivery/6 months	0 Deliveries	8.700	lbs/yr	N/A
Zinc (99%)	20,000 lbs	1 Delivery/6 months	0 Deliveries	40,000	lbs/yr	N/A
Fuel Oil	10,200 gal	5/day	5/day	17,000,000	gal/yr	17, million
Gasoline	10,200 gal	2/month	2/month	300,000	gal/yr	300,000

[1]Nominal delivery size is assumed to be the same for the existing operations, the No Action alternative, and the Proposed Action.
N/A - Not applicable.
Source: Gillespie 1996.

hazardous materials during transportation to the mine, or from the use and storage at the site. The criterion for evaluation of the hazardous material impacts was the risk of a potential spill to sensitive receptors along transport routes or exposure pathways.

The environmental effects of a release would depend on the substance, quantity, timing, and location of the release. The event could range from a minor oil spill on the project site where cleanup equipment would be readily available, to a severe spill during transportation involving a large release of cyanide solution or acid. Some of the chemicals could have immediate adverse effects on water quality and aquatic resources if spills were to enter streams. Spills of hazardous materials could seep into the ground and contaminate the ground water system. Depending on the proximity of people to such spills or the use of degraded water for human consumption, an accidental spill could affect human health.

TABLE 3-52
Hazardous Substances Storage

Storage Site/Description	Reagents	Existing	No Action Alternative	Proposed Action
Sage Mill	Cyanide			25,000 gal
	Lime			85,184 cubic feet
	Flocculant			11,597 cubic feet
	Hydrogen Peroxide			10,000 gal
	Caustic			195,000 gal
	Antiscalant			10,000 gal
	Sulfuric Acid			637,176 gal
Piñon Mill[1]	Cyanide	40,000 gal	40,000 gal	
	Lime	83 ton bin	83 ton bin	
	Flocculant	N/A gal	N/A gal	
	Hydrochloric Acid	5000 gal	5000 gal	
	Caustic	4500 gal	4500 gal	
	Antiscalant	5000 gal	5000 gal	
Juniper Mill[1]	Cyanide	10,000 gal	10,000 gal	
	Lime	60 tons	60 tons	
	Flocculant	19,000 lbs	19,000 lbs	
	Nitric Acid	7,750 gal	7,750 gal	
	Caustic	19,5000 gal	19,5000 gal	
	Antiscalant	3000 gal	3000 gal	
	Zinc	20,000	20,000	
North Pit Leach[1]	Cyanide	25,000 gal	25,000 gal	
	Lime	160 tons	160 tons	
	Antiscalant	9,6000 gal	9,6000 gal	
South Pit Leach[1]	Cyanide	1,800 gal	1,800 gal	
	Lime	200 ton bin	200 ton bin	
	Antiscalant	2700 gal	2700 gal	
Water Treatment	Ferric Sulfate	17,000 gal	17,000 gal	
	WT Flocculant	7200 lbs	7200 lbs	

[1]Storage would not change for the No Action alternative or the Proposed Action.
Source: Gillespie 1996.

3.15.2.1 No Action Alternative

Transportation

The Twin Creeks Mine expects a delivery frequency of 36 sodium cyanide trucks every month, 2 acid trucks every month, and 5 diesel trucks every day, over the life of the No Action alternative (estimated to be approximately 5 years, through the year 2000). This would result in a total of 2,160 shipments of sodium cyanide (432 shipments/year x 5 years); 120 shipments of acid solutions (24 shipments/year x 5 years); and 9,125 shipments of diesel (1,825 shipments/year x 5 years).

The probability of an accident (i.e., release) involving deliveries of these three substances was calculated using the Federal Highway Administration truck accident statistics (Rhyne 1994). According to these statistics, the average rate of truck accidents for rural two-lane roads is 2.19 accidents per million miles traveled. However, the statistics for rural two-lane roads do not differentiate between road surfaces. Considering that the transport route includes a section of improved gravel, the likelihood of an accident in this area may be higher than in the paved section, especially under wet conditions. The average rate of truck accidents for freeways is 0.64 accidents per million miles traveled. Approximately 35 miles

TABLE 3-53
Storage of Oil and Oil-Related Products

Area	Product Stored	Quantity	Storage Container Description
Juniper Area Tank Farm	antifreeze	1	6,000 gallon tank
	diesel	1	21,000 gallon tank
	unleaded gas	1	10,000 gallon tank
	50-weight oil	1	6,000 gallon tank
	engine oil	1	6,000 gallon tank
	gear oil	1	6,000 gallon tank
	hydraulic oil	1	6,000 gallon tank
	used oil	1	10,000 gallon tank
	used oil/diesel	1	10,000 gallon tank
	power transmission fluid	1	6,000 gallon tank
Oil/Water Separator Tank #1	used oil	1	500 gallon tank
Oil/Water Separator Tank #2	used oil	1	250 gallon tank
Oil Pump House	petroleum-based oil	unknown	55 gallon drum
	oil/grease	unknown	500 - 750 gallon portable jumbo tank
Warehouse Barrel Storage Rack Area	miscellaneous oil	approximately 50	55 gallon drum
		unknown	portable jumbo tank
	rock drill oil	2	500 gallon tank
Juniper Barrel Storage Area	miscellaneous oil/grease/crater	unknown	various sized drum
Power Plant Building	lube oil	1	2,400 gallon tank
Generator Building	diesel	2	250 gallon tank
Juniper Preventative Maintenance Shop Building and Small Vehicle/Transportation Shop Building	oil	unknown	55 gallon drum
		unknown	500 - 750 gallon portable tank
	used oil	unknown	40 - 200 gallon filter drain
Juniper Mill Building	gear oil	unknown	unknown
	lubricating oil	2	150 gallon oil vessel
Water Pump House Building	diesel	1	300 gallon tank
Merit Consultants Tank Farm	diesel	1	470 gallon tank
	used oil/diesel	several	55 gallon drum
Midway Facilities	coolant	1	7,000 gallon tank
	diesel	1	20,000 gallon tank
		1	90,000 gallon tank
		1	100,000 gallon tank
	15W40 oil	1	7,000 gallon tank
	30W oil	1	2,000 gallon tank
	50W oil	1	2,000 gallon tank
	AW46 oil	1	7,000 gallon tank
	hydraulic oil	1	7,000 gallon tank
	miscellaneous oil	several	portable jumbo tank
		several	55 gallon drum
	synthetic oil	1	3,400 gallon tank

TABLE 3-53 (continued)
Storage of Oil and Oil-Related Products

Area	Product Stored	Quantity	Storage Container Description
New Drill And Blast Storage Area	diesel	1	10,000 gallon tank
		1	2,000 gallon tank
	mineral oil	1	10,000 gallon tank
	rock drill oil	1	10,000 gallon tank
	used oil/diesel	1	20,000 gallon tank
Piñon Barrel Storage Area	miscellaneous oil/grease/crater	unknown	55 gallon drum
Piñon Maintenance Building #1	motor oil	1	10,000 gallon tank
	power transmission oil	1	10,000 gallon tank
	used oil	1	10,000 gallon tank
	unknown	several	portable drain pan
		several	portable jumbo tank
Piñon Maintenance Building #2	hydraulic oil	1	8,000 gallon tank
	motor oil	1	8,000 gallon tank
	used oil	1	8,000 gallon tank
	unknown	several	portable jumbo tank
		several	portable drain pan
		several	55 gallon drum
Piñon Maintenance Building Jumbo Storage Area (outside Piñon Maintenance Building #2)	oil/grease	several	55 gallon drum
		several	portable jumbo tank
Piñon Area Tank Farm	diesel	1	21,000 gallon tank
	gasoline	1	10,000 gallon tank
	kerosene	1	500 gallon tank
Piñon Contractor Tank Farm	diesel	1	10,000 gallon tank
	gasoline	1	1,000 gallon tank
Piñon Mill Building	crater	1	500 gallon jumbo tank
	lubricating oil	1	150 gallon tank
		1	120 gallon tank
	used oil	1	450 gallon tank
	miscellaneous oil/grease/crater	unknown	55 gallon drum
		unknown	jumbo tank
	diesel	1	300 gallon tank
		1	500 gallon tank
	diesel	1	150 gallon tank
	diesel	2	1,000 gallon tank
		1	1,000 gallon tank
	gasoline	1	500 gallon tank
	oil	several	55 gallon drum
	gasoline	1	500 gallon tank
	compressor oil	1	550 gallon tank
	rock drill oil	1	1,000 gallon tank
	used antifreeze	several	55 gallon drum

Source: JBR Environmental Consultants, Inc. 1996.

TABLE 3-54
Twin Creeks Mine Mobile Tank Inventory
Winter 1996

Mobile Tank ID Number	Type of Oil	Storage Capacity
U602	diesel fuel	1,000 gallons
	90w gear oil	90 gallons
	15/40 motor oil	200 gallons
	30w motor oil	130 gallons
	10w hydraulic oil	150 gallons
	super 46 hydraulic oil	200 gallons
	coolant	140 gallons
	used oil	130 gallons
	50w transmission oil	150 gallons
	grease	50 gallons
	Truck's hydraulic oil reservoir	100 gallons
U606	grease	8,000 lbs.
U611	diesel fuel	1,000 gallons
	15/40 motor oil	100 gallons
	AW46 hydraulic oil	100 gallons
	10w hydraulic oil	100 gallons
	624 synthetic hydraulic oil	50 gallons
	coolant	50 gallons
	used oil	100 gallons
	grease	55 gallons
	Truck's hydraulic oil reservoir	30 gallons
U624	AW46 hydraulic oil	2,250 gallons
	10w hydraulic oil	300 gallons
	grease	40 gallons
	Truck's hydraulic oil reservoir	40 gallons
U630	diesel fuel	2,400 gallons
	85/140 gear oil	100 gallons
	50w motor oil	50 gallons
	30w motor oil	100 gallons
	15/40 motor oil	100 gallons
	AW46 hydraulic oil	218 gallons
	10w hydraulic oil	218 gallons
	624 synthetic hydraulic oil	100 gallons
	coolant	150 gallons
	used oil	150 gallons
	grease	50 gallons
U663	jumbo grease	500 gallons
	jumbo crater grease	500 gallons
	Truck's hydraulic oil reservoir	80 gallons
TOTAL GALLONS OF CAPACITY		**11,241 gallons**

Source: JBR Environmental Consultants, Inc. 1996.

of freeway would be traveled from Battle Mountain to the Golconda exit, and approximately 88 freeway miles from Carlin to the same exit. Approximately 35 miles of two-lane rural road would be traveled from Golconda to the Twin Creeks Mine. The probability of an accident, and potential release, for sodium cyanide solutions, acid solutions, and diesel transported to the facility over the life of the No Action alternative would be:

Sodium Cyanide:

2,160 truck deliveries x 35 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.05 release

2,160 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = 0.16 release

0.05 releases + 0.16 releases = 0.21 (rounded to 0.2) total release

Diesel:

9,125 truck deliveries x 35 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.2 release

9,125 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = 0.7 release

0.2 releases + 0.7 releases = 0.9 (rounded to 1.0) total release

Acid solutions:

120 truck deliveries x 88 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.007 release

120 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = 0.01 release

0.007 releases + 0.01 releases = 0.017 (rounded to 0.02) total release

For this analysis, it was assumed that a "reportable quantity" of the hazardous material would be released if an accident were to occur. Under this assumption, the projected 1.0 release of diesel fuel over the life of the No Action alternative would be a significant impact. The transport of sodium cyanide and acid solutions would not result in a significant impact over the life of the No Action alternative.

This analysis examined the possibility of an accident resulting in the release of sodium cyanide solutions, acid solutions, and diesel. The mine also would be receiving shipments of other hazardous materials such as caustic, gasoline, and other process reagents; however, as shown in ***Table 3-51***, the delivery frequency of these materials would be the same as the existing levels and would be relatively low compared to sodium cyanide, acid solutions, and diesel. Therefore, the potential of an accident and release of these materials would not increase significantly.

<u>Effects of a Release</u>

The environmental effects of a release would depend on the material released, the volume released, and the location. The releases calculated above assume a hazardous material, but do not address volume or location.

An acid release into a stream or other water body would have the potential for migrating from the spill site, lowering the pH of the water, and reducing populations of aquatic invertebrates, amphibians, and fish. Acid spills may be neutralized by alkaline soils.

A release of diesel fuel in high concentrations would "burn" vegetation. Although unlikely, such a spill also could ignite and cause a range fire. A spill into a water body would contaminate the water and sediment, possibly impacting local aquatic populations. With rapid cleanup actions, diesel contamination would not result in long-term increases in various hydrocarbons in soils, surface water, or ground water.

The effects of a sodium cyanide release would be more variable than a release of acid or diesel fuel, and would depend on the amount of the release, the location of the release (e.g., dry upland area, wet meadow area, or flowing stream area), the organisms exposed, and the chemical conditions at the release location. The most likely effect of a release of sodium cyanide would be the poisoning of terrestrial and aquatic species. Animal species that drink contaminated water would suffer severe effects or death depending on the concentration of cyanide and the volume of the water consumed. Environmental effects of a cyanide spill or leak would be limited in extent and time of contamination due to the rapid degradation of cyanide within the environment.

A large-scale release of diesel fuel, acid, or sodium cyanide could 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 was calculated to be low; the probability of a release within a populated area would be lower; and the probability of a release involving an injury or fatality would be lower still. It is not anticipated that a release involving severe effects to human health or safety would occur during the life of the project. In addition, none of the process chemicals or fuels to be used in large quantities are carcinogenic; therefore, no increases in cancer risk as a result of a release or mining activity are expected.

Response to an Off-Site Release

All hazardous substances would be transported by commercial carriers or vendors in accordance with the requirements of Title 49 Code of Federal Regulations. Carriers would be licensed and inspected as required by the Nevada Department of Transportation. Tanker trucks would be inspected and 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 Code of Federal Regulations requires that all shipments of hazardous substances be properly identified and placarded. Shipping papers must be accessible and 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.

In the event of a release off the project site during transport, the transportation company would be responsible for first response and cleanup. Each transportation company would develop a Spill Prevention, Control, and Countermeasures Plan to address the materials they would be transporting. Local and regional law enforcement and fire protection agencies also may be involved initially to secure the site and protect public safety. The Twin Creeks Mine has developed an Emergency Response Plan for transportation accidents occurring on the project site. This plan includes notification of the local emergency response personnel and provides for advice, personnel, and equipment as appropriate to minimize the impact of the accident. In addition, the Chemical Manufacturers' Association maintains the Chemical Transportation Emergency Center, which has a 24-hour "hotline" to provide information, advice, and assistance in identification and mitigation of chemical emergency scenes.

Title 49 Code of Federal Regulations requires that the carrier notify local emergency response personnel, the National Response Center (for discharge of reportable quantities of hazardous substances to navigable waters), and the U.S. Department of Transportation in the event of an accident involving hazardous substances.

Storage and Use

Over the life of the project, the probability of minor spills of materials such as oils and lubricants would be relatively high. These releases could occur during such operations as a result of a bad connection on an oil supply line or equipment failure. Spills of this nature would most likely be localized, contained, and removed. The Twin Creeks Mine would have the necessary spill containment and cleanup equipment available at the site, and personnel would be able to respond quickly.

The design of the leaching operations and hazardous materials storage facilities would minimize the potential for an upset that results in a major spill. Mill sites would be designed to prevent discharge to the vadose zone (unsaturated layer above water table) or to waters of the United States. Hazardous material storage tanks and storage areas would have secondary containment sufficient to hold the volume of the largest tank, as well as allow for additional freeboard. Tanks and vessels would either be positioned on concrete surfaces with interior drains to route any spilled process solutions to lined collection areas, or in bermed storage enclosures.

All hazardous substances would be handled in accordance with applicable Mine Safety and Health Administration or Occupational Safety and Health Administration regulations (Titles 30 and 29 Code of Federal Regulations). The hazardous substances to be used at the mine would be handled as recommended on the manufacturer's Material Safety Data Sheets. With the proposed design features and operational practices in place, the probability of a release occurring at the mill sites, leaching sites, or storage areas would not be significant.

Response to an On-Site Release

In the event of a major or minor spill on the project site, the Twin Creeks Mine has prepared an Emergency Response Plan which establishes procedures for the prevention, control, and reporting of environmental releases in or from facilities located at the Twin Creeks Mine. All spills would be cleaned-up or neutralized and reported, if required, to the Nevada Motor Vehicle Division and Public Safety Division of Special Services, the Office of Emergency Management, the Nevada Division of Environmental Protection, the Bureau of Corrective Actions, the U.S. Environmental Protection Agency National Response Center, and the BLM. In the event of a hydrocarbon-related spill, SFPG has the capacity to treat hydrocarbon-contaminated soil at its bioremediation site. A description of the existing and proposed expansion of the bioremediation site is presented in Section 2.3.13, Development of a Bioremediation Site.

3.15.2.2 Proposed Action

Transportation

As discussed under the No Action alternative, sodium cyanide, acid solutions, and diesel would be the potentially most hazardous materials shipped to the site under the Proposed Action. Sodium cyanide shipments would increase by an additional 19 shipments per month for a total of 55 shipments per month. Sulfuric acid, which was not a required reagent for the No Action Alternative, would be utilized by the mine during the Proposed Action. There would be 17 shipments per month of sulfuric acid. The Proposed Action also would require up to 8 additional shipments per month of nitric acid. Total shipments of acid solutions for the Proposed Action would be 26 shipments per month (compared to 2 under the No Action alternative). Shipments of diesel for the Proposed Action would be the same as the No Action alternative (5 shipments per day). The probability of an accident and potential release for sodium cyanide, acid solutions, and diesel transported to the facility over the life of the Proposed Action (estimated to be approximately 15 years; through the year 2011) would be:

Sodium Cyanide (Proposed Action):

9,900 truck deliveries x 35 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.22 release

9,900 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = 0.76 release

0.22 releases + 0.76 releases = 0.98 (rounded to 1.0) total release

Diesel (Proposed Action):

27,375 truck deliveries x 35 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.61 release

27,375 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = 2.10 releases

0.61 releases + 2.1 releases = 2.71 (rounded to 2.7) total releases

Acid solutions (Proposed Action):

4,680 truck deliveries x 88 mile haul distance (freeway) x 0.00000064 accidents per mile = 0.26 release

4,680 truck deliveries x 35 mile haul distance (rural two-lane) x 0.00000219 accidents per mile = .36 release

0.26 releases + 0.36 releases = 0.62 (rounded to 0.6) total release

The projected 2.7 releases of diesel fuel and one release of sodium cyanide over the life of the Proposed Action would be significant impacts. The transport of acid solutions would not result in a significant impact over the life of the Proposed Action. The potential effects of a release and responses to a release would be the same as described under the No Action alternative.

Storage and Use

Storage and use of hazardous materials under the Proposed Action would be similar to the No Action alternative. Spill containment facilities would be in place, and all hazardous materials would be handled in accordance with applicable regulations. The probability of a release occurring during the Proposed Action would not be significant. Response to an on-site release would be the same as described under the No Action alternative.

3.15.2.3 Other Project Alternatives

Impacts from the transportation, storage, or use of hazardous materials under the other project alternatives would be the same as described for the Proposed Action.

3.15.3 Cumulative Impacts

Cumulative impacts resulting from the shipment of hazardous materials in the area exist due to the existing operations of the Getchell and Pinson Mines. These mines are also accessed by Interstate 80, State Route 789, and County Road 513. These mines also require materials classified as hazardous (i.e., sodium cyanide and petroleum products) for their operations. The probability of an accident occurring along Interstate 80, State Route 789, and County Road 513 (***Figure 1-1***) would increase when the Twin Creeks Mine increases shipments of hazardous materials.

3.15.4 Monitoring and Mitigation Measures

HM-1: Deliveries of hazardous materials to the Twin Creeks Mine would be limited to periods of low traffic volume to further decrease the potential for an accident.

HM-2: Deliveries of hazardous materials would be postponed during extreme adverse weather conditions to de-crease the potential for an accident.

3.15.5 Residual Adverse Effects

The residual adverse effect during transport of a hazardous material would be the potential for a release into a populated area (e.g., Winnemucca, Golconda, Battle Mountain, Carlin), or sensitive environment (e.g., Humboldt River) along the proposed transportation routes. Residual adverse effects from the increased use of hazardous materials on the project site would depend on the substance, quantity, timing, location, and response involved in an accidental spill or release. Prompt cleanup of spills and releases according to the Twin Creeks Mine Emergency Response Plan or a transporter's Spill Prevention, Control, and Countermeasures Plan would minimize the residual adverse effects of such events.

3.16 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

The short-term use of resources during the construction, operation, closure, and reclamation of the project would result in beneficial impacts in the form of additional local employment and the generation of revenue. It would also result in various short-term adverse impacts, such as temporary loss of soil and vegetative productivity, possible wildlife dislocation or mortality, reduced livestock grazing area, increased fugitive dust generation, socioeconomic impacts to the local infrastructure, and increased noise levels. These impacts are expected to end upon closure of operations and would be mitigated through reclamation of the disturbed areas.

Impacts to the long-term productivity of the site (i.e., following project closure and reclamation) would depend primarily on the effectiveness of planned reclamation of the disturbed areas. The reclamation goal is to return the disturbed areas to livestock and wildlife grazing by establishing self-sustaining vegetation communities. The revegetation is also expected to stabilize the disturbed surfaces and control erosion of soil from these areas. Under typical moisture conditions at the site, it is expected that initial reclamation efforts would result in sparse stands of perennial grasses, primarily wheatgrasses, with scattered shrubs, such as fourwing saltbush. With proper management, this initial reclamation community should evolve toward greater abundance of grasses and shrubs. If initial reclamation of the areas occurs in years with above-average precipitation, grasses and shrubs may become established more quickly, thus hastening the evolution toward a self-sustaining mixture of predominantly perennial species.

There would be reductions in surface water flows during operations and postclosure associated with ground water drawdown from pit dewatering

There would be long-term losses in vegetation and wildlife habitat associated with the open pits, which would not be reclaimed.

3.17 Irreversible and Irretrievable Commitment of Resources

The Proposed Action or other project alternatives 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 and cultural resources) or the irretrievable commitment of resources (e.g., the lost production of renewable natural resources during the life of the operation). Irreversible and irretrievable impacts are described below for each resource.

3.17.1 Geology and Minerals

The Proposed Action would result in the mining and extraction of approximately 11.7 million ounces of known gold reserves. This would be an irreversible and irretrievable commitment of resources because once the mineral reserves are mined they would no longer be available for future production. The placement of leach pad E and/or storage area K (Section 8, Township 39 North, Range 43 East), and storage area G and/or leach pad C (Section 30, Township 39 North, Range 43 East) would cover identified economic gold mineralization. This would be an irretrievable commitment of resources since these facilities could be relocated and the mineral reserves mined in the future. No other irreversible and irretrievable commitments of mineral resources are anticipated.

3.17.2 Water Quantity and Quality

An estimated 53,600 acre-feet and 250,000 acre-feet of ground water would be extracted during mine dewatering under the No Action alternative and the Proposed Action, respectively. Of these totals, approximately 41,500 acre-feet and 124,000 acre-feet, respectively, of the pumped ground water would be consumed in the mining and milling operations or lost through evaporation during project operations. The permanent removal of ground water is an irretrievable impact. The remaining 12,100 acre-feet under the No Action alternative and 126,000 acre-feet under the Proposed Action would be discharged to the reinfiltration basins and Rabbit Creek, and would infiltrate back to the ground water system.

At the completion of mining and dewatering activities, ground water inflow is predicted to result in the development of a pit lake. The pit lake is predicted to lose water through evaporation at an estimated rate of 1,500 acre-feet per year and 3,100 acre-feet per year for the No Action alternative and the Proposed Action, respectively.

The continuous inflow of ground water to the lake to replace water loss through evaporation from the lake surface is predicted to maintain a cone of drawdown in the regional ground water surface. The area of the cone of drawdown resulting from the pit lake is predicted to extend out approximately 5 to 7 miles from the center of the pit. Any reduction in flows to streams or springs would also persist into the future. This loss of ground water through evaporation from the pit lake and resultant hydrologic changes that would remain for the foreseeable future represents an irreversible commitment of water resources.

SFPG will comply with the conditions of their National Pollutant Discharge Elimination System Permit(s) and Ground Water Protection Permit(s) for the Twin Creeks Mine. The permitted discharges would, however, contribute to increased chemical concentrations in the regional hydrologic system, resulting in an irreversible and irretrievable commitment of natural resources.

3.17.3 Soils

No irreversible or irretrievable commitment of soil resources are anticipated. Pit alluvium would be salvaged for use as growth media and as basal and cover material for project facilities.

3.17.4 Vegetation

An irreversible commitment of 1,354 acres of vegetation would result from pit development. Project disturbance (approximately 8,353 acres) would constitute an irretrievable commitment of vegetation resources during the life of the operation and subsequent reclamation. These acreage totals include the total incremental disturbance associated with the No Action alternative and Proposed Action.

3.17.5 Wildlife and Fisheries Resources

Approximately 1,354 acres of wildlife habitat would be irreversibly lost from pit development. Total mining disturbance of 8,353 acres would constitute an irretrievable commitment of wildlife habitat during the life of the operation and subsequent reclamation. In addition, project construction would result in the mortality or displacement of an unknown number of small mammals, reptiles, birds, and invertebrates that use habitats within the proposed areas of disturbance; these minor wildlife losses would be irretrievable. These acreage totals include the total incremental disturbance associated with the No Action alternative and Proposed Action.

3.17.6 Range Resources

The proposed project would result in the irretrievable commitment of grazing forage on approximately 9,588 acres of rangeland during project operations and subsequent reclamation. Following reclamation, grazing could resume on the site, excluding the pits where the commitment of range resources (1,354 acres) would be irreversible. These acreage totals include the total incremental disturbance and areas excluded by fencing during operations and reclamation.

3.17.7 Paleontological Resources

No irreversible or irretrievable commitment of paleontological resources is anticipated.

3.17.8 Cultural Resources

The proposed project would result in the irreversible alteration or destruction of seven prehistoric and historic archaeological sites during project construction that have been judged not eligible for the National Register of Historic Places. A total of four sites that have been judged eligible by the archaeological contractor would be directly impacted. However, these sites have not been reviewed by the BLM or State Historic Preservation Office; final determination is pending.

3.17.9 Air Quality

No irreversible or irretrievable commitment of air resources is anticipated.

3.17.10 Land Use and Access

Changes in land use would generally be reversible through reclamation efforts, except for the 1,354 acres lost to pit development. The difference in the project area topography following reclamation may limit the types of land use for which the reclaimed area is suitable; however it should be suitable for livestock grazing and wildlife habitat uses. There would be an irretrievable loss of public lands available for livestock grazing, wildlife habitat, and dispersed recreational opportunities until reclamation is sufficient to restore productivity and allow these activities to resume. There would be no irreversible or irretrievable impacts to public access.

3.17.11 Recreation and Wilderness

The irreversible loss of 1,354 acres to pit development would minimally affect dispersed recreational opportunities in the project area. There would be an irretrievable loss of public lands available for dispersed recreational opportunities until reclamation is sufficient to allow dispersed recreation activities to resume. No irreversible or irretrievable commitment of wilderness resources is anticipated.

3.17.12 Social and Economic Values

No irreversible or irretrievable commitment of socioeconomic resources is anticipated.

3.17.13 Visual Resources

The proposed project would result in irreversible changes in the local landscape and views. These changes would be partially mitigated through reclamation to minimize long-term color and form contrasts.

3.17.14 Noise

No irreversible or irretrievable noise impacts are anticipated.

3.17.15 Hazardous Materials

No irreversible or irretrievable impacts associated with hazardous materials are anticipated. However, if a spill were to affect a sensitive resource, an irreversible impact would occur pending the recovery of the resource.

4.0 Consultation and Coordination

CHAPTER 4.0 Consultation and Coordination

4.1 Public Participation and Scoping

The public participation process for the Twin Creeks Mine Environmental Impact Statement (EIS) includes an open forum for determining the scope of issues to be addressed in the assessment.

The Bureau of Land Management (BLM) published a Notice of Intent to prepare an EIS in the Federal Register on July 26, 1994. Two public scoping meetings were held for the EIS, August 9 and 10, 1994, in Winnemucca and Reno, Nevada, respectively. The public scoping period for the EIS closed on September 9, 1994.

The scope of this EIS reflects input received from the public and from the appropriate government agencies. Key issues identified during the scoping process include the following:

- Impacts from dewatering, drawdown, and recharge
- Potential impacts from acid-generating waste rock associated with the tailings impoundments and pit walls
- Water quality impacts associated with the pit lakes
- Revegetation using natural, indigenous species for reclamation
- Potential traffic impacts associated with construction and operation of the Proposed Action
- Cumulative impacts throughout the Humboldt River Basin

The BLM will publish Notices of Availability of the Draft EIS and Final EIS in the *Federal Register*. There will be a 60-day public review period following the publication of the Draft EIS. There will be two public meetings during the Draft EIS public review period; these meetings will be held in Winnemucca and Reno. Following the publication of the Final EIS, there will be a 30-day public review period. Subsequent to the 30-day review of the Final EIS, the Record of Decision is prepared by the BLM and a Notice of Availability for the Record of Decision is published in the *Federal Register*.

4.2 List of Agency Contacts

During the preparation of the EIS for the proposed mine consolidation and expansion, the BLM communicated with and received input from various federal, state, and local agencies and private organizations. The following sections list these contacts.

4.2.1 Federal Agencies

Bureau of Land Management, Elko Resource Area
USDA Forest Service
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

4.2.2 State Agencies/Universities

Colorado Division of Wildlife
Colorado State University
Nevada Department of Conservation and Natural Resources
Nevada Department of Taxation
Nevada Division of Environmental Protection
Nevada Division of Wildlife
Nevada Natural Heritage Program
Northern Nevada Community College

4.2.3 Local Agencies

Golconda Water District
Humboldt County Assessor
Humboldt County Chamber of Commerce
Humboldt County Commissioners
Humboldt County Department of Transportation
Humboldt County Recorder- Auditor
Humboldt County Rural Fire Department
Humboldt County School District
Humboldt County Sheriff's Department
Lander County School District
Lander County Sheriff's Department
Lander County Water and Wastewater
Tri-County Development Authority
Winnemucca Police Department
Winnemucca Recreation Department
Winnemucca Volunteer Fire Department

4.2.4 Private Organizations and Companies

Battle Mountain General Hospital
Battle Mountain Realty
Century 21
Humboldt General Hospital
Humboldt Realty
Merit Consultants Ltd.
Nevada First Corporation
Sonoma Realty
TRC Environmental Corporation

4.3 List of Agencies, Organizations, and Persons to Whom Copies of This Statement are Sent

Agri Beef Company

AMAX Gold - Sleeper

Audubon Society
Lahontan Chapter

Baker, Dave
Newmont Mining Corporation

Baldrica, Alice
Historic Preservation Office

Baughman, Mike
Humboldt River Water Basin Authority
Intertech Services Corporation

Bell, Scott
USDA, Forest Service

Boughton, Carol
USDI, Geological Survey

Brown, George

Brown, Robert

Bryan, Richard

Buck, Borian

Cameron, Druet
Holme, Roberts & Owen

Chase, Rocky
Rosebud Project

Crawford-Bunch, Sheila
Women in Mining

Crisman, Chuck
Trout Unlimited
Sagebrush Chapter

Crutcher, Wilson
Chair, Fort McDermitt Tribal Council

Daniels, Eric
Echo Bay Minerals Company
McCoy Mine

Deason, Jonathan
USDI, Office of Environmental Affairs

Deisley, David L.
Parsons Behle & Latimer

Division of Water Resources
State Engineer

Elko County Library
Reference Department

Elko Resource Area
Area Manager

Felty, Catherine
Nevada Indian Environmental Coalition

Fields, Russell A.
Nevada Department of Minerals

First Miss Gold-Getchell

French, Jim
Nevada Division of Wildlife

Friesema, H. Paul
Center for Urban Affairs and Policy Research

Fullenwider, Jack

Garcia, Vince
South Fork Band Council of the Te-Moak Tribe of Western Shoshone

Gebhardt, John
Nevada Division of Wildlife

George-Byrd, Darlene
Chair, Lovelock Paiute County

Geselbracht, Jeanne
U.S. Environmental Protection Agency, Region IX

Gettig, Rodney

Glock, Mike
Nevada Department of Transportation

Gonzales, Raymond
Chair, Elko Board of the Te-Moak Tribe of Western Shoshone

Guild, Joe

Happy Creek Land and Cattle Company

Harlow, David
USDI, Fish and Wildlife Service

Heap, Richard
State of Nevada
Division of Wildlife

Hibbs Christison, Jo

Hill, Harriet
U.S. Environmental Protection Agency, Region IX

Hillenbrand, John
U.S. Environmental Protection Agency, Region IX

Hocker, Phil
Mineral Policy Center

Hodges, Bennie
Pershing County Water District

Horning, John
National Wildlife Federation

Humboldt County Commissioners

Humboldt County Library

Humboldt National Forest

Hunt, Tom

Hycroft Mine

Jim, Gelford
Chair, Battle Mountain Board of the Te-Moak Band of Western Shoshone

Johnson, Roger

Johnson, Scott

Kibby, Larry
Consultant/Director, Western Shoshone Historic Preservation Society

King, Wayne
Area Manager, Shoshone-Eureka R.A.

La Puente Gem and Mineral Club

Lander County Commissioners

Lander County Library

Lang, Steve
Santa Fe Pacific Gold Corporation
Twin Creeks Mine

Livermore, J.S.
Cordex Exploration Company

Lopez, Charlene
Graystone

Lynn, Susan

Manning, Lindsay
Chair, Duck Valley Tribal Council

Marigold Mine

Marvel, John
State Assemblyman

McAdoo, Kent
The Wildlife Society
Nevada Chapter

McFarland, Joe
USDI, Bureau of Land Management

Miller, Douglas

Miller, Glenn

Millet, Jerry
Tribal Administrator, Duckwater Tribal Council

Morlock, Dale
USDI, National Park Service

Mudge, John
Newmont Gold Company

Nappe, Tina

National Wildlife Federation
Western Regional Office

The Nature Conservancy
Northern Nevada Office

Nettleton, Jerry
TerraMatrix, Inc.

Nevada Cattlemen's Association

Nevada Division of Environmental Protection
Bureau of Mining Regulation and Reclamation

Nevada Division of Wildlife

Nevada First Corporation

Nevada Mining Association

Nevada State Engineer
Division of Water Resources

Nevada Woolgrower's Association

Osborne, Marv
Chair, Ft. Hall Shoshone-Bannock

Penola, George

Pilippini, Don and Eddyann
Badger Ranch

Pinson Mine

Plummer, Craig
SCS District Conservationist

Protani, Mike
Marigold Mine

Reynolds, Larry

Sager, R.K.
Van Cott, Bagley, Cornwall & McCarthy

Sampson, Jennifer
PTI Environmental Services

Sanchez, Virginia
Citizens Alert Native American

Santa Clara Valley Gem and Mineral Society

Satterthwaite, Deloyd
Ellison Ranching Company

Scheidig, Paul
Nevada Mining Association

Sequra, Ray
Rock Creek Ranch

Siegel, Steve
Sierra Pacific Power Company

Sierra Club
Great Basin Group

Sierra Club
Legal Defense Fund

Sill, Marjorie

Spriggs, Gaylyn

State of Nevada
Department of Conservation and Natural Resources

State of Nevada
Division of State Lands

State of Nevada
Governor's Office

State of Nevada
State Planning Coordinator

Strickland, Rose
Sierra Club
Toiyabe Chapter

Struhsacker, Debbie

Sweeney, Sharon

Taylor, Greg

Toomer, Charlene

University of Nevada - Reno
American Institute of Mining and Metallurgical Engineers of Nevada Section
MacKay School of Mines

University of Nevada - Reno
Getchell Library

University of Nevada - Reno
Nevada Bureau of Mines and Geology

U.S. Air Force (HQ-USAF/LEEV)
Environmental Division

U.S. Air Force
Office of Deputy A/S

U.S. Army Corps of Engineers
South Pacific Division
Chief, Planning Division

U.S. Department of Energy
Office of Environmental Compliance

USDI, Bureau of Land Management

USDI, Bureau of Mines
Branch of Mineral Assessment

USDI, Bureau of Mines
Western Field Operations Center

USDI, Bureau of Reclamation
Denver Federal Center

USDI, Fish and Wildlife Service
Chief, Division of Environmental Coordination

USDI, Fish and Wildlife Service
Fish and Wildlife Enhancement
Eastside Federal Complex

USDI, Geological Survey
Environmental Affairs Program

USDI, Minerals Management Service
Offshore Environmental Assessment Division

USDI, Natural Resources Library

USDI, Office of Environmental Policy and
Compliance

USDI, Office of Public Affairs

USDI, Office of Surface Mining
Chief, Division of Environmental and Economic
Analysis

Vesco, Paul

Vucanovich, Barbara

Wald, Johanna H.
Natural Resources Defense Council

Wasson, Glenn
Chair, Winnemucca Tribal Council

Watson, Charles
Nevada Outdoor Recreation Association

West, Steve
Winnemucca City Manager

WESTEC

Western Shoshone National Council

Whitaker, Nancy
Animal Protection Institute of America

Wilson, Edie

Wilson, Jim
LASER, Inc.

Winnemucca City Council Members

Woods, Jack

Young, Pearl
U.S. Environmental Protection Agency

Yowell, Raymond
Western Shoshone National Council

5.0 List of Preparers and Reviewers

CHAPTER 5.0
List of Preparers and Reviewers

5.1 Bureau of Land Management EIS Team

Discipline	Name	BLM Office Location
Project Manager, NEPA, Air Quality, Entire Document	Gerald Moritz	Winnemucca
Cultural Resources, Ethnography, Paleontology	Regina Smith	Winnemucca
Geology and Minerals	Ken Loda/Rob Ernst	Winnemucca
Land Use and Access	Chuck Valentine	Winnemucca
Range Management	Bob Hopper	Winnemucca
Recreation	Lynn Clemons	Winnemucca
Socioeconomics	Gerald Moritz/Paul Myers	Winnemucca/Reno
Soils, Vegetation	Mike Zielinski	Winnemucca
Threatened and Endangered Plants and Animals, Wildlife	Shane DeForest	Winnemucca
Visual Resources	Lynn Clemons	Winnemucca
Water Quality and Quantity	Craig Drake/Tom Olsen	Winnemucca/Reno

5.2 Riverside Technology, inc. EIS Team

Discipline	Name	Degree(s) and Experience
Project Manager	Valerie Randall Riverside Technology, inc. Fort Collins, Colorado	BA Urban Studies 18 years experience
Assistant Project Manager, Noise	William Theisen Riverside Technology, inc. Fort Collins, Colorado	MS Recreation Resources BS Natural Resources 13 years experience
Water Quantity and Quality, Geology and Minerals	Patrick Plumley, C.E.G., R.G. Riverside Technology, inc. Fort Collins, Colorado	MS Geology BS Geology 13 years experience
Surface Water, Soils	James Burrell Riverside Technology, inc. Fort Collins, Colorado	MS Civil Engineering BS Forest Management 15 years experience
Water Quality	Stephen Johnson Riverside Technology, inc. Fort Collins, Colorado	MS Water Quality/Hydrology BS Biology/Chemistry 9 years experience
Geochemistry	Donald Runnells, Ph.D. Shepherd Miller, Inc. Fort Collins, Colorado	Ph.D. Geology and Geochemistry MA Geology; BA Geology 32 years experience
Geochemistry	Georgia Doyle Shepherd Miller, Inc. Fort Collins, Colorado	MS Hydrology/Hydrogeology BS Hydrology 5 years experience
Ground Water Modeling	Paul Witherspoon, Ph.D. Berkeley, California	Ph.D. Geology and Physical Chemistry MS Petroleum Engineering Physics BS Petroleum Engineering 54 years experience

5.2 Riverside Technology, inc. EIS Team (Continued)

Discipline	Name	Degree(s) and Experience
Ecological Risk Assessment	David Pillard, Ph.D. ENSR Fort Collins, Colorado	Ph.D. Ecology MS Biology BS Biology 10 years experience
Human Health Risk Assessment	Liz Caldwell ENSR Fort Collins, Colorado	Ph.D. Ecology MS Radiation Ecology BS Medical Technology 12 years experience
Air Quality	Vincent Scheetz ENSR Fort Collins, Colorado	MS Systems Management BS Mathematics 23 years experience
Air Quality	Vincent Pirello ENSR Fort Collins, Colorado	BS Meteorology BS Computer Science 8 years experience
Soils	James Nyenhuis Poudre Envir. Consultants, Inc. Fort Collins, Colorado	MS Soil Science (in progess) MS Communication BA History 17 years experience
Vegetation/Threatened and Endangered Species, Range Management	Russell Moore, Ph.D. Poudre Envir. Consultants, Inc. Fort Collins, Colorado	Postdoctoral Ecology Ph.D. Ecology BS Range Management 23 years experience
Wildlife/Threatened and Endangered Species	Lori Nielsen ENSR Fort Collins, Colorado	BS Wildlife Ecology and Management 11 years experience
Fisheries/Threatened and Endangered Species	Rollin Daggett Riverside Technology, inc. Fort Collins, Colorado	MS Aquatic Biology BS Zoology 20 years experience
Land Use and Access, Recreation and Wilderness	Randal Rasmussen ENSR Fort Collins, Colorado	BS Physical Geography 8 years experience
Social and Economic Values	Karin Sable ENSR Fort Collins, Colorado	BA Economics 5 years experience
Visual Resources	Craig Taggart EDAW, Inc. Fort Collins, Colorado	MLA Landscape Architecture BS Zoology 25 years experience
Cultural Resources	Edward Stoner, Jr. WCRM Sparks, Nevada	BA Anthropology 12 years experience
Paleontology	K. Don Lindsey WCRM Sparks, Nevada	MA Paleontology BA Paleontology 25 years experience
Ethnography	Mary Rusco WCRM Sparks, Nevada	MA Anthropology BA Anthropology 40 years experience
Native American Consultation	Polly Quick ICF Kaiser Engineers Oakland, California	Ph.D. Anthropology MA Anthropology BA Anthropology 20 years experience

5.2 Riverside Technology, inc. EIS Team (Continued)

Discipline	Name	Degree(s) and Experience
Hazardous Materials	Terry Geiselman, R.G. Riverside Technology, inc. Fort Collins, Colorado	BS Geology 12 years experience
AutoCAD/EIS Maps, Geology and Minerals	Ana Vargo Riverside Technology, inc. Fort Collins, Colorado	MS Geology BS Geology 6 years experience

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Hydraulic Head	The height of the free surface of a body of water above a given subsurface point. Water flows from high hydraulic head to low, and an increase in head difference between two points will cause an increase in flow.
Hydrostratigraphic Unit	Grouping of stratified, mainly sedimentary rocks that have similar ground water flow conditions.
Impact	A modification in the status of the environment brought about by the proposed action or an alternative.
Impoundment	The accumulation of any form of water in a reservoir or other storage area.
Indirect Impacts	Impacts that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable (40 Code of Federal Regulations 1508.8); synonymous with indirect effects.
Infiltration	The movement of water or some other liquid into the soil or rock through pores or other openings.
Infrastructure	The basic framework or underlying foundation of a community or project, including road networks, electric and gas distribution, water and sanitation services, and facilities.
Interburden	Non-ore grade material interlayed with ore, or located within or horizontally adjacent to the ore, such that it must be removed in the process of extracting ore grade material.
Intermittent Stream	A stream that flows only part of the time or during part of the year.
Irretrievable	Applies primarily to the lost production of renewable natural resources during the life of the project.
Irreversible	Applies primarily to the use of nonrenewable resources, such as minerals, cultural resources, wetlands, or to those factors that are renewable only over long time spans, such as soil productivity. Irreversible also includes loss of future options.
Isotrophic	Applies to hydraulic properties that are the same in all directions; uniform.
Jurisdictional Wetland	A wetland area identified and delineated by specific technical criteria, field indicators, and other information for purposes of public agency jurisdiction. The public agencies that administer jurisdictional wetlands are the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the USDA Soil Conservation Service.
Key Observation Point	An observer position on a travel route used to determine visible area.
Kinetic Testing	A method of testing rock materials to simulate natural weathering used to test the acid-generating potential of rock.
Liquifaction	The sudden large decrease of shearing resistance of a cohesionless soil caused by a collapse of the structure by a shock (such as an earthquake) and associated with an increase of pore pressure.

Fault	A fracture in rock units along which there has been displacement.
Flocculant	A reagent added to water to aggregate minute suspended particles so that they may precipitate out of suspension.
Floodplain	That portion of a river valley, adjacent to the channel, that is built of sediments deposited during the present regimen of the stream and is covered with water when the river overflows its banks at flood stages.
Flux	A substance that promotes the fusing of minerals or metals.
Forage	Vegetation used for food by wildlife, particularly big game wildlife and domestic livestock.
Forb	Any herbaceous plant other than a grass, especially one growing in a field or meadow.
Fugitive Dust	Dust particles suspended randomly in the air from road travel, excavation, and rock loading operations.
Game Species	Animals commonly hunted for food or sport.
Geochemistry	The study of the distribution and amounts of the chemical elements in minerals, ores, rocks, soils, water, and the atmosphere, and their circulation in nature on the basis of the properties of their atoms and ions.
Geotechnical	A branch of engineering concerned with the engineering design aspects of slope stability, settlement, earth pressures, bearing capacity, seepage control, and erosion.
Grade	A slope stated in feet per mile or as feet per feet (percent); the content of precious metals per volume of rock (ounces per ton).
Ground Water Table	The surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere.
Heap Leach	The process of recovering gold from low grade ores by leaching ore that has been mined and placed on a specially prepared pad. A chemical solution is applied through low volume emitters, and the metal-bearing leachate solution percolates and is collected. At the Twin Creeks Mine, the run-of-mine ore is dumped on the leach pads without crushing or agglomeration.
Host Rock	A rock body or wall rock enclosing mineralization.
Hydraulic Conductivity	The capacity of a rock to transmit water. It is expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.
Hydraulic Gradient	Change in head per unit of distance measured in the direction of the steepest change.

Critical Habitat	Habitat that is present in minimum amounts and is the determining factor in the potential for population maintenance and growth.
Cumulative Effects	The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible impact, the combined effect can be significant. Included are activities of the past, present, and reasonably foreseeable future; synonymous with cumulative impacts.
dBA	The sound pressure levels in decibels measured with a frequency-weighing network corresponding to the A-scale on a standard sound level meter. The A-scale tends to suppress lower frequencies, e.g., below 1,000 hertz.
Decibel (dB)	A unit used in expressing ratios of electric or acoustic power. The relative loudness of sound.
Direct Impacts	Impacts that are caused by the action and occur at the same time and place (40 Code of Federal Regulations 1508.7); synonymous with direct effects.
Discharge	The volume of water flowing past a point per unit time, commonly expressed as cubic feet per second, gallons per minute, or million gallons per day.
Disturbed Area	An area where natural vegetation and soils have been removed.
Drainage	Natural channel through which water flows some time of the year. Natural and artificial means for effecting discharge of water as by a system of surface and subsurface passages.
Drawdown	The lowering of the water level in a well as a result of withdrawal; the reduction in head at a point caused by the withdrawal of water from an aquifer.
Electrowinning (Electrometallurgy)	The process of electrolytically depositing metals or separating them from their ores or alloys.
Endangered Species	Any species in danger of extinction throughout all or a significant portion of its range. Plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.
Ephemeral Stream	A stream or portion of a stream that flows briefly in direct response to precipitation in the immediate vicinity and whose channel is at all times above the water table.
Erosion	The wearing away of soil and rock by weathering, mass wasting, and the action of streams, glaciers, waves, wind, and underground water.
Evapotranspiration	The portion of precipitation returned to the air through evaporation and plant transpiration.
Exploration	The search for economic deposits of minerals, ore, and other materials through practices of geology, geochemistry, geophysics, drilling, and/or mapping.

CHAPTER 7.0
Glossary

Acre-feet	The volume of liquid or solid required to cover 1 acre to a depth of 1 foot, or 43,560 cubic feet; measure for volumes of water, reservoir rock, etc.
Aggrade	To fill and raise the level of a stream bed by sediment deposition.
Allotment	A unit of land suitable and available for livestock grazing that is managed as one grazing unit.
Alluvial	Pertaining to material or processes associated with transportation or deposition of soil and rock by flowing water (e.g., streams and rivers).
Alluvium	Unconsolidated or poorly consolidated gravel, sands, and clays deposited by streams and rivers on riverbeds, floodplains, and alluvial fans.
Ambient	The environment as it exists at the point of measurement and against which changes or impacts are measured.
Animal Unit Months	Grazing of a cow/calf pair for 1 month.
Anisotrophic	Variation in hydraulic properties according to direction of flow.
Aquifer	A body of rock that is sufficiently permeable to conduct ground water and to yield economically significant quantities of water to wells and springs.
Artifact	Any object showing human workmanship or modification especially from a prehistoric or historic culture.
Autoclave	Thick-walled vessel with a tightly fitting lid in which substances may be heated over 100°C.
Backfilling	Returning mining wastes underground for disposal and/or subsidence prevention.
Barren Solution	In a metallurgical process, the solution left after the value has been removed.
BLM Sensitive Species	Previous Category 2 (C2) candidate species.
Carbon-in-Leach	The process where activated carbon capable of adsorbing gold is introduced into the ore-leaching circuit as opposed to passing the leach solution through a separate carbon adsorption circuit.
Code of Federal Regulations	The compilation of federal regulations adopted by federal agencies through a rule-making process.
Cone of Depression	The depression of heads around a pumping well caused by the withdrawal of water.
Contrast	The effect of a striking difference in the form, line, color, or texture of the landscape features within the area being viewed.

7.0 Glossary

Lithic Scatter (Archaeology)	A discrete grouping of flakes of stone created as a byproduct in the tool making process. Often includes flakes used as tools as well as formal stone tools, such as projectile points, knives, or scrapers.
Lithology	The description of the physical character of a rock, including mineral composition, grain size, color, and other physical characteristics.
Maximum Credible Earthquake	The largest conceivable earthquake that could occur in an area.
Merrill-Crowe	Process used to recover gold from leachate solution. The solution is deaerated, the pH and cyanide concentration are increased, and the gold is chemically precipitated using powdered zinc.
Mine Rock	Non-ore rock that is extracted to gain access to ore. It contains no ore metals, or contains ore metals at levels below the economic cutoff value, and must be removed to recover the ore; synonymous with waste rock.
Mineralization	The process by which a valuable mineral or minerals are introduced into a rock.
Mitigate, Mitigation	To cause to become less severe or harmful; actions to avoid, minimize, rectify, reduce or eliminate, and compensate for impacts to environmental resources.
Monitor	To systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.
National Environmental Policy Act	The National Environmental Policy Act (NEPA) of 1969; the national charter for protecting the environment. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Regulations from 40 CFR 1500-1508 implement the act.
National Pollutant Discharge Elimination System	A part of the Clean Water Act that requires point source dischargers to obtain permits. These permits are referred to as NPDES permits and are administered by the U.S. Environmental Protection Agency.
National Register of Historic Places	A list, maintained by the National Park Service, of areas that have been designated as being of historical significance.
Native Species	Plants that originated in the area in which they are found, i.e., they naturally occur in that area.
Ore	A deposit of rock from which a valuable mineral or minerals can be economically extracted.
Overburden	Material that must be removed to allow access to an orebody, particularly in a surface mining operation.
Oxidation	The process of combining with oxygen to form a compound such as an oxide. The term is also used more generally to include any reaction in which an atom loses electrons.
Oxide Ore	Ore exposed by erosion and leached of many of its valuable materials.

Particulate(s)	Minute, separate particles, such as dust or other air pollutants.
Peak Flow	The greatest flow attained during melting of winter snowpack or during a large precipitation event.
Perennial Stream	A stream or reach of a stream that flows throughout the year.
Permeable	The property or capacity of a porous rock, sediment, or soil to transmit a liquid.
pH	The measure of the acidity or basicity of a solution.
Plan of Operations	As required by 36 Code of Federal Regulations 228.4: Operators submit plans of operation outlines to the Bureau of Land Management that include the name and address of the operator; location of the proposed area of operation; and information sufficient to describe the type of operation proposed, the type of roads, the means of transportation to be used, the period when the proposal will take place, and measures to be taken to meet the requirements for environmental protection.
PM^{10}	Particulate matter less than 10 microns in aerodynamic diameter.
Porosity	The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of openings in a rock to the total volume of the rock.
Pregnant Solution	Solution derived from the leaching process that contains dissolved metals.
Project Alternatives	Alternatives to the proposed action developed through the NEPA process.
Pyroclastic	Clastic rock material formed by volcanic explosion of aerial expulsion from a volcanic vent.
Raptor	A bird of prey (e.g., eagle, hawk, falcon, and owl).
Recontouring	Restoration of the natural topographic contours using reclamation measures, particularly in reference to roads.
Refractory Ore	Ore difficult to treat for recovery of valuable substances.
Reserves	Identified resources of mineral-bearing rock from which the mineral can be extracted profitably with existing technology and under present economic conditions.
Resources (Geology)	Reserves plus all other mineral deposits that may eventually become available—either known deposits that are not yet recoverable at present, or unknown deposits that may be inferred to exist but have not yet been discovered.
Right-of-Way	Strip of land or corridor over which a power line, access road, or maintenance road would pass.
Riparian	Situated on or pertaining to the bank of a river, stream, or other body of water. Riparian is normally used to refer to plants of all types that grow along streams, rivers, or at spring and seep sites.

Riprap	Large fragments of broken rock thrown together irregularly or fitted together to prevent erosion by waves or currents in order to preserve a surface, slope, or underlying structure.
Runoff	That part of precipitation that appears in surface streams; precipitation that is not retained on the site where it falls and is not absorbed by the soil.
Run-of-Mine Ore	Ore taken from a mine or pit directly to a mill for processing.
Scarify	To break up and loosen the surface of topsoil.
Sediment	Material suspended in or settling to the bottom of a liquid. Sediment input comes from natural sources, such as soil erosion, rock weathering, construction activities, or anthropogenic sources, such as forest or agricultural practices.
Sediment Load	The amount of sediment (sand, silt, and fine particles) carried by a stream or river.
Seismicity	The likelihood of an area being subject to earthquakes; the phenomenon of earth movements.
Sensitive Receptors (Noise)	Activities or land uses that are more susceptible than others to noise interference.
Significant	A term used in NEPA determination of significance; requires consideration of both context and intensity. Context means that the significance of an action must be analyzed in several contexts, such as society as a whole and the affected region, interests, and locality. Intensity refers to the severity of impacts (40 Code of Federal Regulations 1508.27).
Species	A group of individuals of common ancestry that closely resemble each other structurally and physiologically, and in nature interbreed producing fertile offspring.
Stratification	The layered structure of sedimentary rocks.
Stratigraphy	Form, arrangement, geographic distribution, chronological succession, classification, and relationships of rock strata.
Subsidence	Sinking or downward settling of the earth's surface.
Sulfide Ore	Ore containing sulfide minerals.
Tailings	Those portions of washed or milled ore that are regarded as too poor to be treated further, as distinguished from the concentrates, or material of value.
Threatened Species	Any species of plant or animal that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
Total Dissolved Solids	Total amount of dissolved material, organic or inorganic, contained in a sample of water.
Total Suspended Solids	Amount of undissolved particles suspended in liquid.

Transmissivity	The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness.
Tuff	A compacted deposit of volcanic ash and dust that may contain up to 50 percent sediments, such as sand or clay.
Uplift	A structurally high area in the earth's crust produced by upthrusting rocks.
Visual Resource	The composite of basic terrain, geologic features, water features, vegetation patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for viewers.
Visual Resource Management Classes	A classification of landscapes according to the kinds of structures and changes that are acceptable to meet established visual goals (Bureau of Land Management designation).
Water Table	The level in the saturated zone at which the pressure is equal to the atmospheric pressure.
Waters of the U.S.	A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds. The use, degradation, or destruction of these waters could affect interstate or foreign commerce.
Weir	An overflow structure built across an open channel, usually to measure the rate of water flow.
Welded Tuff	A glass-rich pyroclastic rock whose glass shards have been welded together under the combined action of heat and the weight of overlying materials.
Wetlands	Areas that are inundated by surface or ground water with a frequency sufficient to support (and under normal circumstances do or would support) a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

8.0 Index

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Appendices

APPENDIX A

Summary of Water Quality Data

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
Streams															
SW-02	Kelly Creek at	11/16/95	7.71	8.8	144	79.8	72	16.40	2.82	21.4	4.45	9.0	10.9	n/a	<0.078
	Kelly Creek	8/10/95	7.11	17.9	135	79.8	65	14.2	3.89	19.4	4.12	5.5	10.1	<0.02	0.200
	Ranch	5/15/95	7.70	10.8	102	46.8	41	10.8	2.07	12.2	2.46	5.0	8.1	0.26	0.115
		3/20/95	7.40	7.3	93	50	44	12.1	2.1	13.4	2.64	5.6	9.4	<0.02	<0.082
		6/15/94	7.83	20.8	121	66	54	13.0	2.8	16.0	3.3	6.1	8.6	<0.1	<0.1
		3/8/94	7.50	13.9	137	63	70	16.0	3.0	21.0	4.3	11.0	17.0	<0.1	<0.1
SW-03	Kelly Creek at	8/10/95	7.07	15.9	164	106	84	18.7	2.75	25.5	4.83	5.7	9.9	<0.02	<0.1
	Corral S. of	5/16/95	7.77	15.4	137	68.6	64	14.4	3.19	19.5	3.81	7.6	12.4	0.13	0.090
	Kelly Creek Rn.	3/20/95	7.60	8.6	138	84	82	17.8	3.55	24.8	4.88	9.0	16.3	<0.02	0.089
		6/15/94	7.67	17.7	162	90	74	18.0	3.4	23.0	4.1	8.0	12.0	<0.1	<0.1
		3/8/94	7.15	14.0	196	107	98	22.0	3.0	30.0	5.7	11.0	17.0	0.1	<0.1
SW-04	Kelly Creek	5/15/95	7.93	12.6	233	68.7	70	15.3	3.25	20.1	4.92	8.3	20.4	0.16	<0.082
	at Midas Rd.	3/21/95	7.70	10.1	168	100	111	19.5	3.73	28.9	9.34	11.1	42.2	<0.02	<0.082
		3/9/94	8.11	14.6	314	117	214	28.0	5.1	51.0	21.0	21.0	116	<0.1	<0.1
SW-05	Jake Creek	11/15/95	7.14	9.1	107	56.9	48	11.5	1.13	14.7	2.7	3.7	7.3	n/a	0.104
	Hammond Rn.	8/10/95	7.00	21.0	77	45.5	34	8.88	1.63	10.3	1.9	3.6	5.6	<0.02	0.100
		5/31/95	7.62	17.7	82	32.6	22	6.93	1.49	6.62	1.28	3.0	5.1	0.07	<0.082
		3/20/95	7.00	7.9	55	31	25	8.39	1.55	7.63	1.47	3.7	7.1	0.05	<0.082
		9/21/94	7.84	20.6	126	67	55	13.0	2.4	17.0	3.0	7.0	8.0	<0.1	<0.1
		6/16/94	7.53	23.5	83	42	31	9.4	1.9	9.8	1.7	3.7	5.9	<0.1	<0.1
		3/11/94	7.31	6.8	99	38	42	11.0	2.0	13.0	2.4	7.0	14.0	0.2	0.1
SW-06	Jake Creek S.	11/15/95	8.19	12.1	72	87.6	72	15.9	3.04	21.5	4.45	5.1	9.6	n/a	<0.078
	of Desmond Rn.	8/10/95	8.51	20.3	128	90.7	74	14	3.5	22.2	4.62	4.2	7.3	<0.02	0.100
		5/15/95	7.68	10.7	99	44.6	39	9.55	2.61	11.7	2.37	4.8	7.6	0.11	<0.082
		3/20/95	7.20	8.5	70	39	32	9.41	1.9	9.74	1.92	4.3	8.6	0.05	<0.082
		6/16/94	9.30	23.4	140	84	61	17.0	4.1	19.0	3.4	6.5	8.7	<0.1	<0.1
		3/11/94	7.54	7.7	129	59	57	14.0	3.0	17.0	3.6	7.0	14.0	0.1	<0.1
SW-07	Evans Creek	11/15/95	7.51	10.5	38	22.9	15	5.78	1.58	4.51	0.919	2.1	4.2	n/a	<0.078
	above Jake Creek	8/9/95	7.49	19.3	60	24.2	17	4.96	1.65	4.97	1	1.8	2.6	0.10	0.083
		5/15/95	7.54	11.3	82	32.4	24	7.75	1.66	7.14	1.52	3.1	4.4	0.20	<0.082
		3/20/95	6.80	9.7	63	37	25	8.98	1.38	7.27	1.56	3.9	6.6	0.18	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Streams																
SW-02	Kelly Creek at	11/16/95	<0.003	<0.04	0.026	<0.0024	<0.005	<0.003	0.4	0.0450	<0.0002	0.003	<0.001	<0.001	<0.04	<0.002
	Kelly Creek	8/10/95	<0.0022	<0.042	0.026	<0.0019	<0.002	<0.0017	0.5	0.0425	<0.0002	0.0088	<0.001	<0.001	<0.001	<0.0019
	Ranch	5/15/95	<0.002	<0.04	0.015	<0.002	<0.003	<0.003	0.18	0.034	<0.0002	0.0106	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.019	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	0.0160	<0.04	<0.018	<0.001	<0.002
		6/15/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-03	Kelly Creek at	8/10/95	<0.0022	<0.042	0.025	<0.0019	<0.002	<0.0017	0.50	0.0037	<0.0002	0.0019	<0.001	<0.001	<0.001	<0.0019
	Corral S. of	5/16/95	<0.002	<0.04	0.025	<0.002	<0.003	<0.003	0.34	<0.017	<0.0002	0.0153	<0.04	<0.018	<0.001	<0.002
	Kelly Creek Rn.	3/20/95	<0.002	<0.04	0.032	<0.002	<0.003	<0.003	0.50	0.025	<0.0002	0.005	<0.04	<0.018	<0.001	<0.002
		6/15/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-04	Kelly Creek	5/15/95	<0.002	<0.04	0.021	<0.002	0.004	<0.003	0.35	0.021	<0.0002	0.0065	<0.04	0.023	<0.001	<0.002
	at Midas Rd.	3/21/95	<0.002	<0.04	0.035	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	0.007	<0.04	<0.018	<0.001	<0.002
		3/9/94	<0.0005	0.037	<0.1	<0.0002	<0.05	<0.1	0.7	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-05	Jake Creek	11/15/95	<0.003	<0.04	0.020	<0.0024	<0.005	<0.003	0.40	0.262	<0.0002	0.1180	<0.001	<0.001	<0.04	<0.002
	Hammond Rn.	8/10/95	<0.0022	<0.042	0.018	<0.0019	<0.002	0.0017	0.40	0.206	<0.0002	0.0552	<0.001	<0.001	<0.001	<0.0019
		5/31/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.21	0.069	<0.0002	0.0136	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.014	<0.002	<0.003	<0.003	0.40	0.046	<0.0002	0.0170	<0.04	<0.018	<0.001	<0.002
		9/21/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	0.2	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-06	Jake Creek S.	11/15/95	<0.003	<0.04	0.037	<0.0024	<0.005	<0.003	0.60	0.027	<0.0002	0.0040	<0.001	<0.001	<0.04	<0.002
	of Desmond Rn.	8/10/95	<0.0022	<0.042	0.036	<0.0019	<0.002	<0.0017	0.50	0.0336	<0.0002	0.0125	<0.001	<0.001	<0.001	<0.0019
		5/15/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.40	0.034	<0.0002	0.0142	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.50	0.018	<0.0002	0.0090	<0.04	<0.018	<0.001	<0.002
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-07	Evans Creek	11/15/95	<0.003	<0.04	0.010	<0.0024	<0.005	<0.003	0.20	0.115	<0.0002	0.0040	<0.001	<0.001	<0.04	<0.002
	above Jake Creek	8/9/95	<0.002	<0.04	0.012	<0.002	<0.003	<0.003	0.10	0.043	<0.0002	0.003	0.002	<0.001	<0.041	0.002
		5/15/95	<0.002	<0.04	0.025	<0.002	<0.003	<0.003	0.12	0.038	<0.0002	0.0027	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.20	<0.017	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-07	Evans Creek	9/20/94	7.20	15.7	63	29	21	5.9	1.4	6.2	1.3	2.0	3.0	0.1	<0.1
(cont.)	above Jake Creek	6/17/94	7.41	21.6	74	21	13	4.9	1.0	3.8	0.8	1.5	2.5	<0.1	<0.1
		3/11/94	6.55	6.4	86	22	21	7.7	1.6	6.1	1.4	6.0	9.0	1.2	0.4
SW-08	Evans Creek at Hot Springs Rn.	3/22/95	7.80	7.9	125	61	52	15.1	4.91	15.6	3.17	7.0	13.5	<0.02	0.098
SW-09	Rabbit Creek	11/16/95	7.76	15.3	296	129	208	29.5	4.24	48.0	21.4	20.3	91.8	n/a	<0.078
	at GFW Wells	8/10/95	8.20	23.9	320	88.2	220	28.2	4.18	54.0	20.7	15.7	165	<0.02	<0.1
		5/16/95	8.40	25.1	300	125	200	27.6	4.55	47.2	19.9	19.3	96.4	<0.02	<0.082
		3/21/95	8.30	15.8	267	125	197	27.7	4.61	45.7	20.3	20.0	94.0	0.04	<0.082
		11/28/94	8.30	13.6	281	122	199	27.6	4.8	46.6	20.2	20.5	97.0	0.18	<0.3
		9/21/94	8.18	23.7	338	86	198	26.0	4.1	48.0	19.0	17.0	130	<0.1	<0.1
		6/15/94	8.34	24.2	301	108	184	27.0	4.7	44.0	18.0	18.0	110	<0.1	<0.1
		3/11/94	7.89	13.9	322	115	197	30.0	4.7	46.0	20.0	19.0	123	0.3	0.3
SW-10	Rabbit Creek at	11/15/95	8.17	15.6	297	117	195	28.9	4.65	45.1	20.1	21.2	102	n/a	<0.078
	power line road	8/10/95	8.73	23.3	349	95.5	228	28.9	3.8	56.0	21.4	16.5	169	0.02	0.200
		5/16/95	8.88	25.8	277	114	185	28.2	4.75	41.7	19.7	20.3	88.9	<0.02	<0.082
		3/21/95	8.60	15.8	258	122	192	27.8	4.74	43.5	20.2	19.0	99.0	<0.02	<0.082
		11/28/94	8.40	12.8	300	127	206	28.4	5.2	48.2	20.9	19.9	92.5	0.17	<0.3
		9/20/94	8.85	26.4	307	65	178	26.0	4.4	40.0	19.0	17.0	140	<0.1	<0.1
		6/15/94	8.66	23.4	289	33	166	28.0	5.0	37.0	18.0	18.0	110	<0.1	<0.1
		3/8/94	7.54	15.9	328	117	202	29.0	3.9	48.0	20.0	23.0	107	0.1	<0.1
SW-11	Rabbit Creek	11/16/95	8.14	11.5	300	122	199	28.8	4.36	46.2	20.3	20.9	97.8	n/a	<0.078
	at flume	8/10/95	8.84	24.3	334	89.5	214	28	3.85	51.7	20.6	16.9	164	<0.02	0.100
		5/16/95	8.82	24.8	267	112	182	27.7	4.69	41.1	19.3	20.3	88.5	<0.02	<0.082
		3/21/95	8.40	14.9	261	122	189	27.8	4.6	42.9	20	20.0	98.0	<0.02	<0.082
		9/20/94	8.95	24.9	320	60	169	26.0	4.5	38.0	18.0	17.0	140	<0.1	<0.1
		6/15/94	8.69	22.9	283	86	161	28.0	5.1	35.0	18.0	18.0	110	<0.1	<0.1
		3/8/94	8.08	10.2	312	126	205	29.0	4.8	49.0	20.0	20.0	109	0.1	0.1
SW-12	Kelly Creek	5/16/95	8.02	9.6	179	73.5	78	16.1	3.24	22.0	5.6	9.1	21.7	0.11	<0.082
	at Dudley Ranch	3/21/95	7.60	9.2	164	94	110	19.5	3.41	28.8	9.32	11.4	42.1	<0.02	<0.082
		3/9/94	8.06	12.9	308	126	214	27.0	5.2	51.0	21.0	21.0	112	0.4	<0.1

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-07	Evans Creek	9/20/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.2	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
(cont.)	above Jake Creek	6/17/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.1	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-08	Evans Creek at Hot Springs Rn.	3/22/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	0.40	0.073	<0.0002	0.0050	<0.04	<0.018	<0.001	<0.002
SW-09	Rabbit Creek	11/16/95	<0.003	<0.04	0.057	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0060	<0.001	0.028	<0.04	<0.002
	at GFW Wells	8/10/95	<0.0022	<0.042	0.050	<0.0019	<0.002	0.0017	0.70	0.0168	<0.0002	0.0027	<0.001	0.013	<0.001	0.0031
		5/16/95	<0.002	<0.04	0.051	<0.002	<0.003	0.0033	0.71	<0.017	<0.0002	0.0075	<0.04	0.047	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.050	<0.002	0.004	<0.003	0.70	<0.017	<0.0002	0.006	<0.04	0.046	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.044	<0.004	<0.004	<0.003	0.69	0.029	<0.0002	0.006	<0.04	0.05	0.001	<0.004
		9/21/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0006	0.013	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0006	0.015	<0.1	<0.0002	<0.05	<0.1	0.6	0.2	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-10	Rabbit Creek at	11/15/95	<0.003	<0.04	0.056	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0100	<0.001	0.029	<0.04	<0.002
	power line road	8/10/95	<0.0022	<0.042	0.043	0.0025	<0.002	<0.0017	0.70	0.0031	<0.0002	<0.0009	<0.001	0.014	<0.001	<0.0019
		5/16/95	<0.002	<0.04	0.048	<0.002	<0.003	<0.003	0.72	<0.017	<0.0002	0.0052	<0.04	0.033	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	0.0040	<0.04	0.025	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.05	<0.004	<0.004	<0.003	0.69	0.023	<0.0002	0.006	<0.04	0.07	0.001	<0.004
		9/20/94	<0.0005	0.014	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0006	0.025	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0006	0.023	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-11	Rabbit Creek	11/16/95	<0.003	<0.04	0.059	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.0050	<0.001	0.028	<0.04	<0.002
	at flume	8/10/95	<0.0022	0.05	0.031	<0.0019	<0.002	<0.0017	0.70	0.0048	<0.0002	0.0022	<0.001	0.017	<0.001	<0.0019
		5/16/95	<0.002	<0.04	0.049	<0.002	<0.003	<0.003	0.71	<0.017	<0.0002	0.0139	<0.04	0.034	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	<0.001	<0.04	0.022	<0.001	<0.002
		9/20/94	<0.0005	0.018	<0.1	<0.0002	<0.05	<0.1	0.7	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0005	0.028	<0.1	0.0003	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0007	0.023	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-12	Kelly Creek	5/16/95	<0.002	<0.04	0.024	<0.002	<0.003	<0.003	0.42	<0.017	<0.0002	0.0033	<0.04	<0.018	<0.001	<0.002
	at Dudley Ranch	3/21/95	<0.002	<0.04	0.034	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	0.006	<0.04	<0.018	<0.001	<0.002
		3/9/94	<0.0005	0.025	<0.1	<0.0002	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-13	Chimney Creek	11/16/95	7.86	12.1	266	124	93	46.1	8.34	28.5	5.42	18.0	27.8	n/a	0.383
	Reservoir Dam	8/9/95	8.09	20.6	211	99.3	73	33.1	7.47	22.1	4.32	14.3	20.0	0.07	0.191
		5/17/95	7.86	11.5	159	80.9	57	28.1	5.51	17.1	3.37	12.3	18.3	0.02	0.137
		3/22/95	8.10	7.8	216	110	72	45.4	6.86	21.8	4.27	19.0	26.0	0.04	0.198
		11/28/94	8.20	4.7	317	165	117	60.8	10.8	36.0	6.61	26.1	34.2	0.29	0.4
		9/21/94	8.21	16.6	298	14	101	49.0	11.0	31.0	5.7	21.0	29.0	0.3	<0.1
		6/15/94	8.10	16.5	248	122	81	44.0	9.4	25.0	4.4	19.0	25.0	0.2	<0.1
		3/8/94	8.15	9.3	281	113	85	44.0	9.9	26.0	4.9	20.0	44.0	0.4	0.6
SW-15	Kelly Creek E.	5/16/95	7.87	16.9	128	63.4	58	13.9	3.33	17.6	3.45	7.8	12.0	0.13	<0.082
	of Alkali Spring	3/21/95	7.70	11.1	131	75	66	15.6	3.1	20.1	3.95	7.4	13.0	<0.02	<0.082
SW-16	Jake Creek	11/17/95	8.27	8.7	110	88.6	75	17	3.14	22.4	4.61	5.1	9.6	n/a	<0.078
	at Midas Rd.	8/9/95	8.87	25.9	152	94.1	70	13.7	3.67	21.0	4.23	4.4	6.2	<0.02	0.095
		5/15/95	7.71	10.3	69	45.2	39	9.46	2.45	11.7	2.35	4.6	7.6	0.13	0.108
		3/20/95	7.20	8.9	58	38	33	9.77	1.93	10.1	1.99	4.5	8.7	0.03	<0.082
		6/16/94	8.76	21.8	142	89	70	16.0	3.4	21.0	4.3	6.4	8.6	<0.1	<0.1
		3/11/94	7.46	4.7	140	69	63	14.0	2.7	19.0	3.9	9.0	15.0	0.5	<0.1
SW-17	Kelly Creek at	5/16/95	8.47	19.6	140	78.3	76	20.8	4.59	22.3	5.02	9.8	23.0	<0.02	<0.082
	Diesel Tank Road	3/22/95	8.10	8.9	182	93	110	21.1	3.96	28.6	9.36	11.7	41.7	<0.02	<0.082
SW-18	Kelly Creek	3/22/95	8.60	6.3	336	188	112	84	6.37	31.4	8.16	28.0	48.8	<0.02	<0.082
	Cut-off Ditch			-13.5											
SW-19	Hammond Ditch	5/16/95	8.66	21.9	225	103	81	33.1	5.93	24.3	5.06	14.8	24.4	<0.02	0.151
		3/30/95	8.50	8.1	264	162	138	62.0	6.03	38.2	10.5	21.9	51.4	<0.02	<0.082
		9/20/94	9.29	26.7	356	159	53	89.0	6.9	16.0	3.3	23.0	34.0	<0.1	<0.1
SW-21	Spring Creek	11/16/95	7.85	12.1	262	127	129	31.4	6.94	44.2	4.6	21.9	35.7	n/a	0.114
		8/9/95	7.44	21.0	218	133	119	29.9	3.19	40.6	4.35	18.8	19.4	<0.02	0.086
		5/17/95	8.05	13.6	135	83.4	79	23.1	4.28	25.4	3.81	16.2	21.1	<0.02	0.117
		3/22/95	8.20	7.2	270	128	139	35.1	4.49	48.3	4.55	23.0	44.2	<0.02	<0.082
SW-22	N Fork Little	6/2/95	7.98	18.8	201	121	82	32.9	5.82	23.3	5.72	9.6	9.8	<0.02	0.218
	Humboldt River	3/22/95	7.90	7.4	166	78	54	30.3	6.35	15.6	3.75	11.3	20.3	0.03	0.124
SW-23	Kelly Creek	5/17/95	8.91	19.1	390	176	64	113	9.22	18.4	4.39	46.0	49.2	0.02	<0.082
	Above Humboldt	3/20/95	8.50	8.4	456	242	80	139	8.55	23.4	5.36	47.0	61.2	<0.02	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-13	Chimney Creek Reservoir Dam	11/16/95	<0.003	<0.04	0.032	<0.0024	<0.005	<0.003	1.10	0.205	<0.0002	0.0160	<0.001	<0.001	<0.04	0.002
		8/9/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.90	0.371	<0.0002	0.045	<0.001	<0.001	<0.041	<0.002
		5/17/95	<0.002	<0.04	0.026	<0.002	<0.003	0.0075	0.82	0.116	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.027	<0.002	<0.003	<0.003	1.70	0.059	<0.0002	0.070	<0.04	<0.018	<0.001	<0.002
		11/28/94	<0.004	<0.04	0.038	<0.004	<0.004	<0.003	2.54	0.017	<0.0002	0.043	<0.04	<0.02	<0.001	<0.004
		9/21/94	<0.0005	0.013	<0.1	<0.0002	<0.05	<0.1	2.2	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0007	0.011	<0.1	0.0005	<0.05	<0.1	1.7	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0007	0.010	<0.1	<0.0002	<0.05	<0.1	1.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-15	Kelly Creek E. of Alkali Spring	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.39	<0.017	<0.0002	0.0082	<0.04	<0.018	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.023	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002
SW-16	Jake Creek at Midas Rd.	11/17/95	0.067	<0.04	0.034	<0.0024	<0.005	<0.003	0.50	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	0.013
		8/9/95	<0.002	<0.04	0.028	<0.002	<0.003	<0.003	0.50	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/15/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.38	0.042	<0.0002	0.0098	<0.04	<0.018	<0.001	<0.002
		3/20/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.40	0.023	<0.0002	0.007	<0.04	<0.018	<0.001	<0.002
		6/16/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SW-17	Kelly Creek at Diesel Tank Road	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.0034	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.032	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	0.003	<0.04	<0.018	<0.001	<0.002
SW-18	Kelly Creek Cut-off Ditch	3/22/95	<0.002	<0.04	0.016	<0.002	<0.003	<0.003	3.60	<0.017	<0.0002	0.002	<0.04	<0.018	<0.001	<0.002
SW-19	Hammond Ditch	5/16/95	<0.002	<0.04	0.020	<0.002	<0.003	0.0055	0.63	0.03	<0.0002	0.0018	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0228	<0.005	<0.003	<0.010	2.51	<0.050	<0.0002	0.0018	<0.04	<0.018	0.002	<0.0050
		9/20/94	<0.0005	0.006	<0.1	<0.0002	<0.05	<0.1	7.0	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
SW-21	Spring Creek	11/16/95	<0.003	<0.04	0.040	<0.0024	<0.005	<0.003	2.70	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/9/95	<0.002	<0.04	0.029	<0.002	<0.003	<0.003	1.90	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/17/95	<0.002	<0.04	0.027	<0.002	<0.003	0.0097	0.54	0.075	<0.0002	0.0015	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.031	<0.002	<0.003	<0.003	2.80	<0.017	<0.0002	0.001	<0.04	<0.018	<0.001	<0.002
SW-22	N Fork Little Humboldt River	6/2/95	<0.002	<0.04	0.036	<0.002	<0.003	<0.003	1.2	0.035	<0.0002	0.018	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.034	<0.002	<0.003	<0.003	0.9	0.156	<0.0002	0.005	<0.04	<0.018	<0.001	<0.002
SW-23	Kelly Creek Above Humboldt	5/17/95	<0.002	0.06	0.008	<0.002	<0.003	0.0075	2.80	0.047	<0.0002	0.0078	<0.04	0.020	<0.001	<0.002
		3/20/95	<0.002	0.05	0.009	<0.002	<0.003	0.004	5.00	0.039	<0.0002	0.004	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SW-24	Above Kelly Creek Ranch	11/16/95	7.73	9.7	154	80.9	73	17.4	1.63	21.6	4.52	9.7	11.4	n/a	0.097
Springs															
SPG-02	Dog Spring	11/14/95	7.32	14.3	325	178	221	38.5	1.32	50.0	23.5	48.9	53.7	n/a	<0.078
		8/8/95	7.51	16.0	332	179	228	37.6	2.07	51.3	24.3	49.0	54.6	0.77	<0.082
		5/31/95	7.31	16.0	342	180	238	40.9	2.00	53.8	25.3	51.1	50.2	0.87	<0.082
		3/30/95	7.40	13.2	236	175	241	39.7	1.94	55.8	24.8	50.3	53.5	0.86	<0.082
		9/22/94	7.49	16.7	346	167	228	38.0	1.90	52.0	24.0	47.0	54.0	0.8	<0.1
		6/17/94	7.22	18.2	356	175	213	38.0	2.20	49.0	22.0	48.0	54.0	1.0	<0.1
		3/10/94	7.18	14.2	353	180	239	40.0	2.00	53.0	26.0	47.0	60.0	0.8	<0.1
SPG-03	Garden Spring	11/14/95	7.26	14.2	212	124	137	25.4	2.02	35.6	11.6	24.8	23.8	n/a	<0.078
		8/8/95	7.35	16.1	211	123	136	24.2	1.85	35.3	11.6	24.5	27.0	1.57	0.083
		5/31/95	7.34	14.8	228	125	141	25.6	1.89	36.6	12	25.6	25.4	1.67	<0.082
		3/30/95	7.20	13.7	167	122	146	26.0	2.08	38.5	12.1	24.0	25.0	1.65	<0.082
		9/22/94	7.41	15.8	230	119	139	28.0	1.9	36.0	12.0	23.0	23.0	1.6	<0.1
		6/17/94	7.32	19.2	245	123	128	24.0	1.8	33.0	11.0	23.0	23.0	1.6	<0.1
		4/1/94	7.23	12.1	218	116	126	20.0	1.5	34.0	9.9	25.0	23.0	1.6	<0.1
SPG-04	Garret Spring	11/14/95	7.69	14.1	314	189	175	46.0	3.83	52.6	10.5	29.2	28.8	n/a	<0.078
		8/8/95	8.71	27.4	289	159	138	44.8	4.52	39.0	9.94	27.2	31.9	0.54	<0.082
		5/31/95	8.20	20.9	324	193	178	47.3	4.95	53.3	10.9	30.5	30.3	1.17	<0.082
		3/21/95	8.00	13.1	310	191	174	46.1	4.01	52.5	10.5	29.0	29.4	1.34	<0.082
		11/30/94	8.10	13.0	315	189	181	47.8	5.0	54.5	10.9	28.5	28.8	1.57	<0.3
		9/21/94	7.81	16.9	370	184	175	48.0	4.2	52.0	11.0	27.0	28.0	1.8	<0.1
		6/16/94	7.74	20.7	334	185	163	44.0	4.7	50.0	9.4	27.0	28.0	1.9	<0.1
		3/11/94	8.14	10.9	342	183	194	51.0	5.4	58.0	12.0	30.0	37.0	1.5	0.7
SPG-05	Kelly Creek Spring	11/16/95	8.08	11.7	392	237	187	65.7	14.4	52.1	13.9	38.8	36.7	n/a	0.148
		8/8/95	7.91	26.4	407	222	166	52.6	16.4	47.1	11.7	37.5	29.9	0.09	<0.082
		5/31/95	8.10	21.3	335	195	160	50.8	7.33	46.5	10.7	31.3	29.6	0.24	<0.082
		3/22/95	8.40	10.9	306	185	153	52.9	6.59	44.1	10.5	30.0	27.9	0.50	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SW-24	Above Kelly Creek Ranch	11/16/95	<0.003	<0.04	0.021	<0.0024	<0.005	<0.003	0.40	0.272	<0.0002	0.027	<0.001	<0.001	<0.04	<0.002
Springs																
SPG-02	Dog Spring	11/14/95	<0.003	<0.04	0.019	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.017	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.0020	<0.04	0.020	<0.002	<0.0030	<0.0030	0.46	<0.017	<0.0002	<0.001	<0.040	<0.018	<0.001	<0.0020
		3/30/95	<0.0050	<0.04	0.020	<0.005	<0.0030	<0.010	0.47	<0.050	<0.0002	0.0018	<0.040	<0.018	<0.001	<0.0050
		9/22/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.5	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0007	<0.005	<0.1	0.0005	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/10/94	0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.6	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-03	Garden Spring	11/14/95	<0.003	<0.04	0.107	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.092	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	0.003
		5/31/95	<0.002	<0.04	0.106	<0.002	<0.0030	<0.0030	0.42	<0.017	<0.0002	<0.001	<0.040	<0.018	<0.001	<0.0020
		3/30/95	<0.005	<0.04	0.109	<0.005	<0.0030	<0.010	0.47	<0.050	0.0003	<0.001	<0.040	<0.018	<0.001	<0.0050
		9/22/94	<0.0005	0.006	0.1	<0.0002	<0.05	<0.1	0.4	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0009	<0.005	0.1	0.0003	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0006	<0.005	0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-04	Garret Spring	11/14/95	<0.003	<0.04	0.035	<0.0024	<0.005	<0.003	0.90	<0.024	<0.0002	0.0030	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.002	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.029	<0.002	<0.003	<0.003	0.96	<0.017	<0.0002	0.0058	<0.04	<0.018	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.033	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.0010	<0.04	<0.018	<0.001	<0.002
		11/30/94	<0.004	<0.04	0.036	<0.004	<0.004	<0.003	0.89	<0.009	<0.0002	0.004	<0.04	<0.02	<0.001	0.033
		9/21/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	0.9	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/16/94	0.0006	0.007	<0.1	0.0006	<0.05	<0.1	0.9	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0009	0.006	<0.1	<0.0002	<0.05	<0.1	0.8	0.3	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-05	Kelly Creek Spring	11/16/95	<0.003	<0.04	0.046	<0.0024	<0.005	<0.003	1.10	<0.024	<0.0002	0.0430	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	0.04	0.103	<0.002	<0.003	<0.003	1.20	0.134	<0.0002	1.38	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.067	<0.002	<0.003	<0.003	0.88	0.063	<0.0002	0.124	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.049	<0.002	<0.003	<0.003	0.90	<0.017	<0.0002	0.115	<0.04	<0.018	<0.001	<0.002

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SPG-05 (cont.)	Kelly Creek Spring	11/30/94	8.10	6.6	269	176	155	54.9	8.5	44.6	10.7	30.8	31.6	0.76	<0.3
		9/21/94	8.38	17.9	343	177	138	52.0	12.0	37.0	11.0	30.0	28.0	0.2	<0.1
		6/15/94	7.28	21.4	474	256	183	63.0	37.0	52.0	13.0	42.0	27.0	0.3	<0.1
		3/8/94	8.70	14.7	301	172	121	50.0	7.4	34.0	8.8	30.0	32.0	0.1	0.8
SPG-07	Alkali Spring	11/14/95	9.16	17.1	1320	1110	2	614	2.53	0.65	0.094	47.3	99.6	n/a	<0.078
		8/8/95	9.21	16.7	1420	1130	2	586	3.54	0.73	0.129	47.7	98.4	0.05	0.091
		5/31/95	9.10	17.9	1410	1130	3	612	3.87	0.79	0.157	46.9	93.9	<0.02	<0.082
		3/22/95	9.20	11.6	1440	1170	3	655	4.08	1.18	0.134	51.0	106	<0.02	<0.082
		11/29/94	9.10	17.1	1400	1330	2	656	3.5	0.69	0.12	48.5	98.1	<0.005	<0.3
		9/22/94	9.07	18.4	1508	1066	2	650	4.0	0.6	0.1	47.0	100	<0.1	<0.1
		6/18/94	9.16	28.3	1468	1086	2	660	5.7	0.7	0.1	49.0	100	<0.1	<0.1
		3/10/94	9.12	15.7	1523	1153	<1	618	8.2	<0.1	<0.1	48.0	114	<0.1	<0.1
SPG-08	NW of Hammond Ranch	11/14/95	7.73	14.3	288	181	159	41.4	4.30	50.3	8.03	23.7	26.8	n/a	<0.078
		8/8/95	8.12	26.9	317	179	152	38.4	4.44	48.6	7.47	21.8	28.1	0.71	<0.082
		5/31/95	7.89	22.5	311	190	166	40.5	6.01	53.1	8.07	24.4	23.0	0.69	<0.082
		3/21/95	7.90	10.4	282	171	154	39.3	3.11	49.4	7.46	23.0	24.3	0.73	0.104
		11/30/94	7.90	11.7	255	161	148	41.1	4.20	47.3	7.38	20.2	21.4	0.81	<0.3
		6/16/94	8.36	24.3	265	150	113	39.0	5.10	35.0	6.3	21.0	22.0	0.1	<0.1
		3/11/94	7.81	8.7	300	159	142	40.0	4.00	45.0	7.2	21.0	26.0	1.1	0.5
SPG-09	East of Hot Springs Rn.	11/14/95	8.46	21.4	263	131	67	60.0	3.14	21.1	3.46	16.2	26.5	n/a	<0.078
		8/9/95	8.17	25.7	291	133	67	56.6	3.63	21.3	3.49	15.7	25.8	0.29	<0.082
		5/31/95	8.14	25.3	273	141	71	59.7	3.95	22.5	3.65	17.7	26.8	0.26	<0.082
		3/22/95	8.30	13.1	248	139	71	64.1	3.62	22.1	3.78	17.0	26.5	0.26	<0.082
		9/22/94	7.95	20.7	285	135	67	58.0	3.8	21.0	3.6	16.0	25.0	0.2	<0.1
		6/17/94	8.49	23.7	291	136	63	56.0	4.2	20.0	3.2	16.0	25.0	0.2	<0.1
		3/10/94	7.81	16.3	275	122	68	61.0	4.3	21.0	3.7	19.0	32.0	0.3	0.7
SPG-11	Barite Mine Spg. (Christison)	11/14/95	7.72	15.4	321	183	226	33.3	0.93	63.0	16.6	34.3	54.8	n/a	<0.078
		8/8/95	7.90	15.8	305	180	220	30.8	1.51	61.3	16.3	33.1	55.0	0.24	<0.082
		5/31/95	7.79	15.2	326	180	233	33.9	1.55	65.0	17.3	36.2	53.4	0.35	<0.082
		3/30/95	7.80	12.8	248	174	243	33.7	1.87	68.8	17.4	35.6	55.9	0.38	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SPG-05	Kelly Creek	11/30/94	<0.004	<0.04	0.054	<0.004	<0.004	0.004	0.9	0.091	<0.0002	0.178	<0.04	<0.02	<0.001	<0.004
(cont.)	Spring	9/21/94	<0.0005	0.011	<0.1	<0.0002	<0.05	<0.1	1.2	<0.1	<0.0005	0.1	<0.002	<0.5	<0.001	<0.1
		6/15/94	0.0013	0.017	0.2	0.0011	<0.05	<0.1	1.0	<0.1	<0.0005	1.4	<0.001	<0.5	<0.001	<0.1
		3/8/94	0.0008	0.012	<0.1	<0.0002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-07	Alkali Spring	11/14/95	<0.003	0.59	0.060	<0.0024	<0.005	<0.003	17.9	<0.024	<0.0002	0.0010	<0.001	<0.001	<0.04	<0.002
		8/8/95	<0.002	0.60	0.052	<0.002	<0.003	<0.003	15.4	<0.017	<0.0002	0.0030	<0.001	<0.001	<0.041	0.002
		5/31/95	<0.002	0.63	0.060	<0.002	<0.003	<0.003	15.0	<0.017	<0.0002	0.0041	<0.04	<0.018	0.001	<0.002
		3/22/95	<0.002	0.74	0.057	<0.002	<0.003	<0.003	16.1	<0.017	<0.0002	0.0030	<0.04	<0.018	<0.001	<0.002
		11/29/94	<0.004	0.64	0.064	<0.004	<0.004	<0.003	17.8	<0.009	<0.0002	0.003	<0.04	<0.02	<0.001	<0.004
		9/22/94	<0.0012	0.57	<0.1	<0.0002	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.010	<0.5	<0.001	<0.1
		6/18/94	0.0080	0.60	<0.1	0.0064	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.0016	<0.5	<0.001	<0.1
		3/10/94	0.0048	0.78	<0.1	<0.0002	<0.05	<0.1	18.0	<0.1	<0.0005	<0.1	0.0038	<0.5	<0.001	<0.1
SPG-08	NW of	11/14/95	<0.003	<0.04	0.042	<0.0024	<0.005	<0.003	1.10	0.059	<0.0002	0.2160	<0.001	<0.001	<0.04	<0.002
	Hammond Ranch	8/8/95	<0.002	<0.04	0.031	<0.002	<0.003	<0.003	1.00	0.035	<0.0002	0.128	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.047	<0.002	<0.003	<0.003	0.99	0.122	<0.0002	0.254	<0.04	<0.018	<0.001	<0.002
		3/21/95	<0.002	<0.04	0.030	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.043	<0.04	<0.018	<0.001	<0.002
		11/30/94	<0.004	<0.04	0.041	<0.004	<0.004	<0.003	0.89	0.028	<0.0002	0.131	<0.04	<0.02	<0.001	<0.004
		6/16/94	0.0005	0.011	<0.1	0.0004	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/11/94	0.0006	0.007	<0.1	<0.002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-09	East of	11/14/95	<0.003	<0.04	0.004	<0.0024	<0.005	<0.003	4.70	<0.024	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
	Hot Springs Rn.	8/9/95	<0.002	<0.04	0.004	<0.002	0.003	<0.003	4.40	<0.017	<0.0002	0.004	<0.001	<0.001	<0.041	0.002
		5/31/95	<0.002	<0.04	0.005	<0.002	0.0036	<0.003	5.06	0.076	<0.0002	0.0023	<0.04	<0.018	<0.010	<0.002
		3/22/95	<0.002	<0.04	0.005	<0.002	0.003	<0.003	5.10	<0.017	<0.0002	0.001	<0.04	<0.018	<0.001	<0.002
		9/22/94	<0.0005	0.007	<0.1	<0.0002	<0.05	<0.1	4.6	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0007	<0.005	<0.1	0.0005	<0.05	<0.1	4.7	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		3/10/94	0.0007	0.005	<0.1	<0.0002	<0.05	<0.1	4.4	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-11	Barite Mine Spg.	11/14/95	<0.003	<0.04	0.064	<0.0024	<0.005	<0.003	1.00	<0.024	<0.0002	0.0010	<0.001	<0.001	<0.04	0.002
	(Christison)	8/8/95	<0.002	<0.04	0.053	<0.002	<0.003	<0.003	1.00	<0.017	<0.0002	0.004	<0.001	<0.001	<0.041	0.003
		5/31/95	<0.002	<0.04	0.0617	<0.002	<0.003	<0.003	1.06	<0.017	<0.0002	<0.001	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0646	<0.005	<0.003	<0.010	1.04	<0.050	<0.0002	0.0037	<0.04	<0.018	0.0010	<0.005

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	pH (lab)	Temp. (field) (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)
SPG-11	Barite Mine Spg.	9/21/94	7.79	17.6	336	175	232	32.0	1.8	65.0	17.0	34.0	57.0	0.3	<0.1
(cont.)	(Christison)	6/17/94	7.83	16.8	238	178	218	31.0	1.8	61.0	16.0	36.0	58.0	0.3	<0.1
		4/1/94	7.93	14.8	314	175	211	28.0	1.5	60.0	15.0	36.0	55.0	0.3	<0.1
SPG-12	Corral Spring	11/14/95	7.67	16.8	253	173	199	24.7	2.58	56.8	13.9	17.5	51.6	n/a	<0.078
	(Christison)	8/8/95	7.74	18.8	278	173	201	23.8	3.04	57.3	14.1	17.6	51.2	<0.02	<0.082
		5/31/95	7.60	18.1	283	174	207	25.3	2.69	59.1	14.4	18.1	48.3	<0.02	<0.082
		3/30/95	7.60	16.2	191	170	216	25.7	3.12	62.5	14.6	17.0	50.5	<0.02	<0.082
		9/22/94	7.56	19.3	308	165	202	23.0	2.9	58.0	14.0	16.0	52.0	<0.1	<0.1
		6/17/94	7.63	21.4	311	172	191	24.0	3.2	55.0	13.0	16.0	52.0	<0.1	<0.1
		4/1/94	8.03	16.7	285	170	184	20.0	2.6	54.0	12.0	18.0	48.0	0.4	<0.1
SPG-13	Layton Spring	11/16/95	7.64	15.0	220	82.3	97	25.4	3.26	34.2	2.87	20.7	30.0	n/a	0.081
		8/9/95	7.53	16.3	210	82.7	95	23.6	3.36	33.4	2.79	20.0	27.5	0.92	<0.082
		5/31/95	7.89	16.6	228	90.6	102	25.1	3.44	36.0	2.99	21.4	34.2	0.87	<0.082
		3/22/95	7.70	13.0	217	82	102	26.2	3.4	35.8	3.05	22.0	36.2	0.96	<0.082

TABLE A-1
Surface Water Quality Monitoring Data

Sample #	Sample Site	Date Sampled	Ag (mg/l)	As (mg/l)	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
SPG-11	Barite Mine Spg.	9/21/94	<0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
(cont.)	(Christison)	6/17/94	0.0006	<0.005	<0.1	0.0005	<0.05	<0.1	1.0	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0006	<0.005	<0.1	<0.0002	<0.05	<0.1	0.8	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-12	Corral Spring	11/14/95	<0.003	<0.04	0.065	<0.0024	<0.005	<0.003	0.30	0.129	<0.0002	0.0050	<0.001	<0.001	<0.04	<0.002
	(Christison)	8/8/95	<0.002	<0.04	0.058	<0.002	<0.003	<0.003	0.40	0.129	<0.0002	0.006	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.0658	0.0022	<0.003	<0.003	0.34	0.153	<0.0002	0.0069	<0.04	<0.018	<0.001	<0.002
		3/30/95	<0.005	<0.04	0.0679	<0.005	<0.003	<0.010	0.40	0.116	<0.0002	0.0094	<0.04	<0.018	<0.001	<0.005
		9/22/94	<0.0005	0.011	<0.1	<0.0002	<0.05	<0.1	0.4	0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
		6/17/94	0.0005	0.011	<0.1	0.0003	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
		4/1/94	0.0005	<0.005	<0.1	<0.0002	<0.05	<0.1	0.3	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
SPG-13	Layton Spring	11/16/95	<0.003	<0.04	0.023	<0.0024	<0.005	<0.003	2.50	<0.024	<0.0002	0.0020	0.001	<0.001	<0.04	<0.002
		8/9/95	<0.002	<0.04	0.020	<0.002	<0.003	<0.003	2.40	<0.017	<0.0002	0.001	<0.001	<0.001	<0.041	<0.002
		5/31/95	<0.002	<0.04	0.026	<0.002	<0.003	<0.003	2.74	0.024	<0.0002	0.0301	<0.04	<0.018	<0.001	<0.002
		3/22/95	<0.002	<0.04	0.024	<0.002	<0.003	<0.003	2.80	<0.017	<0.0002	0.002	<0.04	<0.018	<0.001	<0.002

Source: WESTEC 1995b

TBA-1.XLS

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
Pit dewatering wells, drains, and seeps																				
DW-05	in pit	Pu	500	433	12/5/94	7.50	25.1	220	170	198	29.3	4.1	47.1	19.6	15.2	46.8	<0.02	<0.3	<0.004	**0.280**
					9/22/94	7.71	26.6	261	169.8	191	26.9	3.71	45.4	18.8	16.3	47.4	N.A.	<0.057	<0.002	**0.244**
					8/29/94	7.88	27.5	286	165	168	25	3.3	41	16.0	16	49	<0.1	<0.1	<0.0005	**0.220**
					6/8/94	7.72	26.6	264	163	181	26	4.3	43	18.0	17	48	<0.1	<0.1	<0.0005	**0.310**
DW-06	in pit	Pu	400	617	11/2/95	7..57	24.7	239	176	190	29.4	4.2	46.5	17.9	12.6	49.7	<0.02	<0.078	<0.003	**0.88**
					7/31/95	7.70	25.5	232	176	184	26.3	3.99	44.6	17.6	12.9	50.8	<0.02	<0.082	<0.002	**0.91**
					5/18/95	7.76	24.3	243	176	195	27.1	3.98	48.7	17.9	12.1	49.7	<0.02	<0.082	<0.002	**1.02**
					3/13/95	7.70	23.7	229	178	188	27.0	4.02	45.7	18.0	12.7	50.2	<0.02	<0.057	<0.002	**0.96**
					12/22/94	7.60	20.6	238	177	207	29.7	4.2	51.3	19.3	12.5	48.6	0.02	0.06	<0.002	**1.180**
					9/26/94	7.80	24.0	261	172	189	25	4.0	46	18.0	12	48	<0.1	<0.1	<0.0005	**0.680**
					9/20/94*	7.72	24.8	268	173.7	194	26.9	4.33	47.9	18.2	12.7	48.4	N.A.	<0.057	<0.002	**0.788**
					6/8/94	7.69	23.6	259	170	182	26	4.7	45	17.0	12	50	<0.1	<0.1	<0.0005	**0.940**
					3/30/94	8.01	23.8	264	168	183	23	4.3	47	16.0	15	48	<0.1	<0.1	0.0006	**1.100**
DW-07	in pit	Pu	500 & 200	786	10/2/95	7.58	24.1	256	168	182	22.5	3.93	43.6	17.7	18.2	44.6	0.03	<0.082	<0.002	**0.25**
					8/5/95	7.81	24.6	N.A.	167	197	26.6	3.98	46.7	19.6	18.1	46.1	<0.02	0.087	<0.002	**0.22**
					5/18/95	7.84	24.3	211	167	195	25.8	4.33	46.5	19.2	18.1	45.4	0.040	<0.082	<0.002	**0.249**
					12/22/94	7.60	19.4	230	168	209	29.1	3.7	50	20.5	18.3	45.3	0.05	0.07	<0.002	**0.280**
					9/21/94*	7.65	23.5	256	155.7	192	25.4	3.95	45.9	18.9	19.1	45.2	N.A.	0.04	<0.002	**0.258**
					9/13/94	8.02	21.8	272	162	190	25	4.2	45	19.0	19	45	0.10	<0.1	<0.0005	**0.270**
					6/6/94	7.88	18.8	267	160	175	25	4.8	42	17.0	19	45	<0.1	<0.1	<0.0005	**0.270**
					3/29/94	8.11	19.5	272	163	185	23	4.1	46	17.0	22	50	0.20	<0.1	0.0006	**0.290**
DW-08	in pit	Pu	500 & 200	785	10/3/95	7.66	26.2	255	174	182	24.3	3.89	43.6	17.7	15.7	48.0	0.05	<0.082	<0.002	**0.27**
					8/11/95	7.61	26.7	239	174	186	26.4	3.8	44.1	18.4	15.9	48.2	0.02	0.200	<0.0022	**0.249**
					12/5/94	7.60	24.5	293	175	208	29.4	4.4	49.4	20.7	18.6	47.3	0.03	<0.3	<0.004	**0.320**
					9/20/94*	7.84	24.9	276	171.2	195	26.7	4.08	46.3	19.3	19.8	46.2	0.05	0.020	<0.002	**0.273**
					8/29/94	8.05	22.6	287	165	177	25	3.5	43	17.0	20	50	<0.1	<0.1	<0.0005	**0.310**
					6/8/94	8.09	26.4	275	166	184	27	4.6	44	18.0	22	50	<0.1	<0.1	<0.0005	**0.340**
DW-09	in pit	Pu		340	10/3/95	7.71	19.0	294	174	208	25.4	4.59	48.4	21.1	26.5	57.7	<0.01	<0.082	<0.002	**0.32**
					8/11/95	7.54	19.1	270	171	215	27.8	3.96	48.8	22.7	28.3	58.9	0.59	0.100	<0.0022	**0.212**
DW-10	in pit	Pu	500	880	10/9/95	7.66	25.4	259	173	199	25.4	4.72	46.1	20.4	20.2	49.8	<0.01	<0.082	<0.002	**0.30**
					8/16/95	7.79	25.6	241	172	190	27.2	4.29	43.7	19.8	20.1	47	0.03	<0.082	<0.002	**0.29**
					3/13/95*	7.90	23.1	253	173	191	26.6	4.45	43.4	20.2	22	47.3	0.04	<0.057	<0.002	**0.31**
					12/22/94	7.80	19.2	243	170	207	28.4	5.3	48.3	21.0	22	47.1	0.11	0.07	<0.002	**0.310**
					9/13/94	8.00	22.8	282	164	199	26	5.3	45	21.0	23	48	0.20	0.2	<0.0005	**0.400**
DW-11	in pit	Pu		1165	10/3/95	7.72	20.6	238	160	176	21.8	3.29	39.1	19.0	23.1	37.6	0.02	<0.082	<0.002	**0.23**
					7/31/95	7.96	21.1	216	159	173	23.9	3.45	38.3	18.8	22.9	40.5	0.17	0.532	<0.002	**0.27**

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
Pit dewatering wells, drains, and seeps																	
DW-05	in pit	Pu	500	433	12/5/94	0.072	<0.004	<0.004	<0.003	0.58	0.122	0.0003	0.023	**<0.04**	**0.070**	<0.001	0.009
					9/22/94	0.0667	<0.002	<0.004	<0.002	0.56	0.173	<0.0002	0.024	<0.001	**0.052**	<0.001	<0.004
					8/29/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/8/94	<0.1	<0.0002	<0.05	<0.1	0.61	**0.4**	<0.0005	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-06	in pit	Pu	400	617	11/2/95	0.068	<0.0024	<0.005	<0.003	0.60	0.047	<0.0002	0.037	<0.001	**0.024**	<0.04	0.004
					7/31/95	0.060	0.002	<0.003	<0.003	0.6	0.128	<0.0002	0.037	0.002	**0.013**	<0.041	0.003
					5/18/95	0.0686	<0.002	<0.003	0.0037	0.58	0.143	<0.0002	0.038	**<0.04**	**0.022**	<0.001	0.0144
					3/13/95	0.067	<0.002	<0.004	<0.002	0.70	0.125	<0.0002	0.037	**<0.04**	**0.026**	<0.001	<0.004
					12/22/94	0.076	<0.002	<0.004	<0.002	0.60	**0.388**	<0.0002	**0.064**	**<0.04**	**<0.02**	<0.001	0.011
					9/26/94	<0.1	<0.0002	<0.05	<0.1	0.60	0.1	<0.0005	<0.1	<0.002	**<0.5**	<0.001	<0.1
					9/20/94*	0.0688	<0.002	<0.004	<0.002	0.56	0.136	<0.0002	0.0466	<0.001	**<0.024**	<0.001	0.0099
					6/8/94	<0.1	<0.0002	<0.05	<0.1	0.69	<0.1	<0.0005	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/30/94	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-07	in pit	Pu	500 & 200	786	10/2/95	0.054	<0.002	<0.003	<0.003	0.60	0.068	<0.0002	0.031	<0.001	**0.03**	<0.041	0.003
					8/5/95	0.054	<0.002	<0.003	<0.003	0.5	0.021	<0.0002	0.035	<0.001	**0.033**	<0.041	0.015
					5/18/95	0.0584	<0.002	<0.003	<0.003	0.57	0.063	<0.0002	0.0312	**<0.04**	**0.048**	<0.001	0.0065
					12/22/94	0.064	<0.002	<0.004	<0.002	0.60	0.055	<0.0002	0.03	**<0.04**	**0.03**	<0.001	<0.004
					9/21/94*	0.0576	<0.002	<0.004	<0.002	0.55	0.0669	<0.0002	0.0283	<0.001	**0.049**	<0.001	<0.004
					9/13/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/6/94	<0.1	<0.0002	<0.05	<0.1	0.57	<0.1	<0.0005	<0.1	<0.001	**<0.5**	<0.001	<0.1
					3/29/94	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.001	**<0.5**	<0.001	<0.1
DW-08	in pit	Pu	500 & 200	785	10/3/95	0.063	<0.002	<0.003	<0.003	0.60	0.061	<0.0002	0.020	<0.001	**0.053**	<0.041	0.004
					8/11/95	0.0611	<0.0019	<0.002	<0.0017	0.6	0.101	0.0003	0.0266	<0.001	**0.079**	**<0.061**	0.0031
					12/5/94	0.075	<0.004	<0.004	<0.003	0.61	0.013	0.0008	0.02	**<0.04**	**0.080**	<0.001	<0.004
					9/20/94*	0.0689	<0.002	<0.004	<0.002	0.66	0.0495	0.00116	0.0244	<0.001	**0.068**	<0.001	<0.004
					8/29/94	<0.1	<0.0002	<0.05	<0.1	0.70	<0.1	0.0005	<0.1	<0.002	**<0.5**	<0.001	<0.1
					6/8/94	<0.1	<0.0002	<0.05	<0.1	0.67	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
DW-09	in pit	Pu		340	10/3/95	0.038	<0.002	<0.003	0.004	0.60	0.042	0.0009	0.029	<0.001	**0.006**	<0.041	0.069
					8/11/95	0.0406	<0.0019	<0.002	<0.0017	0.5	**0.349**	0.0006	0.0241	<0.001	<0.001	**<0.061**	0.111
DW-10	in pit	Pu	500	880	10/9/95	0.068	<0.002	<0.003	<0.003	0.60	<0.017	0.0004	0.019	0.001	**0.023**	<0.041	0.003
					8/16/95	0.069	<0.002	<0.003	<0.003	0.6	0.021	0.0004	0.019	<0.001	**0.081**	<0.041	0.008
					3/13/95*	0.0640	<0.002	<0.004	<0.002	0.70	0.015	0.0005	0.005	**<0.04**	**0.061**	<0.001	<0.004
					12/22/94	0.062	<0.002	<0.004	<0.002	0.60	0.009	0.0007	0.002	**<0.04**	**0.060**	0.002	0.005
					9/13/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	0.0010	<0.1	<0.002	**<0.5**	<0.001	<0.1
DW-11	in pit	Pu		1165	10/3/95	0.066	<0.002	<0.003	<0.003	0.60	0.036	<0.0002	0.008	<0.001	**0.035**	**0.051**	0.011
					7/31/95	0.061	<0.002	<0.003	<0.003	0.70	0.069	<0.0002	0.026	0.002	**0.039**	<0.041	0.01

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
DW-13	in pit	Pu		780	10/2/95	7.66	18.0	286	164	201	24.8	4.27	45.1	21.5	29.6	55.9	<0.01	<0.082	<0.002	**0.37**
					8/11/95	7.51	20.8	270	164	206	27.2	3.88	46.2	22.1	27.5	56.6	0.66	0.100	<0.0022	**0.329**
					6/1/95	7.67	17.9	291	159	219	28.3	3.96	49.4	23.4	30.6	57.4	0.83	0.087	<0.002	**0.34**
DW-14	in pit	Pu		780	10/3/95	7.97	18.1	229	157	175	20.2	4.45	37.9	19.5	20.2	38.0	<0.01	<0.082	0.003	**0.19**
					8/5/95	7.84	17.5	218	152	182	23.8	3.73	40	20	20.5	36.5	<0.02	<0.082	<0.002	**0.13**
DW-15	in pit	Pu		780	10/3/95	7.71	16.9	251	140	171	23.4	3.63	39.3	17.8	30.7	47.7	0.05	<0.082	0.003	**0.15**
					7/31/95	7.90	17.2	238	139	164	25	3.12	36.9	17.5	29.2	42.8	0.38	<0.082	<0.002	**0.14**
DW-16	in pit	Pu		1160	10/3/95	7.71	18.1	229	152	163	21.4	4.24	37.1	17.1	25.0	33.3	<0.01	<0.082	0.002	**0.22**
					7/31/95	7.91	17.9	196	149	161	23.4	3.56	36.1	17.2	24.2	35.7	0.37	<0.082	<0.002	**0.21**
DW-17	south of pit				10/3/95	7.82	17.2	220	142	146	21.1	3.27	33.6	15.1	16.8	22.9	<0.01	<0.082	<0.002	**0.10**
Drain 1 East	in pit-cut 6	Pu			9/15/94	8.00	23.5	275	173	190	25	3.9	45	19.0	19	48	0.20	<0.1	<0.0005	**0.360**
Drain 2	in pit-cut 6	Pu			9/15/94	7.75	25.2	278	165	192	25	4.0	44	20.0	18	48	0.30	<0.1	<0.0005	**0.550**
Drain 3	in pit-cut 6	Pu			9/15/94	8.20	25.1	274	165	183	27	3.8	42	19.0	14	47	<0.1	<0.1	<0.0005	**0.290**
Drain 4	in pit-cut 6	Pu			9/15/94	8.32	25.9	271	168	183	27	4.0	42	19.0	14	47	<0.1	<0.1	<0.0005	**0.380**
Drain 5 West	in pit-cut 6	Pu			9/15/94	7.88	17.4	370	167	255	31	4.7	61	25.0	28	96	0.40	<0.1	<0.0005	**0.980**
Bedrock Drain	in pit	Pu			6/8/94	8.26	24.4	299	164	207	26	4.6	50	20.0	25	62	0.22	<0.1	<0.0005	**0.480**
					3/28/94	7.82	19.9	264	166	220	25	4.2	55	20.0	26	51	0.30	<0.1	0.0006	**0.640**
Lower Drain	in pit	Pu			6/8/94	8.36	20.1	297	171	209	27	4.8	46	23.0	15	84	<0.1	<0.1	<0.0005	**0.070**
					3/28/94	8.25	22.3	282	164	194	23	3.7	48	18.0	27	47	0.20	<0.1	0.0006	**0.530**
North Seep	in pit	Pu	400		10/12/94*	8.29	N.A.	290	175	218	29.7	4.47	50.7	22.2	31.4	63.7	0.22	0.29	<0.002	**0.842**
Pit Sump	in pit	Pu			10/9/95	7.96	16.6	365	186	276	27.5	3.65	65.9	27.2	12.6	115.0	<0.02	0.380	<0.002	**1.04**
					7/31/95	8.35	27.3	305	178	229	25.5	3.65	51.6	24.3	12.3	89.6	<0.02	<0.082	<0.002	**0.34**
					5/18/95	8.25	22.3	253	162	211	26.6	4.07	49.5	21.3	18.3	72.7	0.220	<0.082	0.0021	**0.326**
					3/13/95	8.30	19.8	256	170	193	25.0	3.77	44.2	20.1	17.5	65.9	0.13	<0.057	<0.002	**0.28**
SE Drain	in pit	Pu	400		9/21/94*	7.84	N.A.	268	169	195	26.1	4.27	45.8	19.7	18.6	46.7	N.A.	<0.057	<0.002	**0.323**
South Seep	in pit	Pu	400		9/21/94*	8.24	N.A.	266	169	189	27.8	3.85	44.4	19.1	14.1	46.8	0.03	<0.057	<0.002	**0.284**
Monitoring Wells																				
Dudley Well	S of Midas Road	QTar	100	60	7/14/94	7.68	16.4	**620**	91	216	140	8.4	70	10.1	170	150	0.90	<0.1	<0.0005	0.047
GFW-1	well sheds SE of S. Admin	QTal	100	424	5/17/95	8.09	20.4	200	119	104	31.1	5.03	28.3	8.09	16.9	23.9	0.210	<0.082	<0.002	<0.040
					2/26/95	8.00	19.6	224	120	97	30.7	5.34	26.5	7.53	17.0	22.8	0.17	<0.057	<0.002	<0.04
					12/5/94	7.80	12.1	152	120	91	34.9	6.3	26.3	6.19	13.5	18	0.14	<0.3	<0.004	<0.04
					9/13/94	7.94	18.1	226	117	84	32	5.9	24	5.9	14	18	0.20	<0.1	<0.0005	0.016
					9/21/94*	8.00	18.4	229	123	100	30.5	5.11	27.3	7.75	16	20.7	N.A.	0.123	<0.002	0.01
					6/9/94	7.99	20.1	231	110	91	29	5.4	25	7.0	15	20	0.20	<0.1	0.0005	0.013
GFW-2	well sheds SE of S. Admin	QTal	100	755	5/17/95	8.02	18.3	199	121	88	33.3	6.94	25.4	5.95	14.2	17.4	0.070	0.083	<0.002	<0.040
					2/26/95	7.90	16.3	208	121	84	32.8	6.38	24.1	5.68	13.7	16.3	<0.02	<0.057	<0.002	<0.04
					12/5/94	7.90	13.1	193	121	91	34.6	6.8	26.2	6.18	13.9	17.5	0.09	<0.3	<0.004	<0.04
					9/26/94*	8.06	18.1	204	109	83	30	5.7	24	5.7	13	18	0.20	<0.1	<0.0005	0.019
					6/9/94	7.84	20.0	230	115	80	31	6.3	23	5.5	13	18	0.20	<0.1	<0.0005	0.016

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
DW-13	in pit	Pu		780	10/2/95	0.039	<0.002	0.004	<0.003	0.70	0.022	<0.0002	0.004	<0.001	<0.001	0.056	0.038
					8/11/95	0.0449	<0.0019	<0.002	<0.0017	0.6	0.0202	<0.0002	0.0069	<0.001	0.009	<0.061	0.0642
					6/1/95	0.050	<0.002	<0.003	<0.003	0.60	0.055	<0.0002	0.007	<0.04	<0.018	0.007	0.155
DW-14	in pit	Pu		780	10/3/95	0.043	<0.002	0.005	0.005	0.60	<0.017	<0.0002	0.010	<0.001	0.009	<0.041	0.092
					8/5/95	0.035	<0.002	<0.003	<0.003	0.6	<0.017	0.0007	0.014	<0.001	0.007	<0.041	0.166
DW-15	in pit	Pu		780	10/3/95	0.067	<0.002	0.005	<0.003	0.50	0.037	<0.0002	0.004	<0.001	0.001	<0.041	0.02
					7/31/95	0.060	<0.002	0.003	<0.003	0.6	0.05	<0.0002	0.006	<0.001	0.001	<0.041	0.034
DW-16	in pit	Pu		1160	10/3/95	0.063	<0.002	0.004	<0.003	0.60	0.04	<0.0002	0.006	<0.001	0.054	<0.041	0.018
					7/31/95	0.064	<0.002	<0.003	<0.003	0.6	0.032	<0.0002	0.007	0.003	0.041	<0.041	0.056
DW-17	south of pit				10/3/95	0.062	<0.002	0.005	<0.003	0.50	<0.017	<0.0002	0.009	<0.001	0.003	<0.041	0.07
Drain 1 East	in pit-cut 6	Pu			9/15/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
Drain 2	in pit-cut 6	Pu			9/15/94	<0.1	<0.0002	<0.05	<0.1	0.70	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
Drain 3	in pit-cut 6	Pu			9/15/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
Drain 4	in pit-cut 6	Pu			9/15/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
Drain 5 West	in pit-cut 6	Pu			9/15/94	<0.1	<0.0002	<0.05	<0.1	0.80	<0.1	0.0005	<0.1	<0.002	<0.5	0.005	<0.1
Bedrock Drain	in pit	Pu			6/8/94	<0.1	<0.0002	<0.05	<0.1	0.63	<0.1	<0.0005	<0.1	<0.001	<0.5	0.002	<0.1
					3/28/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	0.0014	<0.1	<0.001	<0.5	<0.001	<0.1
Lower Drain	in pit	Pu			6/8/94	<0.1	<0.0002	<0.05	<0.1	0.53	<0.1	<0.0005	<0.1	<0.001	<0.5	0.001	<0.1
					3/28/94	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.001	<0.5	0.001	<0.1
North Seep	in pit	Pu	400		10/12/94*	0.0465	<0.002	<0.004	0.0076	0.762	<0.006	<0.0002	0.0196	0.001	<0.024	<0.001	<0.004
Pit Sump	in pit	Pu			10/9/95	0.049	<0.002	<0.003	<0.003	0.70	<0.017	<0.0002	0.142	<0.001	0.012	<0.041	<0.002
					7/31/95	0.0450	<0.002	<0.003	<0.003	0.6	<0.017	<0.0002	0.053	0.001	0.055	<0.041	<0.002
					5/18/95	0.0506	<0.0020	<0.003	<0.003	0.65	<0.017	<0.0002	0.049	<0.04	<0.018	<0.001	<0.002
					3/13/95	0.0550	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	0.027	<0.04	0.025	<0.001	<0.004
SE Drain	in pit	Pu	400		9/21/94*	0.0728	<0.002	<0.004	<0.002	0.61	<0.006	0.00034	0.0565	0.001	0.024	<0.001	<0.004
South Seep	in pit	Pu	400		9/21/94*	0.0697	<0.002	<0.004	<0.002	0.59	<0.006	<0.0002	0.0213	<0.001	<0.024	<0.001	<0.004
Monitoring Wells																	
Dudley Well	S of Midas Road	QTar	100	60	7/14/94	<0.1	<0.0002	<0.05	<0.1	0.90	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
GFW-1	well sheds SE of S. Admin	QTal	100	424	5/17/95	0.005	<0.002	<0.003	<0.003	0.56	<0.017	<0.0002	<0.0010	<0.04	<0.018	<0.001	<0.002
					2/26/95	0.005	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	<0.04	<0.024	<0.010	<0.004
					12/5/94	0.01	<0.004	<0.004	<0.003	0.56	<0.009	<0.0002	0.002	<0.04	<0.02	<0.001	<0.004
					9/13/94	<0.1	<0.0002	<0.05	<0.1	0.60	0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
					9/21/94*	0.0063	<0.002	<0.004	<0.002	0.059	<0.006	<0.0002	<0.002	0.002	<0.024	<0.001	<0.004
					6/9/94	<0.1	0.0003	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1
GFW-2	well sheds SE of S. Admin	QTal	100	755	5/17/95	0.0107	<0.002	<0.003	<0.003	0.55	<0.017	<0.0002	0.0053	<0.04	<0.018	<0.001	<0.002
					2/26/95	0.008	<0.002	<0.004	<0.002	0.60	0.020	<0.0002	0.0130	<0.04	<0.024	<0.010	<0.004
					12/5/94	0.01	<0.004	<0.004	<0.003	0.56	<0.009	<0.0002	0.009	<0.04	0.024	<0.001	<0.004
					9/26/94*	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.002	<0.5	<0.001	<0.1
					6/9/94	<0.1	0.0003	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.001	<0.5	<0.001	<0.1

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
GW-1	SW of leach pad J	QTal	100	521	9/23/94*	7.61	24.4	N.A.	144	155	27.4	5.47	37.7	14.9	20.3	33.8	N.A.	0.1	<0.002	**0.065**
GW-2	E of leach pad K	QTal	100	291	10/12/94*	7.80	18.1	327	144	151	24.6	3.64	38.6	13.4	19.2	28.8	1.54	0.057	0.0024	0.018
GW-3	E of tailings A	QTal	100	275	10/12/94*	7.86	14.0	228	146	108	45.2	6.23	30.7	7.56	21.4	28.8	1.67	0.085	<0.002	0.011
GW-4	E of leach pad K	QTal	100	300	9/23/94*	7.64	15.0	N.A.	140	155	23.9	4.54	38.6	14.3	16.1	32.3	N.A.	0.1	<0.002	0.013
M/O 384303-1	SW of The Knolls	QTar	100	400	10/6/95	**8.79**	18.2	276	145	20	73.6	5.36	7.42	0.3	13.4	20.5	0.31	1.530	<0.002	**0.06**
					8/22/95	**8.77**	20.2	265	140	20	80.5	6.02	7.38	0.278	13.9	20.7	0.32	1.580	<0.002	**0.05**
					6/15/95	**8.96**	16.4	275	146	19	79.7	5.8	6.92	0.321	14.5	21.2	0.41	1.440	0.005	**0.05**
					2/28/95	**9.10**	17.4	278	152	20	86.7	6.16	7.65	0.25	13.0	23.3	0.34	1.290	<0.002	<0.04
					11/15/94	**9.30**	20.6	305	158	21	87.6	5.7	8.1	0.19	13.5	24.6	0.36	1.4	<0.004	<0.04
					9/7/94	**9.77**	21.1	308	168	20	90	5.8	7.8	0.2	14	29	0.40	1.8	<0.0005	0.039
					6/10/94	**9.60**	21.1	347	165	21	100	7.7	8.1	0.2	15	42	0.50	<0.1	0.0008	**0.061**
					3/22/94	**9.52**	12.0	328	155	32	79	5.0	12	0.5	21	44	0.30	<0.1	0.0012	0.044
M/O 384305-1	Infiltration Basin	QTar		160	11/18/95	7.37	13.3	269	101	115	40.2	3.70	34.8	6.82	42.8	33	1.45	0.02	<0.003	0.002
					7/11/95	7.69	18.0	249	107	115	36.9	3.28	34.7	6.78	42.7	29.1	1.29	N/A	<0.002	0.003
					7/5/95	7.79	18.1	264	106	111	38.5	3.67	33.7	6.42	40.7	28.6	1.08	N/A	<0.002	0.003
					6/27/95	7.91	18.5	268	105	107	37.5	3.41	32.4	6.23	34.5	27.3	0.78	N/A	<0.002	0.002
M/O 384305-2	Infiltration Basin	QTar		160	11/18/95	7.43	13.1	246	118	121	31.5	3.83	36.5	7.24	24.3	31.9	0.14	0.01	<0.003	0.001
					7/11/95	7.66	16.3	224	119	122	28.2	3.51	36.7	7.26	25.7	28.9	0.16	N/A	<0.002	0.002
					7/5/95	7.81	16.8	247	118	121	29.7	4.06	36.8	7.13	25.7	28.2	0.14	N/A	<0.002	0.002
					6/27/95	7.91	16.3	246	114	122	29.8	3.61	37.1	7.14	25.3	28.5	0.17	N/A	<0.002	0.001
M/O 384305-3	Infiltration Basin	QTar		160	11/18/95	7.43	12.4	305	160	163	38.8	4.61	52.2	7.84	23.5	40	0.28	0.02	<0.003	<0.001
					7/11/95	7.56	15.8	295	166	166	33.6	4.69	52.7	8.33	25.2	39.6	0.08	N/A	<0.002	<0.001
					7/5/95	7.67	17.4	348	169	174	37.1	5.17	55.4	8.69	25.6	42.7	0.06	N/A	<0.002	<0.001
					6/28/95	7.72	15.6	357	160	183	39.3	5.35	58	9.19	23.8	48.5	0.08	N/A	<0.002	<0.001
M/O 384305-4	Infiltration Basin	QTar		140	11/19/95	7.58	13.2	242	118	101	38.6	5.36	32.2	5.12	24.2	30	0.16	0.01	<0.003	0.004
					7/12/95	8.00	13.3	226	119	101	36.8	4.88	31.8	5.24	26.3	25.4	0.18	N/A	<0.002	0.003
					7/6/95	8.00	18.1	234	118	100	36.5	5.30	31.6	5.03	26.3	25.7	0.19	N/A	<0.002	0.003
					6/28/95	8.09	-0.7	248	116	99	36.1	5.20	31.4	4.95	25	25.4	0.18	N/A	<0.002	0.002
M/O 384305-5	Infiltration Basin	QTar		140	11/19/95	6.90	12.7	**1260**	48.6	624	92	5.69	185	39.30	**505**	29.3	**16.50**	0.01	<0.003	<0.001
					7/12/95	7.81	14.4	237	132	111	41.1	3.99	34.2	6.31	28.8	27.5	0.26	N/A	<0.002	0.002
					7/6/95	7.82	17.3	258	130	110	41	3.74	34	6.08	28.7	28.5	0.29	N/A	<0.002	0.001
					6/29/95	7.80	16.4	236	131	118	42.3	4.04	36.8	6.35	28.7	28.4	0.22	N/A	0.002	<0.001
M/O 384305-6	Infiltration Basin	QTar		160	11/18/95	7.05	12.4	**1820**	59.7	957	227	1.42	269	69.50	**721**	201	**37.20**	0.04	<0.003	0.001
					7/14/95	7.96	15.1	248	145	148	33	4.69	46.7	7.57	27.4	**31.4**	0.31	N/A	<0.002	0.002
					7/6/95	7.88	17.4	263	143	139	33.7	4.53	43.7	7.27	26.8	**27.4**	0.32	N/A	<0.002	0.001
					6/30/95	7.85	15.8	202	144	151	34	5.15	48.1	7.44	27.2	**27.9**	0.26	N/A	<0.002	0.001

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
GW-1	SW of leach pad J	QTal	100	521	9/23/94*	0.0923	<0.002	<0.004	<0.002	N.A.	<0.006	<0.0002	<0.002	0.003	**<0.024**	0.001	0.494
GW-2	E of leach pad K	QTal	100	291	10/12/94*	0.0761	<0.002	<0.004	0.0053	0.656	<0.006	<0.0002	<0.002	0.004	**<0.024**	<0.001	0.318
GW-3	E of tailings A	QTal	100	275	10/12/94*	0.031	<0.002	<0.004	0.0045	0.625	<0.006	<0.0002	<0.002	0.004	**<0.024**	<0.001	0.231
GW-4	E of leach pad K	QTal	100	300	9/23/94*	0.0594	<0.002	<0.004	0.0047	N.A.	<0.006	<0.0002	<0.002	0.003	**<0.024**	<0.001	0.0113
M/O 384303-1	SW of The Knolls	QTar	100	400	10/6/95	<0.001	<0.002	0.003	<0.003	0.70	<0.017	<0.002	<0.001	<0.001	<0.001	<0.041	<0.002
					8/22/95	0.002	<0.002	<0.003	<0.003	0.8	0.018	<0.0002	0.001	<0.001	<0.001	<0.041	<0.002
					6/15/95	<0.040	<0.002	<0.003	<0.003	0.70	0.026	<0.0002	<0.003	**<0.04**	**<0.018**	<0.010	<0.002
					2/28/95	0.0030	<0.002	<0.004	<0.002	0.70	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.010	<0.004
					11/15/94	0.004	<0.004	<0.004	<0.003	0.82	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/7/94	<0.1	<0.0002	<0.05	<0.1	0.90	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/10/94	<0.1	0.0009	<0.05	<0.1	1.00	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/22/94	<0.1	<0.0002	<0.05	<0.1	1.00	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384305-1	Infiltration Basin	QTar		160	11/18/95	0.041	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	0.001	N/A	<0.01	<0.002
					7/11/95	0.038	<0.002	<0.003	0.006	0.40	<0.017	<0.0002	0.004	<0.001	N/A	<0.001	<0.002
					7/5/95	0.039	<0.002	<0.004	0.011	0.50	<0.017	<0.0002	0.002	<0.001	N/A	<0.001	<0.002
					6/27/95	0.036	<0.002	<0.004	<0.003	0.40	<0.017	<0.0002	0.002	<0.001	N/A	<0.001	<0.002
M/O 384305-2	Infiltration Basin	QTar		160	11/18/95	0.007	<0.0024	<0.005	<0.003	0.40	<0.024	<0.0002	<0.001	<0.001	N/A	<0.01	<0.002
					7/11/95	0.009	<0.002	<0.003	0.005	0.50	<0.017	<0.0002	0.005	<0.001	N/A	<0.001	<0.002
					7/5/95	0.009	<0.002	<0.004	0.011	0.50	<0.017	<0.0002	0.007	<0.001	N/A	<0.001	<0.002
					6/27/95	0.008	<0.002	<0.004	<0.003	0.40	<0.017	<0.0002	0.009	<0.001	N/A	<0.001	<0.002
M/O 384305-3	Infiltration Basin	QTar		160	11/18/95	0.004	<0.0024	<0.005	<0.003	0.50	<0.024	<0.0002	**0.248**	<0.001	N/A	<0.001	0.011
					7/11/95	0.006	<0.002	<0.003	0.007	0.40	<0.017	<0.0002	**0.037**	<0.001	N/A	<0.001	0.029
					7/5/95	0.007	<0.002	<0.004	0.011	0.40	<0.017	<0.0002	**0.029**	<0.001	N/A	<0.001	0.027
					6/28/95	0.008	<0.002	<0.004	0.011	0.40	<0.017	<0.0002	**0.031**	<0.001	N/A	<0.001	0.034
M/O 384305-4	Infiltration Basin	QTar		140	11/19/95	0.017	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	<0.001	<0.001	N/A	<0.01	<0.002
					7/12/95	0.023	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.004	<0.001	N/A	<0.001	<>0.002
					7/6/95	0.025	<0.002	<0.003	0.004	0.40	<0.017	<0.0002	0.007	<0.001	N/A	0.001	<0.002
					6/28/95	0.025	<0.002	<0.004	0.006	0.30	<0.017	<0.0002	0.008	<0.001	N/A	<0.001	<0.002
M/O 384305-5	Infiltration Basin	QTar		140	11/19/95	0.112	<0.0024	<0.005	<0.003	0.70	<0.024	<0.0002	0.005	<0.001	N/A	<0.01	<0.002
					7/12/95	0.016	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.006	<0.001	N/A	<0.001	<0.002
					7/6/95	0.019	<0.002	<0.003	0.003	0.40	<0.017	<0.0002	0.008	<0.001	N/A	<0.001	<0.002
					6/29/95	0.017	<0.002	0.004	0.005	0.40	<0.017	<0.0002	0.01	<0.001	N/A	<0.001	<0.002
M/O 384305-6	Infiltration Basin	QTar		160	11/18/95	0.031	<0.0024	<0.005	<0.003	1.10	<0.024	<0.0002	<0.001	<0.001	N/A	<0.001	<0.002
					7/14/95	0.011	<0.002	<0.003	0.004	0.30	<0.017	<0.0002	0.003	<0.001	N/A	<0.001	0.003
					7/6/95	0.012	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.003	<0.001	N/A	<0.001	<0.002
					6/30/95	0.013	<0.002	0.005	<0.003	0.30	<0.017	<0.0002	0.001	<0.001	N/A	<0.001	<0.002

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
M/O 384305-7	Infiltration Basin	QTar		140	11/19/95	7.32	13.1	256	106	94	34.2	4.99	30	4.73	21.4	32.4	0.38	0.02	<0.003	<0.001
					7/14/95	7.81	15.6	210	105	99	31.1	4.27	31.8	4.78	22.6	32.4	0.35	N/A	<0.002	<0.001
					7/7/95	7.66	25.3	225	105	95	32.7	4.73	30.3	4.66	23	28.3	0.43	N/A	<0.002	<0.001
					6/29/95	7.59	15.9	226	106	100	33	4.86	32.2	4.75	22.7	28	0.28	N/A	<0.002	<0.001
M/O 384305-8	Infiltration Basin	QTar		140	11/21/95	7.31	13.4	212	114	105	21.2	4.41	34.2	4.74	9.8	19.7	0.24	0.02	<0.003	<0.001
					7/17/95	7.81	16.4	202	115	113	19.5	4.76	37.2	4.87	10.7	25.3	0.25	N/A	<0.002	<0.001
					7/9/95	7.84	15.7	215	112	113	20.3	4.80	37.3	4.88	10.4	27.4	0.20	N/A	<0.002	0.001
					6/30/95	8.65	15.4	232	101	163	21.6	5.68	58.2	4.17	10.6	73.7	0.24	N/A	<0.002	0.002
M/O 384305-9	Infiltration Basin	QTar		140	11/28/95	7.39	13.9	223	93.8	99	30.6	3.05	31.2	5.14	21.8	40.8	0.37	0.06	0.007	0.003
					7/17/95	8.06	21.4	222	87.3	103	26.5	3.00	34.9	3.84	20.9	45.2	0.36	N/A	<0.002	0.003
					7/9/95	7.92	23.3	231	87.2	102	26.7	3.39	35.5	3.16	20.3	46.3	0.40	N/A	<0.002	0.003
					7/3/95	7.89	20.9	235	85.4	119	28.7	4.13	43.6	2.48	20.5	61.2	0.35	N/A	<0.002	0.004
M/O 384305-10	Infiltration Basin	QTar		160	11/20/95	7.44	12.8	219	105	95	33.8	4.42	30.8	4.45	20.7	26.9	0.33	0.02	<0.003	0.001
					7/15/95	7.69	18.0	212	109	96	31.3	4.89	31.1	4.49	21.6	30.6	0.35	N/A	0.002	<0.001
					7/10/95	7.71	29.6	313	106	93	32.1	5.05	30	4.29	21.9	26.5	0.4	N/A	<0.002	0.001
					7/4/95	7.97	21.3	231	106	92	32.2	5.34	29.7	4.3	22	27.2	0.4	N/A	<0.002	<0.001
M/O 384315-1	~3 mi. W of Desmond Ranch	QTag	100	400	11/4/95	7.94	15.1	205	111	68	37.2	5.52	23.7	2.2	15.1	17.1	0.20	0.450	<0.003	<0.04
					8/9/95	7.86	17.4	196	112	69	35.5	5.38	23.8	2.31	15.6	17.5	0.200	0.700	<0.0022	<0.042
					5/12/95	8.20	14.8	210	110	66	34.5	5.20	22.9	2.14	15.3	17.9	0.230	0.545	<0.002	<0.040
					3/16/95	8.10	16.2	200	111	71	39.8	5.58	24.7	2.37	16.0	18.0	0.20	0.705	<0.002	<0.04
					12/16/94	8.10	14.6	205	110	71	39.3	5.5	24.7	2.31	14.9	17.9	0.19	0.64	<0.002	<0.04
					9/9/94	8.79	18.3	256	113	64	40	5.4	22	2.2	16	20	0.30	1.7	<0.0005	0.023
					6/12/94	8.95	21.4	229	108	57	48	6.4	20	1.8	16	24	0.30	<0.1	0.0006	0.036
					3/24/94	9.46	15.2	255	132	46	57	4.8	16	1.5	23	30	0.30	<0.1	0.0009	**0.057**
M/O 384329-1	near Kelly Creek	QTar	100	80	10/8/95	7.42	12.6	260	100	120	30.7	4.79	36.8	6.7	15.9	57.4	0.45	0.050	<0.002	<0.04
					8/3/95	7.56	18.1	245	100	115	31	4.83	35.6	6.37	15.1	52.5	0.470	0.131	<0.002	<0.04
					5/10/95	7.66	14.3	219	99.9	98	27.1	4.51	30.4	5.28	15.1	44.2	0.560	<0.082	<0.002	<0.040
					3/17/95	7.60	13.4	212	100	101	30.3	4.09	31	5.71	15.0	41.3	0.52	0.062	<0.002	<0.04
					11/16/94	7.50	10.6	211	99	88	27.6	4.2	27.5	4.8	12.6	29.8	0.52	<0.3	<0.004	<0.04
					9/6/94	8.14	18.7	216	102	87	26	3.8	27	4.7	12	26	0.60	<0.1	<0.0005	0.012
					6/13/94	7.76	16.1	206	94	85	26	3.8	27	4.3	12	23	0.50	<0.1	<0.0005	0.013
					3/25/94	**8.88**	13.9	184	99	101	20	3.5	35	3.3	15	24	0.30	<0.1	0.0005	0.015
M/O 384331-1	near Summer Camp Creek	QTar	100	78	10/8/95	7.45	14.6	**821**	136	510	55.7	5.15	158	28.0	**277**	96.9	0.69	0.030	<0.002	<0.04
					8/3/95	7.44	18.8	**841**	136	514	56.3	5.35	160	27.9	**321**	102	0.72	0.144	<0.002	<0.04
					5/10/95	7.28	14.2	**766**	120	443	50.5	4.74	138	23.8	**274**	102	0.700	<0.082	<0.002	<0.040
					3/28/95	7.50	10.7	**675**	136	522	56.7	5.32	164	27.2	**255**	85.9	0.69	<0.082	<0.005	<0.04

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
M/O 384305-7	Infiltration Basin	QTar		140	11/19/95	0.023	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	0.001	<0.001	N/A	<0.01	<0.002
					7/14/95	0.025	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.004	<0.001	N/A	<0.001	<0.002
					7/7/95	0.028	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.007	<0.001	N/A	<0.001	<0.002
					6/29/95	0.036	<0.002	<0.004	<0.003	0.30	<0.017	<0.0002	0.01	<0.001	N/A	<0.001	<0.002
M/O 384305-8	Infiltration Basin	QTar		140	11/21/95	0.033	<0.0024	<0.005	<0.003	<0.1	<0.024	<0.0002	0.001	<0.001	N/A	<0.01	<0.002
					7/17/95	0.035	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	0.003	<0.001	N/A	<0.001	<0.002
					7/9/95	0.038	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	0.003	<0.001	N/A	<0.001	<0.002
					6/30/95	0.045	<0.002	<0.003	<0.003	0.10	<0.017	<0.0002	<0.001	<0.001	N/A	<0.01	<0.002
M/O 384305-9	Infiltration Basin	QTar		140	11/28/95	0.046	<0.0024	<0.005	0.004	0.20	<0.024	<0.0002	0.005	<0.001	N/A	<0.01	<0.002
					7/17/95	0.034	<0.002	<0.003	0.005	0.30	<0.017	<0.0002	0.001	<0.001	N/A	<0.001	<0.002
					7/9/95	0.049	<0.002	<0.003	<0.003	0.30	<0.017	<0.0002	0.002	<0.001	N/A	<0.001	<0.002
					7/3/95	0.027	<0.002	<0.004	0.016	0.30	<0.017	<0.0002	<0.001	<0.001	N/A	<0.001	<0.002
M/O 384305-10	Infiltration Basin	QTar		160	11/20/95	0.028	<0.0024	<0.005	<0.003	0.30	<0.024	<0.0002	0.002	0.002	N/A	<0.01	<0.002
					7/15/95	0.037	<0.002	<0.003	0.019	0.40	0.019	<0.0002	0.046	<0.001	N/A	<0.001	<0.002
					7/10/95	0.039	<0.002	<0.003	<0.017	0.40	<0.017	<0.0002	0.033	<0.001	N/A	<0.001	<0.002
					7/4/95	0.037	<0.002	<0.004	<0.017	0.40	<0.017	<0.0002	0.036	<0.001	N/A	<0.001	<0.002
M/O 384315-1	~3 mi. W of Desmond Ranch	QTag	100	400	11/4/95	0.018	<0.0024	<0.005	<0.003	0.50	<0.024	<0.002	<0.001	<0.001	<0.001	<0.04	<0.002
					8/9/95	0.0171	<0.0019	<0.002	0.0017	0.5	<0.0011	<0.0002	<0.0009	<0.001	<0.001	**<0.061**	<0.0019
					5/12/95	0.0173	<0.002	<0.003	<0.003	0.60	0.023	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	0.0024
					3/16/95	0.0180	<0.002	<0.004	<0.002	0.70	<0.006	<0.0002	<0.002	**<0.04**	**0.027**	<0.001	<0.004
					12/16/94	0.019	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/9/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/12/94	<0.1	0.0004	<0.05	<0.1	0.60	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/24/94	<0.1	<0.0002	<0.05	<0.1	0.80	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384329-1	near Kelly Creek	QTar	100	80	10/8/95	0.056	<0.002	<0.003	<0.003	0.30	<0.017	<0.002	<0.001	<0.001	<0.001	<0.041	<0.002
					8/3/95	0.051	<0.002	<0.003	0.011	0.3	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	0.003
					5/10/95	0.0455	<0.002	<0.003	<0.003	0.42	<0.017	<0.0002	0.0019	**<0.04**	**<0.018**	<0.001	0.0023
					3/17/95	0.051	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.001	<0.004
					11/16/94	0.042	<0.004	<0.004	<0.003	0.33	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/6/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	<0.1	0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/25/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384331-1	near Summer Camp Creek	QTar	100	78	10/8/95	0.151	<0.002	0.005	0.011	0.20	<0.017	<0.002	<0.001	<0.001	<0.001	<0.041	0.002
					8/3/95	0.132	<0.002	<0.003	0.006	<0.01	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					5/10/95	0.130	<0.0020	0.0041	<0.003	<0.1	0.033	<0.0002	<0.001	**<0.04**	**<0.018**	0.002	<0.002
					3/28/95	0.143	<0.005	<0.003	<0.010	0.11	<0.050	<0.0002	<0.001	**<0.04**	**<0.018**	0.002	<0.005

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
M/O 384331-1 (cont.)	near Summer Camp Creek	QTar	100	78	11/16/94	7.40	10.3	**769**	16	451	53.3	4.8	140	24.6	**259**	81.7	0.70	<0.3	<0.004	<0.04
					9/9/94	7.66	14.4	**894**	134	491	52	4.9	152	27.0	**260**	83	0.70	<0.1	<0.0005	0.007
					6/13/94	7.30	N.A.	**890**	130	483	57	5.9	152	25.0	**260**	81	0.70	<0.1	0.0011	0.006
					3/26/94	7.73	13.1	**828**	136	526	36	3.8	171	24.0	**268**	89	0.70	<0.1	0.0011	0.007
M/O 384331-2	near Summer Camp Creek	QTar	100	78	10/8/95	7.83	14.8	410	121	245	42.7	4.65	76.3	13.3	74.0	98.1	0.16	0.020	<0.002	<0.04
					8/3/95	7.97	18.2	255	115	131	32.5	4.07	40.9	7.01	29.1	37.8	0.170	0.087	<0.002	<0.04
					5/10/95	8.07	14.9	226	117	104	28.2	3.41	32.5	5.49	25.0	27.9	0.170	<0.082	<0.002	<0.040
					3/28/95	7.90	11.1	204	116	128	33.1	3.65	40.3	6.69	29.1	34.3	0.17	<0.082	<0.005	0.047
					11/16/94	7.70	11.6	439	122	229	45.2	4.4	71.4	12.2	75	84.3	0.13	<0.3	<0.004	<0.04
					9/6/94	8.09	18.2	409	120	222	42	4.4	69	12.0	80	77	0.20	<0.1	<0.0005	0.023
					6/13/94	7.85	18.4	224	110	93	29	3.8	29	5.0	16	20	0.20	<0.1	<0.0005	0.028
					3/26/94	8.13	10.7	204	110	103	25	3.1	33	5.0	19	19	0.20	<0.1	0.0005	0.027
M/O 394224-1	west of pit	Pu	200	800	10/4/95	7.80	16.7	260	190	185	40.4	2.5	37.2	22.4	18.4	39.5	0.63	0.106	<0.002	<0.04
					8/1/95	7.94	19.8	226	190	169	38.5	2.26	33.9	20.5	17.8	43.7	0.66	0.116	<0.002	<0.04
					6/13/95	7.90	18.7	267	190	187	41.7	2.99	38.4	22.2	18.7	39.6	0.64	0.184	<0.002	<0.04
					3/5/95	7.90	12.2	231	189	183	40.8	2.6	37.5	21.8	19.0	39.3	0.70	0.329	<0.002	<0.04
					12/7/94	8.10	14.6	278	191	184	42.2	2.9	38	21.8	18.1	40.7	0.58	0.46	<0.002	**0.060**
					9/24/94*	7.91	18.7	284	187	179	39	2.8	37	21.0	18	39	0.60	1.4	<0.0005	**0.093**
					7/15/94	7.78	20.2	304	186	175	46	3.9	37	20.2	21	40	0.70	<0.1	<0.0005	**0.130**
M/O 394304-1	NE of north mill area	Pu	100	600	10/7/95	7.76	17.3	308	135	139	36.5	6.65	46.8	5.3	20.8	34.9	3.00	0.109	<0.002	<0.04
					8/4/95	7.82	19.9	303	135	140	38	7.5	47.6	5.22	20.7	35.0	2.98	0.308	<0.002	<0.04
					6/23/95	7.85	19.2	312	135	146	38.2	7.01	50	5.15	22.2	36.0	3.04	0.289	<0.002	<0.04
					3/6/95	7.80	15.3	275	140	142	40.7	6.79	48.2	5.27	25.0	35.0	3.00	0.348	<0.002	<0.04
					12/20/94	7.40	11.3	432	146	209	58.8	8.0	71.2	7.44	41.6	34.9	2.76	0.94	<0.002	<0.04
					10/24/94	6.90	21.1	**735**	148	222	74	7.0	77	7.3	79	29	1.60	1.5	<0.0005	0.016
M/O 394318-1	W of Main Ent Rd., W of pit	Pu	300	1000	11/1/95	7.49	15.7	339	188	230	31.2	3.5	55.6	22.3	14.8	75.0	<0.02	<0.082	0.006	**0.65**
					8/18/95*	7.65	20.1	283	190	224	32.6	3.74	54.2	21.5	15.7	66.7	<0.02	<0.082	<0.002	**0.47**
					6/14/95*	7.55	17.9	305	189	227	31	3.74	55.2	21.7	15.3	68.3	<0.02	<0.082	<0.002	**0.51**
					3/31/95*	7.60	19.2	248	185	240	31.4	4.04	59.6	22.3	14.6	72.1	<0.02	<0.082	<0.005	**0.67**
					12/21/94*	7.40	14.7	319	188	268	33.4	4.0	64.8	25.9	13.8	93.8	<0.02	<0.06	<0.002	**0.750**
					9/17/94*	7.16	19.4	423	155	269	31	4.5	65	26.0	13	140	0.10	<0.1	<0.0005	**0.950**
M/O 394319-2	near pit, west	Pu	200 & 100	500	11/8/95	7.76	16.9	285	198	187	36.0	3.52	40.3	21.0	14.3	46.0	0.23	<0.078	0.005	**0.20**
					8/17/95	7.78	18.0	265	199	195	38.1	3.59	42.1	22	13.9	47.7	0.23	<0.082	<0.002	**0.21**
					6/5/95	7.78	16.1	252	198	197	37.1	3.36	42.5	22.1	14.1	46.2	0.23	<0.082	<0.002	**0.22**
					3/28/95	7.80	13.6	184	193	205	36.8	3.54	45.5	22.3	12.8	47.8	0.23	<0.082	<0.005	**0.22**

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
M/O 384331-1 (cont.)	near Summer Camp Creek	QTar	100	78	11/16/94	0.134	<0.004	0.005	<0.003	<0.1	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	0.001	<0.004
					9/9/94	0.2	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	0.2	0.0011	<0.05	<0.1	0.20	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/26/94	0.2	<0.0002	<0.05	<0.1	0.10	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 384331-2	near Summer Camp Creek	QTar	100	78	10/8/95	0.129	<0.002	0.006	<0.003	0.30	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					8/3/95	0.066	<0.002	<0.003	0.006	0.3	<0.017	<0.0002	<0.001	**0.019**	<0.001	<0.041	<0.002
					5/10/95	0.0599	<0.0020	0.0051	<0.003	0.40	<0.017	<0.0002	0.001	**<0.04**	**<0.018**	<0.001	0.0027
					3/28/95	0.0728	<0.005	<0.003	<0.010	0.42	<0.050	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	<0.005
					11/16/94	0.109	<0.004	<0.004	<0.003	0.30	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/6/94	0.1	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					6/13/94	<0.1	0.0003	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
					3/26/94	<0.1	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	<0.1	<0.0010	**<0.5**	<0.001	<0.1
M/O 394224-1	west of pit	Pu	200	800	10/4/95	0.056	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					8/1/95	0.047	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	<0.001	0.001	<0.001	<0.041	<0.002
					6/13/95	0.060	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	0.005
					3/5/95	0.050	<0.002	<0.004	0.002	0.40	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.001	<0.004
					12/7/94	0.049	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/24/94*	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
					7/15/94	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	<0.1	<0.0020	**<0.5**	<0.001	<0.1
M/O 394304-1	NE of north mill area	Pu	100	600	10/7/95	0.069	<0.002	0.004	<0.003	0.40	<0.017	<0.0002	0.002	<0.001	<0.001	<0.041	0.003
					8/4/95	0.0640	<0.002	<0.003	<0.003	0.4	<0.017	<0.0002	0.002	<0.001	<0.001	<0.041	0.007
					6/23/95	0.0710	<0.002	0.014	0.003	0.40	<0.017	<0.0002	0.002	**<0.04**	**<0.018**	<0.01	<0.002
					3/6/95	0.0720	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	0.002	**<0.04**	**<0.024**	<0.001	<0.004
					12/20/94	0.107	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	0.022	**<0.04**	**<0.02**	<0.001	0.009
					10/24/94	0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**0.1**	<0.0020	**<0.5**	<0.001	<0.1
M/O 394318-1	W of Main Ent Rd., W of pit	Pu	300	1000	11/1/95	0.048	<0.002	<0.003	<0.003	0.50	**3.19**	<0.0002	**0.103**	<0.001	**1.4**	<0.041	<0.002
					8/18/95*	0.051	<0.002	<0.003	<0.003	0.5	**2.46**	<0.0002	**0.100**	<0.001	**1.37**	<0.041	0.005
					6/14/95*	0.050	<0.002	<0.003	<0.003	0.50	**2.74**	<0.0002	**0.102**	**<0.04**	**0.84**	<0.001	<0.002
					3/31/95*	0.0486	<0.005	<0.003	<0.010	0.60	**2.96**	<0.0002	**0.111**	**<0.04**	**1.12**	<0.001	<0.005
					12/21/94*	0.045	<0.002	<0.004	<0.002	0.60	**3.63**	<0.0002	**0.14**	**<0.04**	**0.54**	<0.001	0.008
					9/17/94*	<0.1	<0.0002	<0.05	<0.1	0.30	**2.8**	<0.0005	**<0.2**	<0.0020	**1.40**	<0.001	<0.1
M/O 394319-2	near pit, west	Pu	200 & 100	500	11/8/95	0.048	<0.0024	<0.005	<0.003	0.60	<0.024	<0.0002	<0.001	<0.001	0.001	<0.04	<0.002
					8/17/95	0.053	<0.002	<0.003	<0.003	0.5	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	0.01
					6/5/95	0.0524	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	<0.002
					3/28/95	0.0546	<0.005	<0.003	<0.010	0.57	<0.050	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	<0.005

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
M/O 394319-2 (cont.)	near pit, west	Pu	200 & 100	500	11/20/94	7.70	16.6	257	199	193	37.3	3.3	41.8	21.6	13	46.1	0.22	<0.3	<0.004	**0.170**
					9/20/94*	7.82	17.5	284	195.7	193	35.2	3.29	41.6	21.6	13.7	47.2	N.A.	<0.057	<0.002	**0.2**
					9/16/94	7.99	18.8	290	190	193	36	3.5	41	22.0	13	47	0.30	<0.1	<0.0005	**0.250**
					6/5/94	7.73	20.6	293	189	177	34	3.9	38	20.0	13	47	0.24	<0.1	<0.0005	**0.170**
					3/29/94	8.04	17.6	320	189	187	33	3.5	42	20.0	16	49	0.20	<0.1	0.0006	**0.190**
M/O 394319-5	near pit, south	QTal	100	464	11/20/94	7.80	13.6	230	131	167	24.7	3.3	38.5	17.2	26.9	45.5	1.22	<0.3	<0.004	<0.04
					9/21/94*	7.91	27.8	250	123.6	178	24.7	3.69	41.2	18.2	29.1	46.8	1.12	0.061	<0.002	0.020
					9/16/94	8.00	16.6	259	127	169	24	3.3	38	18.0	27	47	1.20	<0.1	<0.0005	0.020
					6/5/94	7.91	15.6	268	125	158	25	3.6	37	16.0	29	45	1.40	<0.1	<0.0005	0.021
					3/31/94	8.08	13.6	234	126	168	21	2.8	41	16.0	31	46	1.50	<0.1	0.0005	0.021
M/O 394319-12	near pit, east	Pu	500?	850	10/24/95	7.68	18.6	275	175	231	23.0	3.32	51.7	24.8	26.3	61.8	<0.02	<0.082	<0.002	<0.04
					8/10/95	7.77	20.7	288	175	235	22.3	3.18	52	25.7	25.8	62.6	<0.02	0.200	<0.0022	<0.042
					6/5/95	7.76	16.3	277	175	240	23.4	3.57	53.2	26	28.0	60.6	<0.02	<0.082	<0.002	**0.05**
					3/14/95	7.90	17.8	260	175	237	23.5	3.35	51.8	26.1	27.0	62.0	<0.02	<0.057	<0.002	**0.05**
					12/2/94	7.60	17.6	279	172	247	24	3.7	54.7	26.8	26.5	61.6	<0.02	<0.3	<0.004	**0.05**
					9/14/94	7.79	19.3	311	169	230	22	3.4	51	25.0	25	63	<0.1	<0.1	<0.0005	0.049
					6/7/94	7.75	17.2	299	167	214	22	3.9	48	23.0	25	62	<0.1	<0.1	<0.0005	**0.061**
M/O 394321-1	east of waste dumps	OTar	100	513	11/5/95	7.91	12.8	182	108	67	35.9	5.16	22.6	2.5	13.9	15.9	0.15	0.109	<0.003	<0.04
					8/13/95	7.67	14.6	189	110	69	35.5	4.97	22.9	2.77	14.4	16.8	0.16	<0.1	<0.0022	<0.042
					6/1/95	7.67	13.3	204	108	71	37	5.52	23.8	2.74	14.6	16.3	0.18	0.082	<0.002	<0.04
					2/27/95	7.90	13.4	204	109	66	34.4	5.73	22.4	2.53	12.8	15.2	0.11	0.233	<0.002	<0.04
					11/30/94	7.70	12.4	182	108	72	38.3	5.6	24.2	2.92	13.6	16.1	0.13	<0.3	<0.004	<0.04
					9/26/94*	8.10	19.2	200	108	73	33	5.1	21	5.1	13	16	0.10	<0.1	<0.0005	0.009
					6/9/94	7.88	15.0	203	102	60	35	5.8	20	2.4	13	16	0.12	<0.1	<0.0005	0.006
					3/28/94	8.00	17.2	218	108	64	32	5.4	21	2.8	15	18	0.10	<0.1	0.0009	0.007
M/O 394329-1	east of tailings E	OTar	100	124	9/22/94*	7.37	15.8	436	133.9	237	41.1	3.88	68.3	16.1	110	38.8	N.A.	0.05	<0.002	0.003
M/O 394329-2	south of tailings E	OTar	100	105	10/12/94*	7.21	12.9	302	120	74	62.8	4.25	20.1	5.81	28	23.6	0.87	3.45	<0.002	0.025
M/O 394329-3	west of tailings E	OTar	100	64	10/12/94*	7.60	11.1	224	165	149	30.4	3.08	41.4	11.1	36.4	12.4	0.45	0.077	<0.002	0.009
M/O 394330 D-1	south of pit	Pu		805	10/19/95	7.75	17.8	196	157	158	25.3	3.17	34.4	17.6	14.9	31.8	0.50	<0.082	<0.002	**0.18**
					8/19/95	8.18	20.1	225	154	162	26.5	2.75	34.8	18.3	15.3	33.7	0.550	<0.082	<0.002	**0.21**
					5/18/95	7.94	19.1	200	153	159	25.5	3.01	34.9	17.6	14.6	30.9	0.580	<0.082	<0.002	**0.112**
					11/19/94	7.80	15.6	202	154	155	25.3	3.6	33.7	17.3	14.8	30	0.53	<0.3	<0.004	**0.190**
					9/12/94	8.00	17.3	219	148	156	24	3.3	33	18.0	15	30	0.60	<0.1	<0.0005	**0.170**
					6/4/94	7.96	18.4	230	146	146	24	3.5	32	16.0	15	30	0.53	<0.1	<0.0005	**0.140**
					3/30/94	8.05	18.7	218	150	156	21	2.9	36	16.0	17	30	0.50	<0.1	0.0005	**0.200**
M/O 394330 S-1	south of pit	OTal	100	500	11/1/95	7.89	14.2	211	135	133	27.2	3.37	31.1	13.4	14.4	21.9	0.46	<0.082	<0.002	<0.04
					8/17/95	7.91	17.1	193	134	125	26.2	2.8	29.5	12.6	14.3	22.4	0.47	<0.082	<0.002	<0.04
					6/2/95	7.73	16.2	186	137	133	25.8	2.91	32.2	12.9	13.9	21.0	0.51	<0.082	<0.002	<0.04
					3/4/95	8.00	12.2	149	135	125	25.6	2.73	29.3	12.5	14.0	22.0	0.48	<0.057	<0.002	<0.04

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
M/O 394319-2 (cont.)	near pit, west	Pu	200 & 100	500	11/20/94	0.052	<0.004	<0.004	<0.003	0.51	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/20/94*	0.0515	<0.002	<0.004	<0.002	0.54	<0.006	<0.0002	<0.002	<0.001	**0.027**	<0.001	<0.004
					9/16/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**<0.1**	<0.002	**<0.5**	<0.001	<0.1
					6/5/94	<0.1	<0.0002	<0.05	<0.1	0.55	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
					3/29/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
M/O 394319-5	near pit, south	QTal	100	464	11/20/94	0.045	<0.004	<0.004	<0.003	0.47	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/21/94*	0.0489	<0.002	<0.004	<0.002	0.48	<0.006	<0.0002	<0.002	<0.001	**<0.024**	<0.001	<0.004
					9/16/94	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	**<0.1**	<0.002	**<0.5**	<0.001	<0.1
					6/5/94	<0.1	<0.0002	<0.05	<0.1	0.47	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
					3/31/94	<0.1	<0.0002	<0.05	<0.1	0.40	0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
M/O 394319-12	near pit, east	Pu	500?	850	10/24/95	0.042	<0.002	<0.003	<0.003	0.40	0.024	<0.0002	0.023	0.001	**0.003**	<0.041	0.003
					8/10/95	0.0393	<0.0019	<0.002	<0.0017	0.4	0.0212	<0.0002	0.0234	<0.001	0.004	<0.061	0.0031
					6/5/95	0.0423	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	0.0268	**<0.04**	**<0.018**	<0.001	0.0026
					3/14/95	0.0450	<0.002	<0.004	<0.002	0.40	0.012	<0.0002	0.024	**<0.04**	**<0.024**	<0.001	<0.004
					12/2/94	0.045	<0.004	<0.004	<0.003	0.36	<0.009	<0.0002	0.026	**<0.04**	**0.027**	<0.001	<0.004
					9/14/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.002	**<0.5**	<0.001	<0.1
					6/7/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
M/O 394321-1	east of waste dumps	QTar	100	513	11/5/95	0.006	<0.0024	<0.005	<0.003	0.40	<0.0011	<0.0002	<0.001	<0.001	<0.001	<0.04	<0.002
					8/13/95	0.0046	<0.0019	<0.002	<0.0017	0.4	<0.0011	<0.0002	<0.0009	<0.001	<0.001	**<0.061**	0.0043
					6/1/95	0.0083	<0.002	<0.003	<0.003	0.40	<0.017	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	<0.002
					2/27/95	0.006	<0.002	<0.004	<0.002	0.40	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.010	<0.004
					11/30/94	0.007	<0.004	<0.004	<0.003	0.42	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					9/26/94*	<0.1	<0.0002	<0.05	<0.1	0.50	<0.1	<0.0005	**<0.1**	<0.002	**<0.5**	<0.001	<0.1
					6/9/94	<0.1	<0.0002	<0.05	<0.1	0.77	<0.1	<0.0005	**<0.1**	<0.0010	**<0.5**	<0.001	<0.1
					3/28/94	<0.1	<0.0002	<0.05	<0.1	0.30	<0.1	<0.0005	**<0.1**	<0.0010	**<0.5**	<0.001	<0.1
M/O 394329-1	east of tailings E	QTar	100	124	9/22/94*	0.0727	<0.002	<0.004	<0.002	0.29	<0.006	<0.0002	**0.906**	<0.001	**<0.024**	<0.001	0.0109
M/O 394329-2	south of tailings E	QTar	100	105	10/12/94*	0.0065	<0.002	<0.004	0.0048	0.579	0.0793	<0.0002	0.0033	0.002	**<0.024**	<0.01	<0.004
M/O 394329-3	west of tailings E	QTar	100	64	10/12/94*	0.0806	<0.002	<0.004	0.007	0.394	0.165	<0.0002	**1.79**	0.001	**<0.024**	<0.001	0.0414
M/O 394330 D-1	south of pit	Pu		805	10/19/95	0.068	<0.002	<0.003	<0.003	0.60	0.166	<0.0002	0.017	0.002	**0.003**	<0.041	<0.002
					8/19/95	0.0720	<0.002	<0.003	<0.003	0.6	0.172	<0.0002	0.018	<0.001	**0.008**	<0.041	<0.002
					5/18/95	0.0700	<0.0020	<0.003	0.0075	0.60	0.163	<0.0002	0.0266	**<0.04**	**<0.018**	<0.001	<0.002
					11/19/94	0.067	<0.004	<0.004	<0.003	0.62	0.098	<0.0002	0.019	**<0.04**	**<0.02**	<0.001	<0.004
					9/12/94	<0.1	<0.0002	<0.05	<0.1	0.70	0.1	0.0008	**<0.1**	<0.0020	**<0.5**	<0.001	<0.1
					6/4/94	<0.1	<0.0002	<0.05	<0.1	0.63	0.2	<0.0005	**<0.1**	<0.0010	**<0.5**	<0.001	<0.1
					3/30/94	<0.1	<0.0002	<0.05	<0.1	0.50	0.2	<0.0005	**<0.1**	<0.0010	**<0.5**	<0.001	<0.1
M/O 394330 S-1	south of pit	QTal	100	500	11/1/95	0.087	<0.002	0.003	<0.003	0.50	<0.017	<0.0002	<0.001	<0.001	**0.006**	<0.041	<0.002
					8/17/95	0.081	<0.002	<0.003	<0.003	0.5	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					6/2/95	0.084	<0.002	0.004	<0.003	0.50	<0.017	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	0.067
					3/4/95	0.080	<0.002	<0.004	<0.002	0.50	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.001	<0.004

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	pH (lab)	Temp. (°C)	TDS (mg/l)	Alkalinity (mg/l $CaCO_3$)	Hardness (mg/l $CaCO_3$)	Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	P (mg/l)	Ag (mg/l)	As (mg/l)
Nevada Drinking Water Primary MCL																	10			0.05
Nevada Federal Drinking Water Secondary MCL (recommended)						6.5 - 8.5		500						125	250	250			0.1	
Nevada Drinking Water Secondary MCL (enforceable)								1000						150	400	500				
M/O 394330 S-1	south of pit	QTal	100	500	11/21/94	7.90	13.9	182	135	125	26	3.2	29.6	12.4	13.7	21.6	0.46	<0.3	<0.004	<0.04
(cont.)					9/18/94*	8.00	17.4	201	130	126	25	2.8	29	13.0	14	21	0.60	<0.1	<0.0005	0.023
					6/6/94	7.95	14.9	217	129	119	25	3.2	28	12.0	14	22	0.47	<0.1	<0.0005	0.016
					3/26/94	8.03	13.6	192	134	138	23	2.8	34	13.0	16	20	0.50	<0.1	0.0006	0.015
M/O 394331-1	E of Leach Pad G	QTal	100	130	9/22/94*	8.00	14.9	175	115.6	112	23.3	2.72	25.4	11.9	16.3	17.6	N.A.	0.03	<0.002	**0.059**
M/O 394331-2	S of Leach Pad G	QTal	100	124	10/12/94*	7.96	13.1	164	120	112	24.2	3.17	26.4	11.2	18.2	16.1	0.62	<0.02	<0.002	**0.051**
M/O 404215-1	NW of Dry Hills	Qae	100	402	10/20/95	8.25	16.5	255	130	82	54.5	7.72	23.4	5.7	22.2	30.4	<0.02	2.650	<0.002	<0.04
					8/2/95	**8.53**	18.6	233	131	76	51.5	7.49	21.8	5.33	22.3	32.7	0.96	2.83	<0.002	<0.04
					5/9/95	**8.53**	17.1	268	132	76	51.5	7.51	21.9	5.16	23.0	31.0	1.04	3.53	<0.002	<0.040
					3/1/95	**8.50**	15.0	267	135	82	60.8	8.54	23.5	5.74	22.0	31.7	0.93	4.54	<0.002	<0.04
					12/20/94	**8.60**	11.3	283	137	78	66.4	7.7	22.2	5.46	22.5	33.3	0.87	6.75	<0.002	<0.04
					10/20/94	8.41	15.9	315	137	61	62	6.4	17	4.6	21	34	0.90	1.6	<0.0005	0.021
M/O 404215-2	NW of Dry Hills	Qae	100	271.5?	10/20/95	7.81	16.1	235	123	80	48.1	7.11	22.4	5.9	23.2	30.0	0.89	0.259	<0.002	<0.04
					8/2/95	8.03	17.8	199	122	78	46.3	6.91	21.5	5.82	23.6	32.7	0.92	0.315	<0.002	<0.04
					5/9/95	8.03	15.1	244	122	78	45.4	7.35	21.8	5.73	24.3	30.0	1.06	0.444	<0.002	<0.040
					3/1/95	7.90	14.0	251	123	83	50.5	7.84	22.9	6.30	23.0	30.0	0.96	0.62	<0.002	<0.04
					12/9/94	8.00	12.9	247	123	85	49.3	7.5	23.5	6.49	24.2	30.2	0.95	0.96	0.003	<0.04
					10/20/94	7.89	14.7	273	121	73	42	6.4	20	5.5	22	30	0.80	1.6	<0.0005	0.016

TABLE A-2
Ground Water Quality Monitoring Data

Well Number	Location	Formation	Zone	Total depth (feet)	Date sampled	Ba (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	F (mg/l)	Fe (mg/l)	Hg (mg/l)	Mn (mg/l)	Pb (mg/l)	Sb (mg/l)	Se (mg/l)	Zn (mg/l)
Nevada Drinking Water Primary MCL						2	0.005	0.1	1.3	4		0.002		0.015	0.006	0.05	
Nevada Federal Drinking Water Secondary MCL (recommended)									1	2	0.3		0.05				5
Nevada Drinking Water Secondary MCL (enforceable)											0.6		0.1				
M/O 394330 S-1	south of pit	QTal	100	500	11/21/94	0.084	<0.004	<0.004	<0.003	0.53	<0.009	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
(cont.)					9/18/94*	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	<0.0005	**<0.1**	<0.0020	**<0.5**	<0.001	<0.1
					6/6/94	<0.1	<0.0002	<0.05	<0.1	0.53	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
					3/26/94	<0.1	<0.0002	<0.05	<0.1	0.40	<0.1	<0.0005	**<0.1**	<0.001	**<0.5**	<0.001	<0.1
M/O 394331-1	E of Leach Pad G	QTal	100	130	9/22/94*	0.0688	<0.002	<0.004	<0.002	0.48	<0.006	<0.0002	<0.002	<0.001	**<0.024**	<0.001	<0.004
M/O 394331-2	S of Leach Pad G	QTal	100	124	10/12/94*	0.0799	<0.002	0.0045	0.0053	0.591	<0.006	<0.0002	<0.002	<0.001	**<0.024**	<0.001	<0.004
M/O 404215-1	NW of Dry Hills	Qae	100	402	10/20/95	0.014	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	0.001	<0.001	<0.041	<0.002
					8/2/95	0.011	<0.002	<0.003	<0.003	0.6	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					5/9/95	0.0119	<0.002	<0.003	<0.003	0.66	<0.017	<0.0002	<0.001	**<0.04**	**<0.018**	<0.001	0.0029
					3/1/95	0.010	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.010	<0.004
					12/20/94	0.01	<0.002	<0.004	<0.002	0.70	0.026	<0.0002	<0.002	**<0.04**	**<0.02**	<0.001	<0.004
					10/20/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	0.0009	**<0.1**	<0.002	**<0.1**	<0.001	<0.1
M/O 404215-2	NW of Dry Hills	Qae	100	271.5?	10/20/95	0.034	<0.002	<0.003	<0.003	0.60	<0.017	<0.0002	<0.001	0.001	<0.001	<0.041	<0.002
					8/2/95	0.031	<0.002	<0.003	<0.003	0.7	<0.017	<0.0002	<0.001	<0.001	<0.001	<0.041	<0.002
					5/9/95	0.033	<0.002	0.0034	<0.003	0.61	<0.017	<0.0002	0.001	**<0.04**	**<0.018**	<0.001	0.0022
					3/1/95	0.035	<0.002	<0.004	<0.002	0.60	<0.006	<0.0002	<0.002	**<0.04**	**<0.024**	<0.010	<0.004
					12/9/94	0.04	0.004	<0.004	<0.002	0.60	0.03	<0.0002	<0.002	**<0.04**	**<0.02**	<0.01	0.008
					10/20/94	<0.1	<0.0002	<0.05	<0.1	0.60	<0.1	0.0007	**<0.1**	<0.002	**<0.1**	<0.001	<0.1

Values in bold exceed applicable maximum contaminant levels
N.A. = not analyzed
* = PTI sampled
Source: WESTEC 1995a, 1995c and PTI 1996

TBA-2.XLS

TABLE A-3
Treated Mine Water Discharge to Rabbit Creek

Determination	Rabbit Creek NPDES Discharge Limits: 30-Day Average	Rabbit Creek NPDES Discharge Limits: Daily Maximum	Sampled Discharge Range
pH	6.5 to 9.0		7.5 to 8.26
TDS	500		267 to 1,040*
TSS	20 mg/l		<0.1 to 155*
Turbidity	20 NTU	50 NTU	0.01 to 54.8*
Cyanide-WAD		0.005 mg/l	<0.005
Phosphorus-Total		0.1 mg/l	<0.01 to 0.02
Arsenic		0.05 mg/l	0.007 to 0.110
Copper	0.15 mg/l	0.3 mg/l	<0.0017 to 0.010
Fe - Soluble	0.3 mg/l	1.5 mg/l	<0.008 to 0.331*
Lead		0.05 mg/l	<0.001 to 0.005
Zinc	75 mg/l	1.5 mg/l	<0.0019 to 0.0353
Total Petroleum HC-IR		1.0 mg/l	<1.0

* indicates value above permit limits

TABLE A-4
Water Quality Data for Water Discharged to the Reinfiltration Basins

Constituent	Units	Nevada Drinking Water Standards MCL		12/19/95	03/07/96	Other Samples Range[4]
		Primary	Secondary			
Physical Properties						
Dissolved Oxygen	mg/las O_2			20.8		
Color	color units		15[1]	<0.005		
Alkalinity	mg/l as $CaCO_3$			0.6		
TDS	mg/l@180°C		500[1]; 1000[2]	277	238	
TSS	mg/l			0.04		
Turbidity	NTU	0.5		7.61		
Inorganic Nonmetals						
Chloride	mg/l as Cl		250[1]; 400[2]	20.8	18.6	
Cyanide	mg/l as HCN	0.2		<0.005	<0.005	
Fluoride	mg/l as F	1.0	2.0[3]	0.6	0.8	
Nitrate	mg/l as N	10				
Nitrite	mg/l as N	1.0		0.14	0.08	
pH	standard units		(6.5-8.5)[1]	7.61		
Sulfate	mg/l as SO_4		250[1]; 500[2]	20.8	59.8	
Metals/Elements						
Aluminum	mg/l as Al		(0.05-0.2)[3]	0.03	<0.024	
Antimony	mg/l as Sb	0.005		0.039		
Arsenic (total)	mg/l as As	0.05		0.006	0.018	0.004 - 0.046
Barium	mg/l as Ba	2.0		0.052	0.055	
Beryllium	mg/l as Be	0.004		<0.001	<0.024	
Boron	mg/l as Be			0.128	0.143	
Cadmium	mg/l as Cd	0.005		<0.0024	<0.0024	
Chromium (total)	mg/l as Cr	0.1		<0.005	<0.005	
Copper	mg/l as Cu	1.0		0.010	<0.003	
Iron	mg/l as Pb		0.3[1]	0.477	<0.024	
Lead	mg/l as Pb	0.0[illegible]5		0.001	0.002	
Magnesium	mg/l as Mg		125[1]; 150[2]	18.2	17.6	
Manganese	mg/l as Mn		0.05[1]; 0.1[2]	0.0[illegible]6	0.027	
Mercury	mg/l as Hg	0.002		<0.0002	<0.0002	
Nickel	mg/l as Ni	0.1		<0.017	<0.017	
Selenium	mg/l as Se	0.05		0.001	<0.001	
Silver	mg/l as Ag		0.1[3]	<0.003	<0.003	
Thallium	mg/l as Tl	0.002		<0.001	<0.001	
Zinc	mg/l as Zn		5.0[3]	0.012	<0.002	

[1] Nevada Secondary recommended maximum contaminant level
[2] Nevada Secondary (Enforceable) maximum contaminant level
[3] Federal Secondary maximum contaminant level
[4] Various samples collected between 11/01/95 and 03/12/96
Source: SFPG

TABLE A-5
Summary of Meteoric Water Mobility Procedure Test Data for Mine Rock

	Constituent		pH	TDS (mg/L)	Al	Sb	As	Be	Cd	F	Fe	Mn	Hg	Ni	Se	SO₄	Tl	Zn
South Pit	Drinking Water Standard		6.5-8.5	6.5-8.5	6.5-8.7	6.5-8.5	6.5-8.9	6.5-8.10	6.5-8.11	6.5-8.16	6.5-8.16	6.5-8.16	6.5-8.16	6.5-8.16	6.5-8.17	6.5-8.16	6.5-8.16	5.0 [4]
	Basalt	min	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	0.004
	30 Samples	max	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	8.39	0.865
		mean	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	0.062
	Exceeding D.W.[1]	n	0	2	0	0	2	2	0	0	2	2	2	0	0	2	2	0
		%	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	0
	Shale	min	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0.004
	27 Samples	max	8.55	8.05	8.55	8.55	8.05	8.55	8.55	8.55	8.05	8.05	8.05	8.55	8.55	8.55	8.05	0.502
		mean	7.9	7.8	7.9	7.8	7.8	7.9	7.9	7.9	7.8	7.8	7.8	7.9	7.9	7.9	7.8	0.004
	Exceeding D.W.[1]	n	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	0
		%	0	0	0	0	2	0	0	0	2	2	0	0	0	0	7	0
	Qal	min	7.1	7.1	7.1	8.1	7.1	8.1	8.1	7.1	7.1	8.1	7.1	7.1	7.1	7.1	8.1	0.004
	66 Samples	max	8.55	8.05	8.55	8.05	8.05	8.05	8.55	8.55	8.55	8.05	8.05	8.55	8.55	8.55	8.05	0.006
		mean	7.9	7.8	7.9	7.8	7.8	7.8	7.9	7.9	7.9	7.8	7.8	7.9	7.9	7.9	7.8	0.0068
	Exceeding D.W.[1]	n	0	2	0	0	2	0	0	0	0	0	2	0	0	0	0	0
		%	0	2	0	0	2	2	0	0	0	0	2	0	0	0	0	0
	Lherz	min	8.1	8.1	7.1	7.1	8.1	8.1	8.1	7.1	8.1	8.1	8.1	8.1	7.1	8.1	8.1	0.004
	2 Samples	max	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	0.004
		mean	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	0.004
	Exceeding D.W.[1]	n	0	2	0	0	2	0	0	0	0	0	0	0	0	2	0	0
		%	0	2	0	0	2	0	0	0	0	0	2	0	0	0	0	0
	Constituent		**pH**	**TDS (mg/L)**	**Al**	**Sb**	**As**	**Be**	**Cd**	**F**	**Fe**	**Mn**	**Hg**	**Ni**	**Se**	**SO₄**	**Tl**	**Zn**
Vista Pit	Drinking Water Standard		6.5-8.5	1000	0.05	0.006	0.05	0.004	0.006	7.1	0.03 [2]	150 [3]	0.002	0.04	0.05	500 [3]	0.002	5.0 [4]
	Basalt	min	3.4	55	0.04	0.02	0.04	0.004	0.002	7.1	0.006	0.002	0.0001	0.04	0.001	1	0.04	0.004
	45 Samples	max	8.94	4920	37.3	0.31	1.55	0.035	0.006	1.8	435	74.8	0.192	8.75	0.466	3280	0.06	5.49
		mean	7.9	258	0.92	0.035	0.23	0.0013	0.0031	0.55	14	1.8	0.004	0.23	0.028	104	0.043	0.014
	Exceeding D.W.[1]	n	0	1	2	7	25	1	1	0	1	2	14	1	0	1	2	1
		%	0	0	2	46	56	2	2	0	2	2	31	2	7	2	13	2
	Shale	min	7.5	112	0.03	0.02	0.05	0.004	0.004	0.5	0.004	0.002	0.006	0.02	0.001	8.2	0.04	0.004
	2 Samples	max	7.9	1360	0.04	0.04	0.14	0.004	0.004	1.7	0.004	0.002	0.0147	0.02	0.004	333	0.04	0.004
		mean	1.7	736	0.04	0.006	0.095	0.004	0.004	0.1	0.004	0.002	0.004	0.02	0.0025	171	0.04	0.004
	Exceeding D.W.[1]	n	0	1	0	0	1	0	0	0	0	0	2	0	0	0	0	0
		%	0	56	0	0	56	2	0	0	0	2	100	0	0	0	0	0
	Sandstone	min	7.7	57	0.03	0.02	0.04	0.004	0.004	7.1	0.004	0.002	0.0002	0.02	0.001	2.5	0.04	0.004
	5 Samples	max	9.53	167	0.06	0.04	0.24	0.001	0.006	0.6	0.004	0.043	0.0176	0.02	0.008	10.3	0.04	0.004
		mean	8.2	105	0.043	0.006	0.002	0.004	0.0048	0.26	0.004	0.0023	0.0048	0.02	0.0024	3.5	0.05	0.004
	Exceeding D.W.[1]	n	1	0	0	1	2	0	1	0	0	0	1	0	0	0	0	0
		%	20	0	0	20	40	0	20	0	0	0	20	0	0	0	0	0
	Limestone	min	7.7	56	0.03	0.02	0.04	0.004	0.004	0.1	0.004	0.002	0.0002	0.02	0.001	2.3	0.04	0.004
	14 Samples	max	8.2	132	0.04	0.04	0.05	0.004	0.004	0.3	0.012	0.002	0.0001	0.23	0.001	23.2	0.06	0.004
		mean	7.9	56	0.004	0.006	0.095	0.004	0.004	0.16	0.0092	0.0001	0.00021	0.001	0.004	2	0.004	0.004
	Exceeding D.W.[1]	n	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
		%	0	0	0	0	14	0	2	0	0	0	0	0	0	0	0	0
	Gouge	min	5	89	0.04	0.02	0.04	0.004	0.004	0.1	0.022	0.002	0.0002	0.02	0.001	0.75	0.04	0.004
	2 Samples	max	8.1	297	1.32	0.02	0.04	0.004	0.004	0.5	0.206	0.006	0.0013	0.02	0.001	50.3	0.04	0.017
		mean	8.55	193	0.66	0.02	0.04	0.004	0.004	0.05	0.14	0.0035	0.00075	0.02	0.001	26	0.04	0.011
	Exceeding D.W.[1]	n	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0
		%	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0

[1]Number (n) and percent (%) of total samples with concentrations that exceed drinking water standards.
[2]Nevada Secondary recommended Maximum Contaminant Levels (MCL).
[3]Nevada Secondary enforceable MCL.
[4]Federal Secondary MCL.

APPENDIX B

Wildlife Species Lists

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada

Common Name	Scientific Name
Birds	
Turkey vulture	Cathartes aura
Bald eagle	Haliaetus leucocephalus
Northern harrier	Circus cyaneus
Swainson's hawk	Buteo swainsoni
Red-tailed hawk	Buteo jamaicensis
Ferruginous hawk	Buteo regalis
Rough-legged hawk	Buteo lagopus
Golden eagle	Aquila chrysaetos
American kestrel	Falco sparverius
Merlin	Falco columbarius
Prairie falcon	Falco mexicanus
Gray partridge	Perdix perdix
Chukar	Alectoris chukar
Sage grouse	Centrocercus urophasianus
Mourning dove	Zenaida macroura
Great horned owl	Bubo virginianus
Burrowing owl	Athene cunicularia
Short-eared owl	Asio flammeus
Common nighthawk	Chordeiles minor
Broad-tailed hummingbird	Selasphorus platycercus
Northern flicker	Colaptes auratus
Gray flycatcher	Epidonax wrightii
Ash-throated flycatcher	Myiarchus cinerascens
Say's phoebe	Sayornis saya
Western kingbird	Tyrannus verticalis
Horned lark	Eremophila alpestris
Barn swallow	Hirundo rustica
Black-billed magpie	Pica pica
American crow	Corvus brachyrhynchos
Common raven	Corvus corax
Rock wren	Salpinctes obsoletus
Mountain bluebird	Sialia currucoides
American robin	Turdus migratorius
Sage thrasher	Oreoscoptes montanus
Loggerhead shrike	Lanius ludovicianus
Northern shrike	Lanius excubitor
European starling	Sturnus vulgaris
Brewer's sparrow	Pooecetes gramineus
Vesper sparrow	Chondestes grammacus
Lark sparrow	Amphispiza belli
White-crowned sparrow	Zonotrichia leucophrys
Lapland longspur	Calcarius lapponicus
Red-winged blackbird	Agelaius phoeniceus
Western meadowlark	Sturnella neglecta

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada
(continued)

Common Name	Scientific Name
Birds (continued)	
Brewer's blackbird	Euphagus cyanocephalus
Brown-headed cowbird	Molothrus ater
Black rosy finch	Leucosticte arctoa
Gray-crowned rosy finch	Leucosticte arctoa
House sparrow	Passer domesticus
Mammals	
Little brown bat	Myotis lucifugus
Long-eared myotis	Myotis evotis
Long-legged myotis	Myotis volans
Small-footed myotis	Myotis ciliolabrum
Silver-haired bat	Lasionycteris noctivagans
Western pipistrelle	Pipistrellus hesperus
Big brown bat	Eptesicus fuscus
Townsend's big-eared bat	Plecotus townsendii
Brazilian free-tailed bat	Tadarida brasiliensis
Black-tailed jackrabbit	Lepus californicus
Mountain cottontail	Sylvilagus nuttallii
Pygmy rabbit	Sylvilagus idahoensis
Townsend's ground squirrel	Spermophilus townsendii
Belding ground squirrel	Spermophilus beldingi
Least chipmunk	Tamias minimus
Botta's pocket gopher	Thomomys bottae
Northern pocket gopher	Thomomys talpoides
Little pocket mouse	Perognathus longimembris
Great basin pocket mouse	Perognathus parvus
Dark kangaroo mouse	Microdipodops megacephalus
Ord kangaroo rat	Dipodomys ordii
Chisel-toothed kangaroo rat	Dipodomys microps
Deer mouse	Peromyscus maniculatus
Northern grasshopper mouse	Onychomys leucogaster
Desert woodrat	Neotoma lepida
Sagebrush vole	Lemmiscus curtatus
House mouse	Mus musculus
Kit fox	Vulpes macrotis
Coyote	Canis latrans
Long-tailed weasel	Mustela frenata
Badger	Taxidea taxus
Striped skunk	Mephitis mephitis
Mountain lion	Felix concolor
Bobcat	Lynx rufus
Mule deer	Odocoileus hemionus
Pronghorn	Antilocapra americana

TABLE B-1
Wildlife Species List
Lower Sagebrush/Grassland Steppe
Northeastern Nevada
(continued)

Common Name	Scientific Name
Reptiles	
Western skink	Eumeces skiltonianus
Western whiptail	Cnemidophorus tigrus
Desert collared lizard	Crotaphytus insularis
Long-nosed leopard lizard	Gambelia wislizenii
Desert spiny lizard	Sceloporus magister
Sagebrush lizard	Sceloporus graciosus
Western fence lizard	Sceloporus occidentalis
Side-blotched lizard	Uta stansburiana
Desert horned lizard	Phrynosoma platyrhinos
Short-horned lizard	Phrynosoma douglassii
Long-nosed snake	Rhinocheilus lecontei
Ground snake	Sonora semiannulata
Night snake	Hypsiglena torquata
Gopher snake	Pituophis melanoleucus
Racer	Coluber constrictor
Striped whipsnake	Masticophis taeniatus
Western rattlesnake	Crotalus viridis

Source: Gray 1995.

TABLE B-2
Species Occurrence
Humboldt River Study Database

Species	Number of Occurrences
Birds	
American bittern	
American coot	3
American crow	2
American kestrel	
American robin	2
Barn swallow	1
Bewick's wren	2
Black-billed magpie	4
Black-crowned night heron	4
Black-headed grosbeak	1
Black-necked stilt	1
Blue-winged teal	1
Brewer's blackbird	7
Brown-headed cowbird	1
Bushtit	1
Cinnamon teal	3
Cliff swallow	2
Common nighthawk	
Common raven	1
Common snipe	1
Common yellowthroat	5
Gadwall	2
Great blue heron	2
Great egret	
Green-winged teal	1
Horned lark	1
Killdeer	5
Lark sparrow	2
Lazuli bunting	2
Lesser scaup	1
Loggerhead shrike	1
Mallard	4
Marsh wren	1
Mourning dove	4
Northern mockingbird	
Northern oriole	1
Northern pintail	1
Northern rough-winged swallow	1
Prairie falcon	
Red-tailed hawk	
Redwinged blackbird	10
Sage thrasher	1
Savannah sparrow	3
Song sparrow	7
Sora	1

TABLE B-2
Species Occurrence
Humboldt River Study Database
(continued)

Species	Number of Occurrences
Birds (continued)	
Snowy egret	
Spotted sandpiper	4
Swainson's hawk	
Western kingbird	3
Western meadowlark	6
Willet	1
Yellow warbler	1
Yellow-breasted chat	1
Yellow-headed blackbird	1
Mammals	
Mule deer	
Coyote	
Cottontail rabbit	
Black-tailed jackrabbit	
Porcupine	
Bobcat	
Pygmy rabbit	
Muskrat	
Deer mouse	
House mouse	
Ord's kangaroo rat	
Northern grasshopper mouse	
Little pocket mouse	
Reptiles	
Great basin whiptail	
Desert spiny lizard	

Source: Gebhart 1996.

APPENDIX C

Ecological Risk Assessment

Appendix C
Ecological Risk Assessment

An ecological risk assessment was conducted to identify chemicals in the Twin Creeks Mine pit lake that would pose a potential hazard to wildlife that may consume the pit water, associated vegetation, and invertebrates from the lake. The risk assessment includes an evaluation of the potential risks to wildlife from exposure to these chemicals. The risk assessment was conducted in two stages: a screening-level risk assessment, followed by a baseline risk assessment.

C.1 Screening-Level Risk Assessment

In the screening-level risk assessment, conservative assumptions were made regarding the potential exposure of receptor species to chemical concentrations in the pit lake. As the name implies, the screening-level risk assessment provided a screening to identify chemicals of potential concern that would require further investigation. Chemicals identified as not posing risks were excused from further consideration.

Two alternative pit lake scenarios were analyzed (the No Action alternative and the Proposed Action), and an ecological risk assessment was conducted for each alternative. The estimated time required for the South Pit to fill to hydrologic equilibrium is approximately 127 years for the No Action alternative and 230 years for the Proposed Action. To identify potential ecological risks during the filling period and at equilibrium, three ecological risk assessment scenarios were developed for each alternative: 5 years after the cessation of mining, 27 years after the cessation of mining, and equilibrium.

The ecological risk assessment was conducted in three phases: (1) problem formulation, (2) exposure and effects characterization, and (3) ecological risk characterization. Each of these phases provided information for the subsequent phase.

C.1.1 Problem Formulation

Problem formulation included the following tasks:

- Site characterization
- Identification of chemicals of potential concern
- Identification of receptor species
- Development of exposure scenarios

This information was used to characterize exposure and effects in the second phase of the ecological risk assessment process.

C.1.1.1 Site Characterization

Site characterization included a description of the physical environment of the lake, such as surface area, filling rate, water depth, wall slope, distance to the rim, and wave action. This information was derived from geological, hydrological, and climatological data.

Characterization of the site included determining site access and potential food availability. At the 127/230-year time period, for example, the lake filling rate would probably slow to a point where shallow zones would exist for extended periods, and littoral vegetation would develop, provided the substrate were appropriate and nutrients were available. Pit lake characteristics for the alternative pit lakes are presented in ***Table C-1***.

For each of the two alternatives, the lake filling rate and the pit wall configuration were used to estimate the type of habitat that would be available at each time interval. The effects of wave action on pit walls were also considered relative to littoral and riparian habitat availability. The predicted habitat conditions for the pit lakes are presented in ***Table C-2***.

During the early stages of filling, the rapid rate at which the water level would increase is predicted to preclude the formation of either littoral or riparian habitat. Steep 20- to 40-foot uneroded bench walls would be expected to dominate shorelines during the early stages of lake development.

At 5 years, both alternative lake configurations would consist of two lakes (north and south). At 27 years, a single lake would have formed under the No Action alternative, while two lakes would still be present under the Proposed Action. At equilibrium, or hydrologic steady state, a single lake would have formed in both pits.

C.1.1.2 Chemicals of Potential Concern

Chemicals of potential concern were identified from analysis of ground water and geological material sampled at the existing South Pit (PTI 1996a). No

TABLE C-1
Predicted Pit Lake Characteristics

Parameter	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Number of Lakes	2	1	1
Fill Rate (minimum)	27 feet/year	4.5 feet/year	0.12 foot/year
Depth of Water	362 feet	580 feet	680 feet
Vertical Distance from Pit Rim to Lake Surface	500 feet	280 feet	180 feet
Littoral Substrate	None	None	None
Trophic State	Possibly Eutrophic	Oligotrophic	Oligotrophic
Proposed Action (Equilibrium ≈ 230 years)			
Number of Lakes	2	2	1
Fill Rate (minimum)	24 feet/year	8 feet/year	0.04 foot/year
Depth of Water	200 feet	514 feet	780 feet
Vertical Distance from Pit Rim to Lake Surface	860 feet	530 feet	280 feet
Littoral Substrate	None	None	None
Trophic State	Possibly Eutrophic	Oligotrophic	Oligotrophic

Source: Parametrix 1996.

TABLE C-2
Predicted Pit Lake Habitat Conditions

Parameter	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Littoral Habitat	None	None	Some Present
Riparian Habitat	None	None	Some Present
Upland Habitat	Present	Present	Present
Proposed Action (Equilibrium ≈ 230 years)			
Littoral Habitat	None	None	Some Present
Riparian Habitat	None	None	Some Present
Upland Habitat	Present	Present	Present

Source: Parametrix 1996.

persistent organic chemicals are expected to be present at closure. The following inorganic chemicals were identified as chemicals of potential concern:

- Aluminum
- Antimony
- Arsenic
- Cadmium
- Chromium
- Copper
- Fluoride
- Lead
- Manganese
- Mercury
- Nickel
- Selenium
- Silver
- Thallium
- Zinc

Other chemicals (e.g., iron and calcium), although present, were not included as chemicals of potential concern since geochemical studies determined that they would be present at very low concentrations, relative to toxicity levels and background concentrations and/or they are considered essential nutrients for plants and animals (Parametrix 1996).

C.1.1.3 Receptor Species

Parametrix (1996) selected receptor species for the ecological risk assessment to represent certain functional groups, taxonomic levels, trophic levels, habitats, and body sizes. Threatened or endangered species were also considered. Six species, four birds and two mammals, were chosen as receptor species for this ecological risk assessment. These species are presented in ***Table C-3***.

TABLE C-3
Receptor Species

Mammals		Birds	
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
Little Brown Myotis	Myotis lucifugus	Mallard Duck	Anas platyrhunchos
Mule Deer	Odocoileus hemionus	Spotted Sandpiper	Acitis macularia
		Cliff Swallow	Petrochelidon pyrrhonota
		Bald Eagle	Haliaeetus leucocephalus

The mallard was selected to represent waterfowl that may breed, winter, or stop over at the pit lake during migration. The mallard may drink from the pit lake and forage on both aquatic plants and invertebrates. The spotted sandpiper represents shorebirds that may drink from the pit lake and feed on aquatic invertebrates found along the lake shoreline. The cliff swallow was selected to represent passerine birds, especially swallows and other aerial feeders, that may drink from the pit lake and forage on emergent aquatic insects. The bald eagle was considered as the receptor species for raptors because it is a federally threatened species that occurs in northern Nevada; migrating bald eagles move through the state and may occupy winter habitats in Nevada. Eagles may drink from the pit lake and forage on fish and waterfowl at the pit lake. The little brown myotis (bat) was selected to represent small, insect-eating mammals, especially the bat group, which may drink from the pit lake, forage on emergent aquatic insects, and breed and roost on the rocky walls of the pit. The mule deer was selected as the receptor species for large mammals; mule deer are relatively common in the pit lake vicinity and may be at risk if they were to drink water from the pit lake. The mule deer is a food source for carnivores, scavengers, and humans. These species were chosen following a review of data on the wildlife resources in the project area and consultation with the applicable resource agencies.

Parametrix (1996) determined that two of the potential receptor species, the bald eagle and the mule deer, would be either subject to negligible risk, or the exposure pathways would be incomplete. Therefore, these two organisms were eliminated from further examination. A brief discussion of the rationale for removing these animals from consideration is discussed below.

The primary route of exposure for bald eagles would be through food consumption. However, Parametrix (1996) assumed that the bald eagle would not likely be exposed to chemicals of potential concern via a food pathway for the following reasons:

- Bald eagles do not currently nest in Nevada and, therefore, would not be present most of the year.

- Bald eagles generally concentrate their fishing efforts in shallow areas of water bodies; under the No Action alternative and Proposed Action, SFPG would minimize such areas in the future pit lake.

- Wintering bald eagles that occur in Nevada primarily occupy portions of western Nevada and the Ruby Lake area.

- Wintering bald eagles typically feed on waterfowl and mammals, which were assumed not to be prevalent at the pit lake.

- Fish populations are unlikely to develop in the pit lake to a degree that would support bald eagles due to the (1) oligotrophic (limited food) nature of the lake, (2) lack of shallow littoral regions that would act as spawning habitat, (3) lack of suitable substrate for spawning, and (4) lack of cover for fry (i.e., little, if any, vegetation and few protected embayments).

- Favorable roosting trees for bald eagles (tall trees) would not occur within several miles of the pit lake. Bald eagles, particularly juveniles, tend to wander in the winter to various foraging areas. Adult bald eagles generally prefer feeding areas with high concentrations of prey, and often those areas are along marshes and rivers.

Mule deer are unlikely to have access to lake waters. During the summer, for example, mule deer are expected to move to higher areas in the Osgood and Snowstorm mountain ranges. Mule deer in the vicinity of the pit lake would most likely limit water ingestion to more easily accessible streams (e.g., Kelly Creek) and stock ponds. The sheer walls of the pit lake (an estimated 100 feet from the rim to the water's surface at equilibrium) and SFPG's proposed measures to limit access (e.g., blasting pit access roads) would also restrict mule deer from reaching the water.

Based on these biological assumptions, Parametrix (1996) eliminated both the bald eagle and mule deer from further ecological risk assessment.

C.1.1.4 Exposure Scenarios

It is necessary to identify the pathways through which a chemical of concern could come into contact with a receptor species. To be included in a potential exposure pathway, the chemical must be bioavailable, and there must be an identifiable route from source to receptor (i.e., complete pathway). The exposure pathways used in the ecological risk assessment are summarized in ***Table C-4***. To minimize the formation of habitats that could increase the availability of food for receptor species and to limit access to the water source, SFPG proposes the following risk management actions:

- Shallow areas and protected embayments (coves) would be engineered out of the final design.

- Pit access roads would be removed.

Because of the lack of access roads and the steep, unstable pit walls, access to the pit lake water would be difficult.

It is predicted that the pit lake would be slightly eutrophic at 5 years and oligotrophic for the remainder of the filling period. The term eutrophic (literally, "well-fed") indicates that the lake would be sufficiently high in nutrients (primarily nitrogen and phosphorus) to promote primary production (algae and macrophytes). Because of the rapid filling of the lake during early lake development, however, production should be almost exclusively algal, not macrophytic. Macrophyte growth would be further discouraged by the lack of protected embayments (which would protect plants from harsh wave action), steep slopes, and the probable absence of fine substrates needed for root attachment. At 27 years and beyond, the lake would be oligotrophic (literally, "few-fed"), and less productive.

Based on previous studies in Nevada pit lakes (PTI and RCI 1996), phytoplankton, zooplankton, and macroinvertebrate populations would be expected to develop in the No Action alternative and Proposed Action pit lakes. During the initial development of the pit lake at 5 years, macroinvertebrate production would likely be limited to low numbers of chironomid midges and oligochaete worms because of the lack

TABLE C-4
Exposure Pathways

Species	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Mallard	Food, Water	Water	Water
Spotted Sandpiper	None	Food/Water	Food/Water
Cliff Swallow	Food, Water	Food/Water	Food/Water
Little Brown Myotis	Food, Water	Food/Water	Food/Water
Proposed Action (Equilibrium ≈ 230 years)			
Mallard	Food, Water	Water	Water
Spotted Sandpiper	None	Food/Water	Food/Water
Cliff Swallow	Food, Water	Food/Water	Food/Water
Little Brown Myotis	Food, Water	Food/Water	Food/Water

Source: Parametrix 1996

of a littoral zone and very limited food supply in the form of organic matter. Other invertebrate groups would be expected to colonize the pit lake at 27 years and at equilibrium, as littoral areas develop. However, macroinvertebrate densities would likely be relatively low, since macrophyte growth would be limited. Phytoplankton and zooplankton (cladocerans, copepods, and rotifers) populations would gradually increase throughout the development of the lake. Many aquatic insects exist as juveniles underwater, emerging as winged adults to breed (e.g., chironomids). The very low numbers of aquatic juveniles, therefore, severely limits the number of adults on which birds and bats could feed. The food pathway is, therefore, eliminated in the early years (5-year scenario) of pit development because of the absence of a food source exposed to the chemicals of concern.

Another consideration in constructing the exposure scenarios was whether the exposure would be acute (short-term) or chronic (long-term). Acute exposure would occur if organisms stop or rest in the exposure area for short periods of time. For chronic exposure to occur, organisms would likely remain in the exposure area over an extended period of time. Often this would entail breeding and nesting in the exposure area. A summary of the anticipated acute/chronic exposure routes is provided in ***Table C-5***.

The individual receptor organisms were evaluated for their likelihood of chronic exposure.

Mallard

No chronic exposure was anticipated for mallards in the ecological risk assessment because (1) there would be a lack of sufficient cover for nesting and brooding within approximately 100 yards of the pit, (2) there would likely be insufficient shallow aquatic vegetation upon which birds could feed, and (3) mallards are not expected to overwinter at the pit lake due to lack of cover, insufficient food supply, and the presence of more attractive habitat nearby.

Mallards may stop over at the pit lake during migration in the spring and fall and thus may be exposed to acute levels of toxicants.

Spotted Sandpiper

Spotted sandpipers, which feed along shorelines, would be expected to forage along the edge of the lake and ingest water from the lake. They may also breed in the exposure area. Since it is not anticipated that aquatic invertebrates would be in abundance during the 5-year scenario, chronic exposure is anticipated only during the 27-year and equilibrium scenarios.

Cliff Swallow

Swallows, including the cliff swallow, would be expected to nest in and on the pit walls. Since swallows construct their nests primarily from mud, incidental ingestion of water while collecting mud

TABLE C-5
Acute and Chronic Exposure Routes

Species	5 Years	27 Years	Equilibrium
No Action Alternative (Equilibrium ≈ 127 years)			
Mallard	Acute	Acute	Acute
Spotted Sandpiper	None	Chronic	Chronic
Cliff Swallow	Chronic	Chronic	Chronic
Little Brown Myotis	Chronic	Chronic	Chronic
Proposed Action (Equilibrium ≈ 230 years)			
Mallard	Acute	Acute	Acute
Spotted Sandpiper	None	Chronic	Chronic
Cliff Swallow	Chronic	Chronic	Chronic
Little Brown Myotis	Chronic	Chronic	Chronic

Source: Parametrix 1996

could occur, along with direct ingestion from drinking, resulting in chronic exposure. As with the sandpiper, however, chronic exposure via the food pathway would not be expected until the 27-year and equilibrium scenarios.

<u>Little Brown Myotis</u>

Bats would be expected to colonize openings in the pit walls. Through ingestion of water, bats could be exposed chronically during all three time scenarios. However, since significant populations of aquatic insects are not expected to be present at 5 years, chronic exposure via food would be anticipated to occur only during the 27-year and equilibrium scenarios.

C.1.2 Exposure Assessment

For each wildlife receptor having a complete exposure pathway, chemical doses were estimated by using predicted water concentrations and receptor-specific body weights and ingestion rates. As part of the conservative nature of the screening-level risk assessment, it was assumed that all water and/or food would come from the pit lake.

The following equation was used to calculate the chemical dose for each receptor:

$$EED = ((C_{water} * BCF * IR_{food}) + (C_{water} * IR_{water}))/BW$$

where:

EED = expected environmental dose of a chemical from food and water (milligrams/kilogram/day)
C_{water} = chemical concentration in water (milligrams/liter)
BCF = bioconcentration factor (liters/kilogram)
IR_{food} = ingestion rate of food (kilograms/day)
IR_{water} = ingestion rate of water (liters/day)
BW = body weight of receptor (kilograms)

Food and water ingestion rates were derived from the literature or calculated using allometric equations obtained from U.S. Environmental Protection Agency sources. For example, the equation to calculate food ingestion in birds is:

$$IR_{food} = 0.0582 * BW^{0.651}$$

where:

IR_{food} = ingestion rate of food (kilograms/day)
BW = body weight of receptor (kilograms)

Table C-6 summarizes the assumed values used to calculate chemical dose.

Bioconcentration factors were determined using both historical laboratory studies as well as data from a pit lake analog study (PTI and RCI 1996). In the analog study, existing Nevada pit lakes were examined for chemical and physical parameters, including chemical concentrations in water and body tissue. If multiple sources of data were found, either from the field study or from literature-based laboratory studies, the geometric mean of the bioconcentration factors was calculated and used in the screening-level risk assessment. The invertebrate and plant bioconcentration factors used in the screening-level risk assessment are presented in ***Table C-7***.

Ecological effects levels, or doses, are toxicological benchmark values that are expected to result in no adverse effects on the receptor organism. The no-adverse-effect levels may be for chronic or acute (lethal) exposure. No U.S. Environmental Protection Agency criteria or state of Nevada standards currently exist for wildlife. Therefore, the benchmark values used in the screening-level risk assessment were derived from the scientific literature. Acute toxicity data were generally presented as LD_{50}s (the dose of a chemical that causes 50 percent mortality in the test organisms); chronic endpoints included no-observed-adverse-effect levels for such things as survival, reproduction, and growth. Since the number of species for which toxicity data are available is generally quite limited, data from surrogate species were often used. For example, avian effects levels may have been derived from laboratory tests using chickens or ducks.

C.1.3 Ecological Risk Characterization

To characterize the risk in this screening-level risk assessment, the estimated exposure doses were compared to the estimated ecological effects levels to yield a quantitative evaluation of potential

TABLE C-6
Values Used to Calculate Chemical Dose

	Species			
Parameter	Little Brown Myotis	Mallard	Cliff Swallow	Spotted Sandpiper
Ingestion rate of food (IR_{food}, kg/day)	0.00267	0.066	0.0058	0.00745
Ingestion rate of water (IR_{water}, L/day)	0.00118	0.067	0.0047	0.0072
Body weight (kg)	0.0073	1.2	0.023	0.043
Percent Diet	100 (insect)	100 (plant)	100 (insect)	100 (insect)

Source: Parametrix 1996

TABLE C-7
Bioconcentration Factors

Chemical	Invertebrate Bioconcentration Factors	Plant Bioconcentration Factors
Aluminum	62.6	9.7
Antimony	4.2	1.3
Arsenic (V)	5.9	344.6
Cadmium	53.2	299.1
Chromium	1.0	299.1
Copper	539.1	73.5
Fluoride	2.3	76.0
Lead	90.9	9.7
Manganese	1800.0	76.0
Mercury (inorganic)	1621.1	438.7
Nickel	72.3	891.5
Selenium (VI)	15.7	6.3
Silver	16.8	15.5
Thallium	34.0	76.0
Zinc	560.6	684.5

Source: Parametrix 1996

risk to wildlife. The resulting ratio is known as a hazard quotient (Barnthouse et al. 1986; Suter 1993). The hazard quotient equation is given below:

Hazard Quotient = expected environmental dose/ toxicological benchmark value

A hazard quotient less than 1.0 indicates that the dose of a chemical that an organism would receive is less than the level that could cause adverse effects. Therefore, a hazard quotient less than 1.0 indicates that toxicity is unlikely to occur given the conservative nature of screening-level risk assessments. For example, exposure is considered high (assuming all water and food, for example, comes from the pit lake), and adverse effect levels are low (use of the lowest no-observed-adverse-effect levels, for example).

If a hazard quotient is calculated to be greater than 1.0, then the concentration of a contaminant expected to occur in the environment is greater than levels found in laboratory or field studies to cause no adverse effects to a receptor organism. A hazard quotient greater than 1.0 does not necessarily imply that adverse effects would occur. This is especially true in this screening-level risk assessment where the lowest-observed-adverse-effect level was used as the effects threshold. The lowest-observed-adverse-effect level is the lowest effects threshold available in the literature. The use of a more realistic (higher) effects threshold would result in a lower hazard quotient. A hazard quotient greater than 1.0, therefore, is an indicator that a chemical should be considered a chemical of potential concern, and further evaluation is required.

The magnitude of the hazard quotient is important. Because of the conservative nature of a screening-level risk assessment, hazard quotients between 1.0 and 10.0 are often not considered indicative of significant risk, while hazard quotients greater than 10.0 indicate a potentially significant risk. The assumptions used to calculate the hazard quotients (e.g., adverse effects levels) must be considered when interpreting the results. The more conservative the assumptions, the less likelihood that a hazard quotient greater than 1.0 indicates a tangible risk.

For the mallard, no hazard quotients exceeded 1.0 for any of the time periods modeled for the No Action alternative or the Proposed Action pit lakes. The receptor species for which one or more hazard quotients exceeded 1.0 are listed in ***Table C-8.***

The screening-level risk characterization identified the following wildlife receptors and chemicals of potential concern for further analysis in a baseline risk assessment:

TABLE C-8
Hazard Quotients for Affected Species[1,2]
Screening-Level Risk Assessment

No Action Pit Lake					
		5 Years			
Receptor	**Chemical**	**North**	**South**	**27 Years**	**Equilibrium (127 Years)**
Little Brown Myotis	Aluminum	1.00	0.12	0.49	0.48
	Antimony	45.70	3.76	20.60	36.71
	Arsenic	0.72	0.57	0.72	1.49
	Selenium	4.70	1.27	2.38	2.47
	Thallium	1.36	0.38	0.72	1.20
	Zinc	0.96	1.22	0.84	0.72
Cliff Swallow	Antimony	34.00	2.80	15.34	27.30
	Selenium	2.53	0.68	1.28	1.33
Spotted Sandpiper	Antimony	24.30	2.00	10.97	19.55
	Selenium	1.77	0.48	0.90	0.93

Proposed Action Pit Lake						
		5 Years		**27 Years**		**Equilibrium (230 Years)**
Receptor	**Chemical**	**North**	**South**	**North**	**South**	
Little Brown Myotis	Aluminum	1.03	0.04	0.64	0.05	0.23
	Antimony	45.80	3.77	50.34	3.55	31.67
	Arsenic	0.63	1.02	1.40	0.97	1.90
	Selenium	5.59	0.58	3.11	0.54	1.42
	Thallium	1.51	0.26	1.48	0.22	1.02
	Zinc	1.04	0.65	0.55	0.72	0.69
Cliff Swallow	Antimony	34.10	2.81	37.50	2.64	23.58
	Selenium	3.01	0.31	1.67	0.29	0.77
	Thallium	1.05	0.18	1.03	0.15	0.71
Spotted Sandpiper	Antimony	24.30	2.01	26.81	1.89	16.87
	Selenium	2.11	0.22	1.17	0.20	0.54

[1]Hazard quotients are unitless; they were rounded to two decimal places.
[2]Species and chemicals for which one or more hazard quotient exceeded 1.
Source: Parametrix 1996.

- Little brown myotis (bat species) was found to be potentially at risk from exposure to aluminum, arsenic, antimony, selenium, thallium, and zinc.
- Cliff swallow was found to be potentially at risk from exposure to antimony, selenium, and thallium.
- Spotted sandpiper was found to be potentially at risk from exposure to antimony and selenium.

Based on these results, a baseline risk assessment was conducted to further evaluate the potential ecological risks of these chemicals in the Twin Creeks Mine pit lake.

C.1.4 Uncertainty Analysis

As with most risk assessments, the screening-level risk assessment conducted for the Twin Creeks Mine has several uncertainties. The uncertainties are related to assumptions regarding exposure (including bioavailability and bioconcentration factors) and toxicological benchmark (i.e., no effect level) values. The uncertainties contribute to the possibility that the risk to receptors may be over- or under-estimated. The sources of uncertainty in the Twin Creeks Mine screening-level risk assessment are shown in ***Table C-9***.

The first two uncertainty factors assume not only that all food and water would come from the pit lake, but that all chemicals would be bioavailable. It is highly unlikely that all food and water would come from the pit lake, especially considering that other water sources (e.g., the Humboldt River) are available in the area. It is also unlikely that chemicals would be 100 percent bioavailable. Most metals tend to bind to sediments and suspended particulates and are not available for uptake into body tissue. While it is possible that the uncertainty related to other factors, including dose and benchmark values, could underestimate risk, the conservative nature of the screening-level risk assessment should compensate for any underestimations.

C.2 Baseline Risk Assessment

The purpose of the baseline ecological risk assessment was to further examine the chemicals of concern that have the potential for adverse effects based on the results of the screening-level risk assessment. The baseline risk assessment re-evaluated key assumptions used in the screening-level risk assessment and refined these assumptions to produce a more realistic estimation of potential risk.

The screening-level risk assessment included assumptions that resulted in uncertainties about the risk estimations. These uncertainties are described in Section C.1.4 and are summarized in ***Table C-9***. In general, these assumptions resulted in an overestimation of risk to receptor species. In the baseline risk assessment, some of the assumptions were modified to provide what is believed to be more realistic estimations of exposure and/or effects. Three quantitative changes were made in the baseline risk assessment:

- **Ecological Effects Characterization - No-Observed-Adverse-Effect Level for Antimony**. In the screening-level risk assessment, the no-observed-adverse-effect level used for antimony was 0.035 milligrams/kilogram per day, which

TABLE C-9
Sources of Uncertainty in the Screening-Level Risk Assessment

Sources of Uncertainty	Effect of Uncertainty
Assumed 100 percent bioavailability of chemicals	Overestimate of risk
Assumed 100 percent of food and water intake from pit lake	Overestimate of risk
Invertebrate and plant bioconcentration factors	Over- or underestimate of risk
Receptor ingestion rates	Over- or underestimate of risk
Receptor body weights	Over- or underestimate of risk
Toxicological benchmark values	Over- or underestimate of risk
Predicted concentration of chemicals in lake water	Over- or underestimate of risk

Source: Parametrix 1996.

was derived from a rat study involving longevity. In the baseline risk assessment, a no-observed-adverse-effect level of 2 milligrams/kilogram per day was used. This value was obtained from a study of ewes and lambs in which reproduction was the endpoint to represent a population-level impact.

- **Ecological Effects Characterization - Threshold Value.** In the screening-level risk assessment, the no-observed-adverse-effect level was used as the concentration below which no adverse effects are anticipated to occur. The actual concentration at which effects do occur lies somewhere between the no-observed-adverse-effect level and the lowest-observed-adverse-effect level. This concentration, sometimes referred to as the chronic value, can be estimated by calculating the mean of the no-observed-adverse-effect level and the lowest-observed-adverse-effect level. The resulting dose was referred to as the toxicity threshold value and was used to calculate hazard quotients in the baseline risk assessment.

- **Ecological Exposure Assessment - Food Ingestion for Bats.** In the screening-level risk assessment, the food ingestion rate for the little brown myotis was assumed to be 0.37 kilograms/kilogram-day, which is an average value from several ages of bats. The baseline risk assessment used a higher ingestion rate of 0.48 kilograms/kilogram-day, which is the maximum ingestion rate of a lactating female. This higher rate results in a higher estimate of dose to the bat. In addition, the assumption regarding the bat's foraging range was adjusted to include both when both lakes exist.

Using the revised estimates of exposure and effects, new hazard quotients were calculated for the chemicals and species that were found to be at potential risk in the screening-level risk assessment.

The recalculated hazard quotients for the baseline risk assessment are presented in ***Table C-10***.

The only hazard quotients greater than 1.0 were for the little brown myotis for the metal selenium. These hazard quotients occurred in Year 5 of lake development for both the No Action alternative and Proposed Action North Pit lakes. The selenium hazard quotients are not considered significant because of their magnitude (they were barely over 1.0), the knowledge that these hazard quotients were not statistically distinguishable from 1.0 because of the uncertainties inherent in the assumptions and calculations, and understanding that the toxicity threshold values were conservative values given the use of safety factors in their derivation. For example, while a hazard quotient of 1.1 was based on selenium concentrations in the north lake of the No Action alternative pit at 5 years (***Table C-10***), the projected foraging of the bat over both the south and north pit lakes would result in an average hazard quotient of 0.7. Additionally, whereas a hazard quotient of 1.3 was associated with the selenium concentrations predicted for the north lake of the Proposed Action pit at 5 years (***Table C-10***), the projected foraging of the bat over both the south and north pit lakes would result in an average hazard quotient of 0.7. No risks to other receptor organisms were identified. Therefore, the baseline risk assessment indicated that none of the receptor organisms would be at risk from the Twin Creeks Mine No Action alternative and Proposed Action pit lakes.

TABLE C-10
Hazard Quotients for Affected Species[1]
Baseline Risk Assessment

No Action Pit Lake					
Receptor	**Chemical**	**5 Years**		**27 Years**	**Equilibrium (127 Years)**
		North	**South**		
Little Brown Myotis	Aluminum	0.24	0.03	0.12	0.11
	Antimony	0.19	0.02	0.08	0.15
	Arsenic	0.17	0.13	0.17	0.35
	Selenium	1.11	0.30	0.56	0.58
	Thallium	0.32	0.09	0.17	0.07
	Zinc	0.23	0.29	0.20	0.17
Cliff Swallow	Antimony	0.11	0.009	0.05	0.09
	Selenium	0.46	0.12	0.23	0.24
	Thallium	0.17	0.05	0.09	0.04
Spotted Sandpiper	Antimony	0.08	0.006	0.04	0.05
	Selenium	0.32	0.09	0.16	0.17

Proposed Action Pit Lake						
Receptor	**Chemical**	**5 Years**		**27 Years**		**Equilibrium (230 Years)**
		North	**South**	**North**	**South**	
Little Brown Myotis	Aluminum	0.25	0.009	0.15	0.01	0.05
	Antimony	0.19	0.02	0.20	0.01	0.13
	Arsenic	0.15	0.24	0.33	0.23	0.44
	Selenium	1.32	0.14	0.73	0.13	0.34
	Thallium	0.36	0.06	0.35	0.05	0.06
	Zinc	0.25	0.16	0.13	0.17	0.16
Cliff Swallow	Antimony	0.11	0.009	0.12	0.008	0.08
	Selenium	0.55	0.06	0.30	0.05	0.14
	Thallium	0.19	0.03	0.19	0.03	0.03
Spotted Sandpiper	Antimony	0.08	0.008	0.09	0.006	0.05
	Selenium	0.38	0.04	0.21	0.04	0.10

[1] Hazard quotients are unitless.
Source: Parametrix 1996.

APPENDIX D

Human Health Risk Assessment

Appendix D Human Health Risk Assessment

A risk assessment was conducted to evaluate potential human health risks associated with the Twin Creeks Mine pit lake. The chemicals that could pose a potential risk to humans were identified in a screening-level risk assessment and subsequently evaluated in a baseline risk assessment for the Twin Creeks Mine.

D.1 Screening-Level Risk Assessment

The pit lakes associated with the No Action alternative and Proposed Action were evaluated in the human health risk assessment. The human health evaluation process paralleled the ecological risk assessment. Problem formulation, or development of the conceptual site model, is discussed in the ecological risk assessment (see Appendix C). Chemicals of primary concern included in the screening-level ecological risk assessment were also considered in the screening-level human health assessment. These chemicals are listed in Section C.1.1.2 in Appendix C. In contrast to the ecological risk assessment, the human health measurement endpoints were identified as the protection of individuals, rather than the population at potential risk.

The human health risk assessment used a method for evaluating potential risks similar to the method used for the ecological risk assessment. Hazard quotients, or the ratio of the estimated exposure dose or intake to a known dose below which adverse effects would not be expected, were calculated for each chemical and exposure pathway. If the hazard quotient was less than 1.0, the potential for adverse effects was considered negligible, and there was no need to evaluate the chemical further in the baseline risk assessment.

D.1.1 Exposure Assessment

Potential receptors and exposure pathways were identified for evaluation, and the media-specific dose or intake was quantified. Receptors are not likely to be exposed to the pit lake at 5 years post-closure for the No Action alternative or the Proposed Action because of the distance from the pit rim to the lake; therefore, risks were not quantified for the 5-year scenario. The only reasonable potential receptor for all of the other postclosure scenarios was assumed to be an adventurous hiker who visits the lake for a single weekend in a single year. The hiker is assumed to swim in the lake and, at the 127/230 year postclosure scenario, catch and consume fish from the lake. The potential exposure pathways evaluated in the human health screening-level risk assessment are shown in ***Table D-1***.

Media-specific intake of chemicals through incidental ingestion of surface water, dermal contact with surface water, and ingestion of fish were calculated as the mass of the chemical ingested or absorbed, divided by the mass of the receptor. Intake of fish and water, and dermal absorption were calculated following standard risk assessment guidelines (U.S. Environmental Protection Agency 1989). It was assumed in the screening-level risk assessment that the receptor would ingest 250 grams of fish caught from the lake; swim for 2.6 hours; and while swimming, 19,400 square centimeters of skin (the whole body) would be exposed to the surface water. An average adult body weight of 75 kilograms was assumed in the calculations.

Dermal absorption of chemicals during swimming was estimated using chemical-specific skin permeability values published in U.S. Environmental Protection Agency Dermal Guidance (U.S. Environmental Protection Agency 1992) and shown in ***Table D-2***.

Expected environmental concentrations in the lake at 27, 127, and 230 years postclosure

TABLE D-1
Potential Exposure Pathways

Alternative	5 Years	27 Years	Equilibrium
No Action Alternative	No receptors due to the distance to the lake.	Dermal contact with water while swimming. Incidental ingestion of water while swimming.	Dermal contact with water while swimming. Incidental ingestion of water while swimming. Ingestion of fish.
Proposed Action	No receptors due to the distance to the lake.	No receptors due to the distance to the lake.	Dermal contact with water while swimming. Incidental ingestion of water while swimming. Ingestion of fish.

TABLE D-2
Summary of Chemical-Specific Parameters Used in the Human Health Risk Assessment

Constituent	Fish Bioconcentration Factor (liters/kilogram)	Dermal Kp[1] (unitless)	10-Day Health Advisory (milligrams/kilogram-day)
aluminum	62.6	0.001	5.0×10^{-1}
antimony	0.5	0.001	1.3×10^{-2}
arsenic	0.5	0.001	1.0×10^{-2}
cadmium	21.5	0.001	4.0×10^{-3}
chromium	1.7	0.001	1.0×10^{-1}
copper	0.5	0.001	1.3×10^{-1}
fluoride	2.3	0.001	6.5×10^{-1}
lead	24.0	0.000004	6.4×10^{-2}
manganese	1800	0.001	1.0×10^{-1}
mercury	2,998	0.001	1.3×10^{-2}
nickel	0.5	0.0001	1.0×10^{-1}
selenium	30.5	0.001	4.1×10^{-3}
silver	14.5	0.0006	2.0×10^{-2}
thallium	65.7	0.001	7.0×10^{-4}
zinc	397.1	0.0006	6.0×10^{-1}

[1] Kp-Dermal Partition Coefficient
Source: Parametrix 1996

were estimated using the modeled around water results presented in Section 3.2 of the environmental impact statement. Fish tissue concentrations were estimated by multiplying chemical-specific bioconcentration factors by the modeled surface water concentrations. The fish tissue bioconcentration factors used in the risk assessment are shown in ***Table D-2***.

D.1.2 Toxicity Assessment

The toxicity assessment is the equivalent of the ecological effects characterization in the ecological risk assessment. Toxicological properties of each chemical were evaluated, and appropriate toxicity values for comparison with the estimated exposure dose were selected. Because the pit lake is not intended for recreational purposes, only acute, noncarcinogenic exposures were evaluated.

The measurement endpoint selected for the human health toxicity assessment is the 10-day Health Advisory (U.S. Environmental Protection Agency 1989, 1995). The 10-day Health Advisory represents the chemical concentration in drinking water that is not expected to cause adverse noncarcinogenic effects for up to 14 days of exposure to a child. Health Advisories were selected as a conservative estimate of a safe exposure level for acute adult exposures.

Health advisories are calculated by selecting an appropriate no-observed-adverse-effect level or lowest-observed-adverse-effect level, applying safety factors if necessary, and adjusting to a water concentration that is protective of a child. In order to compare the 10-day Health Advisory to the acute intake value (milligrams/kilogram per day) calculated in the exposure assessment, it was necessary to convert the water concentration Health Advisory back to the equivalent dose by dividing by the body weight of a child (10 kilograms) and multiplying by the child's assumed ingestion rate of water (1 liter/day) (U.S. Environmental Protection Agency 1990).

Safety factors that had been used in calculating the Health Advisory were not modified, with one exception. The U.S. Environmental Protection Agency incorporated a safety factor of 1,000 for protecting of sensitive individuals in the derivation of the antimony Health Advisory. A safety factor of 100 was considered more appropriate for use in this risk assessment, because it was assumed that only healthy, strong individuals would climb down to the pit lake and be exposed to chemicals.

Published 10-day Health Advisories were available for antimony, cadmium, chromium, nickel, silver, thallium, and zinc. For manganese and selenium, the Health Advisories were taken from their respective U.S. Environmental Protection Agency drinking water criteria documents. A 1-day Health Advisory was used for copper, because no 10-day Health Advisory was available. Health Advisories were derived for aluminum, arsenic, fluoride, lead, and mercury using relevant acute studies from the scientific literature, appropriate safety factors, and standard U.S. Environmental Protection Agency procedures. The 10-day Health Advisories used in the human health risk assessment are shown in ***Table D-2***.

D.1.3 Human Health Risk Characterization

Hazard quotients, or the ratio of the estimated acute intake or dose from the exposure assessment to the acute dose derived from the 10-day Health Advisory, were calculated for each chemical and each exposure pathway. The hazard quotients were summed across pathways to give a total hazard quotient for the receptor for each chemical. A hazard quotient less than 1.0 indicated that acute health effects were not likely to occur as a result of exposure to chemicals in the pit lake. Chemicals with a hazard quotient less than 1.0 ere not identified as chemicals of primary concern and were eliminated from further evaluation in the baseline risk assessment. A hazard quotient greater than 1.0 implied that the potential exists for human health effects to occur. Those chemicals with total hazard quotients greater than 1.0 were selected as chemicals of primary concern for further evaluation in the baseline risk assessment.

The hazard quotients for the No Action alternative at the 27-year postclosure scenario were all less than 1.0, indicating that potential health impacts would not be likely to occur based on the exposure assumptions and water concentrations for that scenario. The total hazard quotient for thallium for both the No Action alternative 127-year post-closure scenario and the Proposed Action 230-year postclosure scenario was 11.3 and 9.5, respectively. Therefore, thallium was identified as a chemical of potential concern to humans if they were to consume fish from the pit lake.

Thallium and its compounds have not been well studied. Little information is available on absorption, distribution, and metabolism. Animal studies suggest that thallium is completely absorbed and transported in the body in a manner similar to iron. Animal studies also indicate thallium accumulates in the kidney, heart, brain, bone, skin, and blood.

Occupational exposure to thallium has been reported to affect the nervous system. Workers have complained of crawling of the skin, prickling skin, numbness of the extremities, burning feet, and muscle cramps (Agency for Toxic Substances and Disease Registry 1990). No data are available on the carcinogenic response associated with thallium in animals or humans (U.S. Environmental Protection Agency 1996).

D.1.4 Uncertainty Analysis

There are several possible sources of uncertainty in the human health risk assessment. These include the modeled pit lake water chemical concentrations, the fish bioconcentration factors, the exposure assumptions made in the dose equations, and the use of the 10-day Health Advisories as the toxicological benchmark values. The range of uncertainty in these values is discussed below, and the specific sources of uncertainty for thallium are presented in ***Table D-3***.

As the concentrations of chemicals in the pit lake were predicted from an empirical model (PTI 1996a), there is some uncertainty associated with the estimated water concentrations. For example, in the model, future concentrations of metals in ground water were estimated based on current ground water concentrations and predictions of the future ground water flow characteristics. However, in cases when a metal was not detected in the ground water under present conditions, it was assumed to be present at one-half of its laboratory detection limit. This practice may cause an overestimate of the predicted water concentration in the pit lake and subsequently may cause an overestimate of the risks to human health.

The concentrations of metals in fish tissue also are a source of uncertainty, as a bioconcentration factor is applied to the predicted water concentration. For most metals, the range of fish bioconcentration factors spans less than one order of magnitude. Other sources of uncertainty in the human health risk assessment include the exposure assumptions used in estimating the dose of water and fish that a person would consume from the pit lake. As the range of fish consumption rates or any other exposure parameter might span an order of magnitude, the uncertainty in the resulting estimate may also range up to an order of magnitude.

Use of the 10-day Health Advisories for children as a benchmark dose for protecting adults against acute effects is another source of uncertainty. The population likely to be exposed to the pit lake would be comprised of healthy, adventurous people who are assumed to be capable of a rigorous climb into and out of the pit lake. This targeted population is quite different than the sensitive population (e.g., children and the elderly) targeted for the 10-day Health Advisories. Therefore, the risks predicted using these values as the benchmark dose may overpredict the actual risks to the exposed population.

TABLE D-3
Sources of Uncertainty in the Human Health Risk Assessment of Thallium

Sources of Uncertainty	Effect of Uncertainty
Fish bioconcentration factor	Over- or underestimate of risk
Use of 10-day Drinking Water Health Advisory	Overestimate of risk
Assumed 100 percent bioavailability of chemicals	Overestimate of risk

D.2 Baseline Risk Assessment

The baseline risk assessment made several refinements in the risk evaluation in order to produce a more realistic estimate of the potential risk to humans consuming fish from the pit lake.

The surface water concentration for thallium used in the screening-level risk assessment was refined in the baseline risk assessment, resulting in a 3.8 to 6.3 factor reduction in the exposure point concentration. The value used in the screening-level risk assessment was based on a conservative interpretation of below-detection-limit data in the ground water, resulting in an overestimation of the potential thallium concentration in pit lake water. Ground water data from 22 wells were used in the screening-level risk assessment. Three of four samples analyzed from a single well (M/O 394318-1) exhibited elevated thallium detection limits when compared with a sample analyzed by a more sensitive analytical technique. Because of the higher detection limits in these three samples, the average ground water concentration of thallium used in the screening level risk assessment to predict the future lake concentration was probably artificially inflated.

For the baseline risk assessment, the water quality simulation model was rerun using one-half the detection limit to replace the three elevated values used in the screening-level risk assessment. One-half the detection limit was determined to be a more appropriate representation of the actual value based on (1) the previous analysis using the more sensitive measurement technique, (2) an evaporative concentration experiment performed by PTI, and (3) the time invariant results for detected analytes from Well M/O 394318-1 (PTI 1996a). Using one-half the detection limit resulted in a reduction in the predicted thallium concentration in pit lake water by a factor of approximately 4 from the screening-level risk assessment estimates. In addition to revisions of the exposure point concentration, the toxicity value used in the screening-level risk assessment was reviewed and modified. The drinking water advisory developed by the U.S. Environmental Protection Agency's Office of Water was used in the screening-level risk assessment to screen the future pit lake concentration for evaluation of adverse effects to humans. The drinking water advisory is a nonregulatory concentration for protecting human health via drinking water. The U.S. Environmental Protection Agency has developed a draft subchronic oral reference dose for thallium based on the same no-observed-adverse-effects level used to derive the drinking water health advisory. The reference dose does not, however, include the additional safety factor for protecting sensitive members of the population that is included in the derivation of the drinking water advisory value. In addition, the baseline risk assessment modified the U.S. Environmental Protection Agency draft subchronic reference dose using standard procedures to account for differences in derivation of acute versus subchronic values. This resulted in a toxicity threshold value that is 10 percent of the rat no-observed-adverse-effects level. The value is considered to be protective because it falls two orders of magnitude below the range of exposure levels associated with sever acute effects to humans (Parametrix 1996).

As a result of these modifications, no human health risks from exposure to thallium by fish ingestion were identified in the baseline risk assessment. All of the estimated hazard quotients for human exposure to all chemical concentrations in the pit lake were less than 1.0. Therefore, no significant impacts to humans are anticipated from exposure to chemicals in the Twin Creeks Mine No Action alternative and Proposed Action pit lakes.

APPENDIX E

National Register of Historic Places Status of Cultural Resources Within the Project Area

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. ARS 762					
26Hu0514	lithic scatter/base camp		JE	---	---
26Hu2860	residential base camp		JE	---	---
26Hu3206	residential base camp/ranch		JE	---	---
26Hu3208	residential base camp		JE	---	---
26Hu3207	lithic scatter		JI	---	---
26Hu3208	lithic scatter		JI	---	---
26Hu3209	lithic scatter		JI	---	---
26Hu3210	lithic scatter/trash scatter		JI	---	---
26Hu3211	lithic scatter/field camp		JE	---	---
26Hu3212	lithic scatter/trash scatter		JE	---	---
26Hu3213	lithic scatter		JI	---	---
26Hu3211	lithic scatter		JI	---	---
26Hu3216	lithic scatter		JI	---	---
26Hu3216	lithic scatter		JI	---	---
26Hu3217	trash scatter		JE	---	---
26Hu3216	trash scatter		JI	---	---
26Hu3216	lithic scatter		JI	---	---
26Hu3220	field camp and lithic scatter/trash scatter		JE	---	---
26Hu3221	lithic scatter/field camp		JE	---	---
26Hu3222	lithic scatter		JI	---	---
26Hu3223	lithic scatter		JI	---	---
26Hu3220	lithic scatter/tool concentration		JI	---	---
26Hu3225	lithic scatter		JI	---	---
26Hu3225	historic rock cairn		JI	---	---
26Hu3227	lithic scatter		JI	---	---
26Hu3228	lithic scatter		JI	---	---
26Hu3225	lithic scatter		JE	---	---
26Hu3230	lithic scatter		JI	---	---
26Hu3231	residential base camp	Rabbit Creek Diversion	JE	---	ME
26Hu3232	lithic scatter		JI	---	---
26Hu3230	lithic scatter		JI	---	---
26Hu3230	lithic scatter		JI	---	---
26Hu3235	lithic scatter		JI	---	---
26Hu3236	lithic scatter		JE	---	---
26Hu3237	lithic scatter		JI	---	---
26Hu3238	lithic prospect/scatter		JI	---	---
26HU3239	lithic scatter		JI	---	---
26HU3240	lithic scatter		JE	---	---

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
26HU3241	lithic scatter		JE	---	---
26HU3242	lithic scatter		JI	---	---
26Hu3249	residential base camp		JE	---	---
26Hu3249	lithic scatter		JE	---	---
26Hu3245	lithic scatter		JE	---	---
26Hu3246	lithic scatter		JI	---	---
26Hu3247	lithic scatter/field camp		JE	---	---
26Hu3249	lithic scatter		JI	---	---
26Hu3249	lithic scatter/field camp		JE	---	---
26Hu3250	lithic scatter		JI	---	---
26Hu3251	lithic scatter		JI	---	---
26Hu3252	lithic scatter		JI	---	---
26Hu325[illegible]	lithic scatter		JI	---	---
26Hu3264	lithic scatter		JI	---	---
26Hu3256	lithic scatter		JI	---	---
26Hu3256	lithic scatter/field camp		JE	---	---
26Hu3257	residential base camp		JE	---	---
26Hu3258	residential base camp/trash scatter		JE	---	---
26Hu3256	residential base camp		JE	---	---
26Hu3264	lithic scatter		JI	---	---
26Hu3264	lithic scatter/trash scatter		JE	---	---
26Hu3262	lithic scatter		JI	---	---
26Hu3263	lithic scatter		JI	---	---
26Hu3264	lithic scatter		JE	---	---
26Hu3265	historic irrigation system		JI	---	---
26Hu3265	ranch complex		JE	---	---
Report No. CR2-0015(P)					
CrNV-21-0103	lithic scatter		UN		AV
CrNV-21-0104	lithic scatter		UN		AV
CrNV-21-0105	lithic scatter		UN		AV
Report No. CR2-0028(P)					
CrNV-02-0093	lithic scatter		UN		AV
CrNV-02-0094	lithic scatter		UN		AV
CrNV-02-0095	lithic scatter		UN		AV
CrNV-02-0096	rock shelter/cave		UN		AV
CrNV-02-0097	lithic scatter		UN		AV
CrNV-02-0098	lithic scatter/tool concentration		UN		AV
CrNV-02-0099	lithic scatter		UN		AV
CrNV-02-0102	lithic scatter		UN		AV
Report No. CR2-0045(P)					
CrNV-02-0100	rock shelter/petroglyph		UN		AV

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. CR2-0070(P)					
CrNV-02-0761	lithic scatter		UN		AV
CrNV-02-0763	lithic scatter		UN		AV
CrNV-02-0820	lithic scatter		UN		AV
CrNV-21-0752	lithic scatter/historic bldg		UN		AV
CrNV-21-0753	lithic scatter/ranch complex		UN		AV
CrNV-21-0757	lithic scatter		UN		AV
CrNV-21-0755	lithic scatter		UN		AV
CrNV-21-0756	lithic scatter		UN		AV
CrNV-21-0757	lithic scatter		UN		AV
CrNV-21-0756	lithic scatter		UN		AV
CrNV-21-0764	lithic scatter		UN		AV
CrNV-21-0752	lithic scatter/base camp		EL		
CrNV-21-0764	rock shelter		UN		AV
CrNV-21-0755	lithic scatter/camp site		UN		AV
CrNV-21-0764	lithic scatter		UN		AV
CrNV-21-0771	lithic scatter		UN		AV
Report No. CR2-0183(P)					
CrNV-02-0958	lithic scatter		UN		AV
Report No. CR2-0192(P)					
CrNV-02-1011	lithic scatter		JI	---	---
CrNV-02-1012	lithic scatter/camp site		JI	---	---
CrNV-02-1013	lithic scatter		JI	---	---
Report No. CR2-0194(P)					
26Hu0855	lithic scatter		UN		AV
CrNV-02-1037	lithic scatter/camp site		UN		AV
Report No. CR2-0196(P)					
CrNV-02-1125	lithic scatter		NEL	NA	NA
Report No. CR2-0210(P)					
CrNV-21-3761	lithic scatter		NEL	NA	NA
Report No. CR2-0544(P)					
CrNV-02-2649	lithic scatter		NEL	NA	NA
Report No. CR2-0587(P)					
CrNV-02-2726	lithic scatter/camp site		NEL	NA	NA
Report No. CR2-0745(P)					
CrNV-02-2860	residential base camp		JE	---	---
CrNV-02-2863	lithic scatter		UN		AV
CrNV-02-2864	lithic scatter		UN		AV
CrNV-21-2861	lithic scatter		UN		AV
Report No. CR2-0760(P)					
CrNV-21-2898	lithic scatter		NEL	NA	NA
Report No. CR2-1031(P)					
CrNV-21-3339	rock wall		UN		AV

TABLE E-1
National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. CR2-1063(P)					
CrNV-21-3386	lithic scatter/camp site	overburden storage	JI	---	---
Report No. CR2-2004(P)					
CrNV-21-3544	lithic scatter		NEL	NA	NA
Report No. CR2-2025					
26Hu2581	lithic scatter		NEL	NA	NA
Report No. CR2-2039(P)					
CrNV-21-3622	lithic scatter		NEL	NA	NA
Report No. CR2-2092(P)					
CrNV-21-3684	lithic scatter and tool concentration/camp site		NEL	NA	NA
Report No. CR2-2093(P)					
CrNV-21-3725	lithic scatter		NEL	NA	NA
CrNV-21-3689	lithic scatter	heap leach pad	NEL	NA	NA
CrNV-21-3708	lithic scatter		NEL	NA	NA
CrNV-21-3685	lithic scatter		NEL	NA	NA
CrNV-21-3685	lithic scatter		NEL	NA	NA
CrNV-21-3685	lithic scatter		NEL	NA	NA
CrNV-21-3697	lithic scatter		NEL	NA	NA
CrNV-21-3698	lithic scatter		NEL	NA	NA
CrNV-21-3685	trash scatter		NEL	NA	NA
CrNV-21-3700	lithic scatter		NEL	NA	NA
CrNV-21-3703	lithic scatter		NEL	NA	NA
CrNV-21-3715	prospect		NEL	NA	NA
CrNV-21-3717	lithic scatter/camp site		NEV		AV
CrNV-21-3722	prospect pit		NEL	NA	NA
CrNV-21-3733	lithic scatter		NEL	NA	NA
Report No. CR2-2108(P)					
CrNV-21-3761	lithic scatter		NEL	NA	NA
Report No. CR2-2111(P)					
CrNV-21-3767	lithic scatter		NEL	NA	NA
CrNV-21-3768	lithic scatter		NEL	NA	NA
CrNV-21-3763	lithic and ceramic scatter		NEL	NA	NA
CrNV-21-3770	two (2) lithic isolates		NEL	NA	NA
CrNV-21-377[illegible]	two (2) lithic isolates		NEL	NA	NA
CrNV-21-3772	lithic scatter		NEL	NA	NA
CrNV-21-3773	lithic scatter		NEL	NA	NA
Report No. CR2-2176(P)					
CrNV-21-4007	lithic scatter		NEL	NA	NA
CrNV-21-4009	lithic scatter		NEL	NA	NA
CrNV-21-4010	lithic scatter		NEL	NA	NA

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National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
Report No. CR2-2204(P)					
CrNV-21-4120	lithic scatter		NEL	NA	NA
CrNV-21-4121	lithic scatter		NEL	NA	NA
CrNV-21-4122	lithic scatter/camp site		NEV		AV
CrNV-21-412[illegible]	lithic scatter		NEL	NA	NA
CrNV-21-4124	ranch and industrial vestige		NEL	NA	NA
CrNV-21-4125	lithic scatter		NEL	NA	NA
Report No. CR2-2246(P)					
CrNV-21-4452	lithic scatter	overburden storage	JI	---	---
CrNV-21-4453	lithic scatter	overburden storage	JI	---	---
CrNV-21-4459	lithic scatter		JI	---	---
CrNV-21-4453	lithic scatter	overburden storage	JI	---	---
CrNV-21-4461	lithic scatter		JI	---	---
Report No. CR2-2271(P)					
CrNV-21-4578	lithic scatter		NEL	NA	NA
CrNV-21-5873	lithic scatter		JI	---	---
CrNV-21-5884	trash scatter		JI	---	---
CrNV-21-5886	lithic scatter		JI	---	---
CrNV-21-5887	lithic scatter		JI	---	---
CrNV-21-5886	lithic scatter		JI	---	---
Report No. CR2-2351(P)					
CrNV-21-4998	lithic scatter		NEL	NA	NA
CrNV-21-4999	lithic scatter		NEL	NA	NA
CrNV-21-5006	lithic scatter/camp site		E		
Report No. CR2-2476(P)					
CrNV-21-5541	lithic scatter		NEL	NA	NA
Report No. CR2-2567(P)					
CrNV-02-0768	residential base camp/historic dam		JE;historic component UN	---	---
CrNV-21-2651	lithic scatter		JE	---	AV
CrNV-02-2682	lithic scatter		JE	---	AV
CrNV-21-5733	lithic scatter/trash scatter		JE	---	AV
CrNV-21-5734	lithic scatter		JE	---	---
CrNV-21-5735	lithic scatter		JE	---	---
CrNV-21-5736	lithic scatter		JI	---	---
CrNV-21-5759	lithic scatter		JE	---	---
CrNV-21-5759	lithic scatter		JI	---	---
CrNV-21-5759	lithic scatter		JI	---	---
CrNV-21-5761	lithic scatter		JE	---	AV

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National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5762	lithic scatter		JI	---	---
CrNV-21-5763	lithic scatter		JI	---	---
CrNV-21-5764	lithic scatter		JE	---	AV
CrNV-21-5765	lithic scatter		JI	---	---
CrNV-21-5766	lithic scatter		JI	---	---
CrNV-21-5767	lithic scatter		JI	---	---
CrNV-21-5768	lithic prospect/scatter		JE	---	AV
CrNV-21-5769	lithic scatter		JE	---	---
CrNV-21-5770	lithic scatter		JI	---	---
CrNV-21-5771	lithic scatter		JI	---	---
CrNV-21-5772	lithic scatter		JI	---	---
CrNV-21-5773	lithic scatter		JI	---	---
CrNV-21-5774	lithic scatter/field camp		JE	---	AV
CrNV-21-5775	lithic scatter		JI	---	---
CrNV-21-5776	lithic scatter		JI	---	---
CrNV-21-5777	lithic scatter		JI	---	---
CrNV-21-5778	lithic scatter		JI	---	---
CrNV-21-5779	lithic scatter		JI	---	---
CrNV-21-5780	lithic scatter		JE	---	AV
CrNV-21-5781	lithic scatter		JI	---	---
CrNV-21-5782	lithic prospect/quarry		JI	---	---
CrNV-21-5783	lithic scatter		JI	---	---
CrNV-21-5784	lithic scatter		JI	---	---
CrNV-21-5785	lithic scatter		JI	---	---
CrNV-21-5786	lithic scatter		JE	---	AV
CrNV-21-5787	lithic prospect/scatter		JI	---	---
CrNV-21-5788	lithic scatter		JI	---	---
CrNV-21-5789	lithic scatter		JI	---	---
CrNV-21-5790	lithic scatter/field camp		JE	---	AV
CrNV-21-5791	lithic prospect/scatter		JI	---	---
CrNV-21-5792	lithic prospect/scatter		JI	---	---
CrNV-21-5793	lithic prospect/scatter		JI	---	---
CrNV-21-5794	lithic scatter		JE	---	AV
CrNV-21-5795	lithic scatter		JI	---	---
CrNV-21-5796	lithic prospect/scatter		JI	---	---
CrNV-21-5797	lithic scatter		JI	---	---
CrNV-21-5798	lithic scatter		JI	---	---
CrNV-21-5799	lithic scatter		JI	---	---
CrNV-21-5800	lithic scatter		JI	---	---
CrNV-21-5801	lithic scatter		JI	---	---
CrNV-21-5802	lithic scatter		JI	---	---
CrNV-21-5803	lithic scatter		JI	---	---
CrNV-21-5804	lithic scatter		JI	---	---
CrNV-21-5805	lithic scatter		JI	---	---

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National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5806	lithic scatter		JI	---	---
CrNV-21-5807	lithic scatter		JI	---	---
CrNV-21-5809	lithic prospect/scatter		JI	---	---
CrNV-21-5809	lithic scatter		JI	---	---
CrNV-21-5810	hunting blind		JI	---	---
CrNV-21-581[illegible]	lithic prospect/scatter		JI	---	---
CrNV-21-581[illegible]	lithic scatter		JI	---	---
CrNV-21-5813	lithic scatter/trash scatter		JE	---	---
CrNV-21-5810	lithic scatter		JI	---	---
CrNV-21-581[illegible]	lithic scatter		JI	---	---
Report No. CR2-2568(P)					
CrNV-21-5859	lithic scatter	Tailings Impoundment	JI	---	---
CrNV-21-5860	lithic scatter	Tailings Impoundment	JI	---	---
CrNV-21-5861	lithic scatter/historic isolate		JE	---	---
CrNV-21-5862	lithic scatter		JI	NA	NA
CrNV-21-5863	lithic scatter		JI	---	---
CrNV-21-5864	field camp/historic isolate	tailings impoundment overburden storage interburden storage	JE	---	ME
CrNV-21-5859	lithic scatter	tailings impoundment	JI	---	---
CrNV-21-5866	lithic scatter/field camp	tailings impoundment overburden storage	JE	---	ME
CrNV-21-5867	lithic scatter/field camp	tailings impoundment overburden storage interburden storage	JE	---	ME
CrNV-21-5868	lithic scatter/field camp		JE	---	---
CrNV-21-5869	lithic scatter		JI	---	---
CrNV-21-5870	lithic scatter		JI	---	---
CrNV-21-5874	lithic scatter		JI	---	---
CrNV-21-587[illegible]	lithic scatter		JI	---	---
CrNV-21-5873	lithic scatter		JI	---	---
CrNV-21-5874	lithic scatter		JI	---	---
CrNV-21-5875	lithic scatter		JI	---	---

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National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5876	lithic scatter		JI	---	---
CrNV-21-5877	lithic scatter/trash scatter		JI	---	---
CrNV-21-5878	lithic scatter		JI	---	---
CrNV-21-5879	lithic scatter/field camp		JE	---	---
CrNV-21-5880	lithic scatter		JI	---	---
CrNV-21-5881	lithic scatter		JI	---	---
CrNV-21-5982	lithic scatter		JI	---	---
CrNV-21-5889	lithic scatter		JI	---	---
CrNV-21-5881	historic artifact scatter		JI	---	---
CrNV-21-5880	lithic scatter		JE	---	---
CrNV-21-5889	lithic scatter		JI	---	---
CrNV-21-5987	lithic scatter		JI	---	---
CrNV-21-5888	lithic scatter		JI	---	---
CrNV-21-5889	lithic scatter		JI	---	---
CrNV-21-5889	lithic scatter		JI	---	---
CrNV-21-5891	lithic scatter		JI	---	---
CrNV-21-5892	lithic scatter		JI	---	---
CrNV-21-5889	lithic scatter		JE	---	---
CrNV-21-5894	lithic scatter/field camp		JE	---	---
CrNV-21-5889	lithic prospect/scatter		JI	---	---
CrNV-21-5896	lithic scatter		JI	---	---
CrNV-21-5897	lithic scatter		JI	---	---
CrNV-21-5898	field camp/trash scatter		JE	---	---
CrNV-21-5898	lithic scatter		JI	---	---
CrNV-21-5900	lithic scatter		JI	---	---
CrNV-21-5900	field camp/location		JE	---	---
CrNV-21-5902	lithic scatter		JI	---	---
CrNV-21-5903	lithic scatter		JI	---	---
CrNV-21-5900	lithic scatter		JI	---	---
CrNV-21-5905	lithic scatter		JE	---	---
CrNV-21-5809	lithic scatter		JI	---	---
CrNV-21-5907	lithic scatter		JI	---	---
CrNV-21-5809	lithic scatter		JI	---	---
CrNV-21-5909	residential base camp		JE	---	---
CrNV-21-5910	lithic scatter		JI	---	---
CrNV-21-5910	lithic scatter		JI	---	---
CrNV-21-5912	lithic scatter		JE	---	---
CrNV-21-5910	lithic scatter		JI	---	---
CrNV-21-5917	lithic scatter		JI	---	---
CrNV-21-5915	lithic scatter		JI	---	---
CrNV-21-5916	lithic prospect/scatter		JI under d, UN under a-c	---	---
CrNV-21-5917	lithic scatter		JI	---	---
CrNV-21-5918	lithic scatter		JI	---	---

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National Register of Historic Places Status of Cultural Resources Within the Project Area

Agency Site No. or Smithsonian No.	Brief Site Description	Project Association	National Register of Historic Places Potential	Project Disturbance	Mitigation
CrNV-21-5919	residential base camp/historic isolate		JE	---	---
CrNV-21-5920	lithic scatter/field camp		JE	---	---
CrNV-21-5921	lithic scatter		JI	---	---
CrNV-21-5922	hunting blind		UN		AV
CrNV-21-5923	lithic scatter		JI	---	---
CrNV-21-5924	lithic scatter/field camp		JE	---	---
CrNV-21-5925	lithic scatter		JI	---	---
FORM ONLY					
Ao-0122	lithic scatter		UN		AV
CrNV-02-1124	quarry/lithic scatter		UN		AV
CrNV-21-0422	Getchel Mine Complex		UN		AV
CrNV-21-5543	Shoshone Mike Massacre Site	Overburden and interburden storage or heap leach pad	UN		AV

AV = Avoid
JE = Judged eligible
JI = Judged ineligible
E = Eligible (State Historic Preservation Office concurrence)
ME = Mitigative excavations
NA = No Action required
NEV = Eligible pending further evaluation (State Historic Preservation Office concurrence)
NEL = Not eligible (State Historic Preservation Office concurrence)
UN = Unevaluated