U.S. Department of the Interior

Bureau of Land Management

Elko District Office

Elko, Nevada

May 1993

DRAFT

Environmental Impact Statement Newmont Gold Company's South Operations Area Project

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 on 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/EK/PL-93/009+1793

United States Department of the Interior

TAKE PRIDE IN AMERICA

BUREAU OF LAND MANAGEMENT
Nevada State Office
850 Harvard Way
P.O. Box 12000
Reno, Nevada 89520-0006

IN REPLY REFER TO:

1793.4/3809
(NV-010)
N16-81-009P

MAY 7 1993

Dear Reader:

Enclosed for your review is the Draft Environmental Impact Statement (EIS) for Newmont Gold Company's South Operations Area Project prepared by the Bureau of Land Management, Elko District Office. This Draft EIS analyzes the potential environmental impacts that could result from a decision to implement the Plan of Operations, submitted by Newmont Gold Company to the Elko District Office. Newmont's proposal incorporates expansion of the open pit Gold Quarry Mine, as well as extraction of ore from two new open pit mines in the Carlin Trend, approximately six miles north of Carlin, Nevada. The Draft EIS also analyzes impacts from construction of ancillary facilities associated with the mining expansion.

Proposed expansion of the Gold Quarry Mine entails deepening the mine pit by approximately 775 feet below the water table. Mining of the sulfidic ore below the water table would necessitate dewatering of the mine pit. Identification of the potential impacts associated with the dewatering process was one of the major reasons for preparing an EIS.

In addition to the Proposed Action (based on Newmont Gold Company's Plan of Operations), four alternatives, including the No Action Alternative, have been analyzed in the Draft EIS. The Bureau's Preferred Alternative incorporates portions of both the Proposed Action and Alternative 3.

The Bureau of Land Management would appreciate your review and comment on the adequacy and accuracy of this document. Written comments on the Draft EIS must be submitted before close of business on Monday, July 19, 1993, and should be sent to:

Bureau of Land Management
Elko District Office
Attn: David Vandenberg, EIS Coordinator
P.O. Box 831
Elko, Nevada 89803

Comments may be FAXed to the Elko District Office on or before July 19th at (702) 753-0255. A hard copy of the FAXed comments, with original signatures, must be received at the above address within one week after the FAX has been sent or the comments will not be accepted.

In addition, public meetings to accept verbal and/or written comments on the Draft EIS are scheduled for the following dates, places, and times:

1. June 23rd in Elko at the Elko Convention Center at 700 Moren Way from 7:00 - 9:00 pm.

2. June 24th in Reno at the Holiday Inn at 1000 E. Sixth Street from 7:00 - 9:00 pm.

Following the public review and comment period, a Final Environmental Impact Statement will be prepared considering the public comments received through the review process. An abbreviated format may be used to present this information, therefore, it is suggested that this copy be retained for reference purposes.

Your interest in managing public lands is appreciated. If you have any questions or need further information, please contact David Vandenberg, Planning and Environmental Coordinator for the Elko District Office at (702) 753-0200.

Sincerely,

K. Lynn Bennett

For Billy R. Templeton
State Director, Nevada

DRAFT

ENVIRONMENTAL IMPACT STATEMENT NEWMONT GOLD COMPANY'S SOUTH OPERATIONS AREA PROJECT

LEAD AGENCY

U.S. Department of the Interior
Bureau of Land Management
Elko District Office
Elko, Nevada

PROJECT LOCATION

Elko and Eureka Counties, Nevada

COMMENTS ON THIS DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS) SHOULD BE DIRECTED TO:

David Vandenberg, EIS Coordinator
Elko District Office
Bureau of Land Management
P.O. Box 831
Elko, NV 89803
(702) 753-0200

DATE DRAFT EIS WAS MADE AVAILABLE TO THE ENVIRONMENTAL PROTECTION AGENCY AND THE PUBLIC

May 21, 1993

DATE BY WHICH COMMENTS SHOULD BE RECEIVED BY THE BUREAU OF LAND MANAGEMENT

July 19, 1993

ABSTRACT

The Draft Environmental Impact Statement analyzes impacts associated with a proposal to continue and expand gold mining operations on a site in northeastern Nevada. The Proposed Action includes: (1) mining 775 feet below the groundwater level in a currently operating open pit mine, (2) dewatering the mine and discharging warm groundwater (up to 42,000 gallons per minute) directly into Maggie Creek, six miles above the confluence with the Humboldt River, (3) mining two new open pit mines, (4) constructing ancillary mine facilities, as well as, (5) constructing a new haul road for transport of ore from a private mine north of the project area. Three alternatives to the Proposed Action are analyzed in the document. The Agency Preferred Alternative includes portions of both the Proposed Action and Alternative 3. A considerable portion of the Draft Environmental Impact Statement addresses and analyzes impacts associated with dewatering issues and the resulting cone of depression. Significant impacts include long-term flow reduction or elimination of springs, seeps and streams in the area, and an additive disruption to a major mule deer migration corridor. Habitat of the Federally-listed threatened Lahontan cutthroat trout would also be impacted.

DRAFT ENVIRONMENTAL IMPACT STATEMENT
NEWMONT GOLD COMPANY'S
SOUTH OPERATIONS AREA PROJECT

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SUMMARY

Newmont Gold Company (Newmont) proposes activities that would support continued operation and expansion of gold mining and processing at its South Operations Area in Eureka and Elko Counties, Nevada; 6 miles northwest of Carlin. The South Operations Area is located on both private lands owned or controlled by Newmont and on public lands administered by the Bureau of Land Management (BLM). Newmont submitted a Plan of Operations (POO) amendment describing proposed activities at the South Operations Area Project in February 1992. BLM reviewed the POO and determined that the Proposed Action had the potential to result in significant environmental impacts and that preparation of an Environmental Impact Statement (EIS) would be necessary.

This EIS describes components of, reasonable alternatives to, and environmental consequences of implementing the South Operations Area Project. Direct, indirect, and cumulative impacts on the affected environment have been analyzed for the Proposed Action and alternatives to the extent necessary to determine if impacts are significant. The impacts described in this document will be the basis for a decision regarding the Proposed Action or alternatives and selection of appropriate mitigation. No distinction has been made between impacts occurring on public versus privately owned land that would result from the possible federal authorization.

SUMMARY OF THE PROPOSED ACTION

The Proposed Action would provide for continuation of mining at the Gold Quarry Mine and expansion of mining which would incorporate two satellite ore bodies, the MAC and Tusc Mines, all contained within the South Operations Area. In addition, Newmont would construct a haul road from its North Operations Area to the South Operations Area. This road would allow haulage of mill-grade sulfidic ore mined from Newmont's private Post Mine in the North Operations Area for processing at the South Operations Area. Total disturbance in the South Operations Area associated with the Proposed Action would be 1,573 acres, of which 763 acres are private lands and 810 acres are public lands. The disturbed area would include mine pits, leach pads, waste rock disposal areas, haul roads, and ancillary mine facilities associated with the Proposed Action.

Mining and processing operations would result in recovery of oxide and sulfide ores by deepening the existing Gold Quarry Mine pit approximately 775 feet, and creating two new open pit mines (MAC and Tusc). Total disturbance area associated with development of the open pit mines would be 197 acres. Mining at the South Operations Area is expected to continue through year 2001 and ore processing would continue through 2009.

Deepening of the Gold Quarry Mine pit would result in further mining below the regional groundwater table and would require installation of additional dewatering wells to keep groundwater out of the mine pit. Dewatering would result in pumping water in excess of Newmont's water needs at the South Operations Area. Newmont proposes to pump water at rates of up to 42,000 gallons per minute (gpm), treat the water to State of Nevada standards, and discharge the water to Maggie Creek near the mine site.

In addition, discharge water would be cooled, when necessary, such that the temperature of the Humboldt River at Palisade would be maintained within 2°C of ambient water temperatures. This cooling would be accomplished by using a cooling system constructed adjacent to the water treatment facility.

Newmont also proposes to expand its existing Maggie Creek Ranch Reservoir, located east of the mine area, to store excess water during periods of high natural streamflow. The expanded Maggie Creek Ranch Reservoir would have a capacity of approximately 6,000 acre-feet, which would provide approximately 4 weeks of storage capacity at the maximum pumping rate of 42,000 gpm. Dewatering activities would cease at the conclusion of open pit mining in year 2001.

Waste rock generated during mining would be disposed at the existing South Waste Rock Disposal Area and two new waste rock disposal areas: the MAC Waste Rock Disposal Area and the Tusc Waste Rock Disposal Area. Waste rock disposal at the South Waste Rock Disposal Area would require an expansion of approximately 50 acres. Waste rock placed on the MAC and Tusc disposal areas would disturb approximately 315 acres. The combined total waste rock production for the three mine pits would be 181 million tons.

Combined ore production for the three open pits is expected to be about 151 million tons. Of this amount, approximately 111 million tons would be oxide and mill-grade sulfide ore. The remaining 40 million tons would be low-grade sulfide ore. Newmont's private Post Mine is anticipated to produce 16.5 million tons of mill-grade sulfide ore.

Ore processing at the South Operations Area would include continuation of milling, cyanidation, and gold recovery through the Mill 5/6 complex (formerly Mill 2/5 complex) and heap leaching. Mill 6 would replace Mill 2 through modification in order to allow processing of sulfidic ores produced from the Post Mine and the Gold Quarry Mine. Sulfide or refractory ores would require pre-treatment prior to gold recovery. Oxide ores would continue to be processed either through Mill 5 or placed on existing leach pads.

Two methods are proposed by Newmont to pre-treat the sulfidic ores: roasting and bio-oxidation. The roasting process would be used for high grade sulfidic ores. After crushing and milling, the sulfidic ore would be processed through a roaster facility that would oxidize the ore by heating it to 1,020°F. The roaster facility would be cooled using a closed circuit cooling tower system. Oxidation would allow the ore to be further processed through Mill 6.

Low-grade sulfidic ores would be pre-treated through a bio-oxidation process. Bio-oxidation involves the use of naturally occurring bacteria to oxidize the ore. Once bio-oxidation is complete, the ore can be leached with cyanide solutions. Four new leach pads would be constructed to treat and leach low-grade sulfidic ore. A total of 378 acres would be disturbed for construction of the leach pads.

Tailing generated by the Mill 5/6 complex would be disposed at the existing Mill 2/5 Tailing Storage Facility. The embankment height of this facility would be increased to provide for an additional 35 million cubic yards of storage capacity. No additional acreage would be disturbed for expansion of the tailing storage facility.

Proposed reclamation activities at the South Operations Area would include neutralization of process solutions, regrading of disturbance areas, replacement of topsoil, and seeding, fertilizing, and mulching. The mine pits would not be reclaimed; however, each mine pit would be fenced.

PROJECT ALTERNATIVES

Alternatives identified in this EIS were developed in response to issues raised during public scoping and BLM review of the Proposed Action. Alternatives selected for detailed review in the EIS were based on three principal issues related to potential impacts resulting from the Proposed Action:

***Issue 1*:** Changes in fisheries and aquatic habitat resulting from discharge of large volumes of warm groundwater (approximately 25°C or 77°F) as a result of mine dewatering.

Issue 2: Feasibility of backfilling open mine pits to be consistent with Nevada Administrative Code (519A.250) concerning solid minerals reclamation standards and policy statements outlined in the Federal Land Policy Management Act (PL 94-579, 43 USC 1701).

Issue 3: Changes in quantity and quality of surface water and groundwater resources within Maggie Creek Basin.

Three alternatives were developed to address the issues outlined above. In addition, the No Action Alternative was also carried forth for analysis. The alternatives are as follows:

Alternative 1: Operation of the cooling tower system at the water treatment plant to ensure that discharge water, when mixed with Maggie Creek and/or the Humboldt River, will be maintained within 2°C (State of Nevada water quality standard) of Humboldt River ambient temperature at a point one-half mile downstream of the Maggie Creek confluence.

Alternative 2: Backfilling of the MAC open pit mine with waste rock generated from the Tusc open pit mine.

Alternative 3: Discharge of treated groundwater from the mine dewatering system directly to the Humboldt River via pipeline.

No Action Alternative: Expansion of the South Operations Area Project mining facilities would not be approved. The MAC and Tusc geologic reserves would not be mined, and the Gold Quarry Mine would not expand beyond the currently approved POO.

As a result of the analysis in this EIS, the BLM developed its preferred alternative.

Agency Preferred Alternative: Implementation of the Proposed Action and a modified version of Alternative 3. A direct discharge pipeline to the Humboldt River would be constructed to transport dewatering flows greater than Maggie Creek's bankfull capacity.

In addition, modification of the Maggie Creek channel would be required to minimize erosion and sedimentation that would occur as a result of increased flows in lower Maggie Creek. This would necessitate a Section 404 Permit from the U.S. Army Corps of Engineers.

Selected mitigating measures, as identified in Chapter 4, would be required by BLM in the Record of Decision for whichever alternative is ultimately selected, subsequent to public review.

SUMMARY OF IMPACTS

Detailed analysis of potential impacts and mitigations are presented in Chapter 4, Consequences of the Proposed Action and alternatives. Resources that are analyzed in this EIS and are determined to have minimal impacts as a result of the Proposed Action and alternatives include: Paleontology, Air Quality, Wilderness, and Noise. The following is a summary of potential impacts, by resource, resulting from implementation of the Proposed Action and alternatives.

PROPOSED ACTION

Geology and Minerals

Newmont's proposed mine expansion project would move waste rock and ore from the Gold Quarry, MAC, and Tusc mine pits to waste rock disposal areas and a tailing storage facility. Relocation of these rock materials would modify landscape and topography of the South Operations Area. Approximately 7 million ounces of gold would be extracted from the geologic resource.

Water Resources

The Proposed Action would require the expansion of pit dewatering operations. Approximately 500,000 acre-feet of groundwater would be removed through dewatering concurrent with mining activities. As a result, groundwater levels in the mine area would decline, causing reduced flows or loss of springs, seeps, and streamflow in the project area. Based on the extent of groundwater drawdown predicted by a numeric model, approximately 25 spring and seep sites would be impacted. During the dewatering period, discharge of mine water would increase flow in lower Maggie Creek and the Humboldt River. Reductions or possible elimination of streamflow would be expected to occur in portions of lower Susie Creek, Marys Creek (including the Carlin "Cold" Springs), upper Maggie Creek, as well as James, Soap, Simon, Lynn, and East Cottonwood Creeks due to the resulting groundwater cone of depression. These streams, along with lower Maggie Creek and some sections of the Humboldt River below Carlin, would also experience declines in, or possible losses of, flow after cessation of dewatering.

Flows in springs, seeps and streams would eventually return to pre-mining conditions after pumping has ceased and the groundwater cone of depression has recovered sufficiently. Complete recovery of the water table may take nearly 100 years; however, results of the model indicate that 95 percent of groundwater recovery would occur within 18 years after dewatering ceases.

Discharge of warm groundwater (approximately 25°C) generated by mine dewatering to Maggie Creek would result in increased water temperatures to the receiving water from the point of discharge to the Humboldt River; a distance of approximately six miles. Increased sediment load and changes in channel stability are also anticipated on Maggie Creek. In the Humboldt River, below the confluence with Maggie Creek, there would be a thermal mixing zone of approximately ten miles where water temperatures would be elevated. Sediment load would also increase. Excess mine water would be treated to acceptable water quality standards prior to discharge.

The Gold Quarry Mine pit would fill with groundwater to an ultimate saturated depth of about 775 feet. Most of the pit lake would form during the first 10 to 20 years after mining ceases. As a result of several factors, including carbonate rock in the pit walls, the ultimate pit lake chemistry is expected to be similar to that of existing groundwater.

Soils

Soils located on approximately 1,573 acres would be disturbed by the Proposed Action. Implementation of the proposed reclamation plan would result in soils being redistributed on approximately 1,376 acres which includes all proposed disturbance areas except the mine pits. Soil losses are expected to be minimal as a result of establishing vegetation cover on stockpiles to reduce wind and water erosion.

Vegetation

Mining expansion would disturb approximately 1,573 acres of vegetation. With the exception of 197 acres associated with the mine pits, reclamation would restore vegetation cover on all proposed disturbance areas.

Riparian Areas and Wetlands

A total of 1,356 acres of riparian vegetation would be affected by the proposed dewatering program. Approximately 1,342 acres of the total disturbance is associated with the tributaries of the Humboldt river. Potentially affected wetland/riparian areas are associated with the seven streams discussed in the Water Resources section. In addition, a reduction or loss of flow in 25 spring and seep sites would cause an additional 14 acres of riparian/wetlands to be affected. Due to increased flows in the Humboldt River, there may be up to 71 acres of stream deposits covered up for the duration of the dewatering. Subsequent to the mine dewatering, there would be a 10 - 20 year period where up to 89 acres of stream deposits may be exposed due to the effects of the groundwater cone of depression.

Discharge of excess water to Maggie Creek during the dewatering period may create additional riparian vegetation and habitat.

Terrestrial Wildlife

Impacts on terrestrial wildlife would include loss of habitat and loss and displacement of wildlife from the affected habitat. Construction of the North Area Haul Road and mining of the MAC and Tusc ore deposits would impede seasonal migration of 2,000 to 4,000 mule deer. Reductions or elimination of flows in springs, seeps, and streams due to dewatering would impact wildlife species dependent on these sites (e.g. amphibians and certain birds) and may affect distribution of other species (e.g. bats mule deer, and pronghorn antelope) that use these sites as part of a larger habitat complex.

Aquatic Habitat and Fisheries

Reductions or elimination of streamflow associated with dewatering would decrease habitat quality for fish and other aquatic organisms in the Humboldt River, Maggie Creek, and Susie Creek. These flow changes would occur primarily during low-flow periods for several years after dewatering. Intermittent streamflows would eliminate or restrict fish and many aquatic insects in dewatered portions of streams.

Discharge of warm water would increase growth rates of fish, aquatic invertebrates, and algae by increasing water temperatures in Maggie Creek and the Humboldt River during winter when normal temperatures are suboptimal for growth. During the summer, peak water temperatures would be slightly lowered which could have a positive effect on fish.

Threatened, Endangered, and Candidate Species

Lahontan cutthroat trout could be directly affected by the proposed mine expansion. Habitat in portions of Maggie and Susie Creeks would be temporarily degraded or eliminated by flow reductions resulting from mine dewatering. Final determination of impacts to Lahontan cutthroat will be made in consultation with the U.S. Fish and Wildlife Service.

Livestock Grazing

The Proposed Action would affect three grazing allotments and permittees. Twenty-five spring and seep sites and several streams within the Study Area would be affected by groundwater drawdown, reducing availability of stockwater. Stocking rates would likely be reduced on some grazing allotments throughout the period of drawdown and recovery for the cone of depression. A total of 8,092 animal unit months on public and private land could be lost due to dewatering and surface disturbance.

Some areas, such as mine pits, would be permanently lost to livestock grazing. Steep slopes on reclaimed waste rock disposal areas or leach pads may result in limited use by livestock. Permanent losses in grazing areas associated with the mining pits, coupled with uncertainty regarding stockwater availability, may result in permanent reductions in stocking rates on some allotments.

Recreation

The Proposed Action would result in fewer acres being available for recreational use during and after mining. Temporary residents associated with the construction force would create additional pressure on the currently stressed recreational facilities within Elko County.

Visual Resources

The primary impact on visual resources from the Proposed Action would be large-scale modification of landforms. There would be little additional visual contrast in areas where existing facilities are visible. Modification of the existing landscape would result from development of the MAC and Tusc mine pits, and construction of the North Area Haul Road. Cooling towers associated with the roaster and water treatment facilities would create visible steam plumes during certain weather conditions.

Cultural Resources and Ethnography

Thirty seven cultural resources have been recorded in the area of direct effects. Three of these are considered eligible for listing on the National Register of Historic Places (NRHP) and would be impacted through construction of the North Area Haul Road.

Based on data presented the technical report, *Consultation With The Western Shoshone Regarding the Proposed Expansion of Newmont's Gold Quarry Mine, Carlin, Nevada* (Deaver 1993), the BLM has determined that there would be no direct or indirect impacts to Newe/Western Shoshone traditional values, practices, properties, or human remains and cultural items as a result of the Proposed Action.

Social and Economic Impacts

Temporary socioeconomic impacts from the proposed mine expansion would occur during the construction period primarily within local communities. Fiscal impacts would occur within affected counties. Newmont projects that no additional employees would be hired during the operational life of the proposed mine expansion, however, up to 758 temporary construction workers would be hired during the largest phase of expansion.

Influxes of temporary construction workers and their families would have both positive and negative impacts. Stresses on retail facilities, community services, and housing would be the principal adverse effects. Benefits to local communities would result from increased retail sales and generation of short term employment. Property taxes and net proceeds of mining taxes would be paid to Eureka County, whereas most sales tax revenues would accrue to Elko County. Commercial and residential development induced by mine expansion in Elko County would increase revenues from property and sales taxes. Wages spent by miners and workers in mining related occupations would continue to contribute to local revenues through sales and use taxes.

ALTERNATIVES

Where specific impacts, by resource, are not presented under each alternative, it is to be assumed that those impacts would be the same as that of the Proposed Action.

ALTERNATIVE 1

Water Resources

Implementation of Alternative 1 would bring the water temperature in Maggie Creek and the Humboldt River closer to ambient conditions. Potential thermal impacts to the Humboldt River in the mixing zone would be reduced to less than one-half mile.

Visual Resources

The operation of the cooling tower at the water treatment facility upon initiation of dewatering would create a steam plume under certain weather conditions. This plume would occur sooner in the mine project in comparison to the Proposed Action and would have an additive visual contrast with the plume from the roaster facility. The plumes would draw attention to the area.

ALTERNATIVE 2

Geology and Minerals

Backfilling of the MAC mine pit would make it more difficult and more expensive in the future to mine additional geologic ore reserves identified in the MAC pit area.

Soils

Backfilling the MAC pit would result in redistribution of soils on an additional 40 acres, increasing the total soil redistribution area to 1,416 acres for reclamation purposes.

Vegetation

Backfilling of the MAC pit would result in an additional 40 acres of lands being revegetated through reclamation, increasing the total reclaimed area to 1,416 acres.

ALTERNATIVE 3

Soils

An additional 56 acres of soils would be disturbed due to construction of the pipeline to the Humboldt River, increasing the total soil disturbance to 1,629 acres. Redistribution of soils would occur on 1,432 acres.

Water Resources

Direct discharge to the Humboldt River would eliminate sediment and channel stability problems in Maggie Creek. Impacts from the elevated water temperature and the ten mile mixing zone entering the Humboldt River would be equivalent to that of the Proposed Action.

The cone of depression would extend a greater distance to the north and east which would increase the affect on 2 - 10 springs. Baseflow in Susie Creek and the Carlin "Cold" Spring system would be further reduced.

Vegetation

An additional 56 acres of vegetation along the proposed pipeline route would be disturbed, increasing the total disturbance to 1,629 acres. Reclamation would occur on 1,432 acres.

Riparian Areas and Wetlands

Modifying the point of discharge to the Humboldt River would reduce or eliminate potential for developing riparian habitat along Maggie Creek.

Visual Resources

A weak linear contrast would become evident in the low-visibility corridor along Interstate 80 due to construction of the pipeline.

Cultural Resources and Ethnography

The 56 acres associated with the pipeline have not yet been inventoried. Based on distribution of sites throughout the Study Area, it is projected that no more than one NRHP eligible property is located within the proposed pipeline area.

NO ACTION ALTERNATIVE

Under this alternative, the proposed Plan of Operations and further disturbance of public land would not occur.

AGENCY PREFERRED ALTERNATIVE

Soils

An additional 56 acres of soils would be disturbed due to the construction of the Humboldt River pipeline, increasing the total disturbance to 1,629 acres. Soil redistribution would occur on a total of 1,432 acres.

Water Resources

The direct discharge pipeline would be used when flow in Maggie Creek exceeds its bankfull capacity of approximately 36,000 gallons per minute (80 cubic feet per second). This discharge rate is expected to be exceeded during the last two to three years of operations. Through modification of Maggie Creek into a stable channel configuration, as well as use of the direct discharge pipeline to the Humboldt River, impacts from sediment load as well as channel stability would be significantly reduced or eliminated.

Vegetation

An additional 56 acres of vegetation along the proposed pipeline route would be disturbed, increasing the total disturbance to 1,629 acres. This area would be reclaimed, increasing total reclamation to 1,432 acres.

Riparian Areas and Wetlands

A greater opportunity would exist for the establishment of a riparian community along Maggie Creek.

Visual Resources

A weak linear contrast would become evident in the low-visibility corridor along Interstate 80 due to construction of the pipeline.

Cultural Resources and Ethnography

The 56 acres associated with the pipeline have not yet been inventoried. Based on distribution of sites throughout the Study Area, it is projected that no more than one NRHP eligible property is located within the proposed pipeline area.

CHAPTER 1

INTRODUCTION

Elko District of the Bureau of Land Management (BLM) received an amended Plan of Operations from Newmont Gold Company (Newmont) In February 1992, proposing activities that would support continued operation and expansion of existing open-pit gold mining and ore-processing facilities at its South Operations Area.[1] Newmont's South Operations Area is located on public and private lands approximately 6 miles northwest of the town of Carlin in both Eureka and Elko counties, Nevada (Figure 1-1). Since certain proposed facilities in the South Operations Area are located on public land administered by BLM, review and approval of Newmont's amended Plan of Operations are required by BLM pursuant to 43 CFR 3809 ("Surface Management Regulations"). Due to the potential for the proposed project to result in significant environmental impacts, BLM determined that an environmental impact statement (EIS) would be necessary, as required by the National Environmental Policy Act of 1969 (NEPA).

The BLM is serving as lead agency in preparing this EIS for the proposed continued operation and expansion of Newmont's existing gold mining operation. This document follows regulations promulgated by the Council on Environmental Quality (CEQ) for implementing the procedural provisions of NEPA (40 CFR 1500-1508) and BLM's NEPA Handbook (H-1790-1).

This EIS describes the components of, reasonable alternatives to, and environmental consequences of continued operation and expansion of mining and processing facilities in the South Operations Area. Chapter 1 describes Purpose and Need, the role of BLM, and summarizes public participation in the EIS process. Chapter 2 provides a historical perspective of gold mining in the project area, a complete description of the existing operations and Proposed Action, and alternatives to the Proposed Action. Chapter 3 describes the existing environment in the South Operations Area.

Direct, indirect, and cumulative impacts associated with the Proposed Action and alternatives, and possible mitigations to reduce or minimize impacts, are described in Chapter 4. Consultation and coordination with state and federal agencies and a list of preparers is included in Chapter 5. Chapter 6 contains a list of references cited in developing the EIS.

PURPOSE AND NEED

Newmont's purpose in proposing the continued operation and expansion of its existing open-pit mining and ore-processing operations at the South Operations Area is to use its existing work force, mining and milling equipment, and ore-processing facilities to produce gold from: (1) deeper reserves contained in the Gold Quarry Mine, (2) two near-surface satellite ore bodies, and (3) mill-grade refractory ore from its North Operations Area. Gold is an established commodity with international markets. Uses include investments, standard for monetary systems, jewelry, and electronics and other industrial applications.

[1] The original amended Plan of Operations and all previous public documents regarding this environmental impact statement referred to the action as the Gold Quarry Mine Expansion. Newmont has since revised the title of its amended Plan of Operations to read "South Operations Area Project" to more accurately reflect the scope of the proposal.

AUTHORIZING ACTIONS

A proposal submitted to the BLM may be approved only after an environmental analysis is completed as required by NEPA. BLM decision options include approving Newmont's amended Plan of Operations as submitted, approving alternatives to the amended Plan of Operations to mitigate environmental impacts, approving the Plan of Operations with stipulations to mitigate environmental impacts, or denying the amended Plan of Operations.

A substantial portion of Newmont's South Operations Area facilities would be located in whole or in part on unpatented mining claims administered by BLM; such operations must comply with BLM regulations for mining on public lands (43 CFR 3809, Surface Management Regulations), the Mining and Mineral Policy Act of 1970, and the Federal Land Policy and Management Act of 1976. These regulations recognize the statutory right of mining claim holders to develop federal mineral resources under the General Mining Law of 1872. These statutes, however, in combination with other BLM policies (i.e., the Resource Management Plan) also require the BLM to analyze proposed mining operations to ensure that: (1) adequate provisions are included to prevent undue or unnecessary degradation of public lands, (2) measures are included to provide for reasonable reclamation of disturbed areas, and (3) proposed operations will comply with other applicable federal, state, and local laws and regulations.

In addition to BLM, other federal, state, and local agencies have jurisdiction over certain aspects of the Proposed Action. Table 1-1 provides a comprehensive listing of the agencies and identifies their respective permit/authorizing responsibilities (also see Chapter 6, Statute Glossary).

RELATIONSHIP TO BLM AND NON-BLM POLICIES, PLANS, AND PROGRAMS

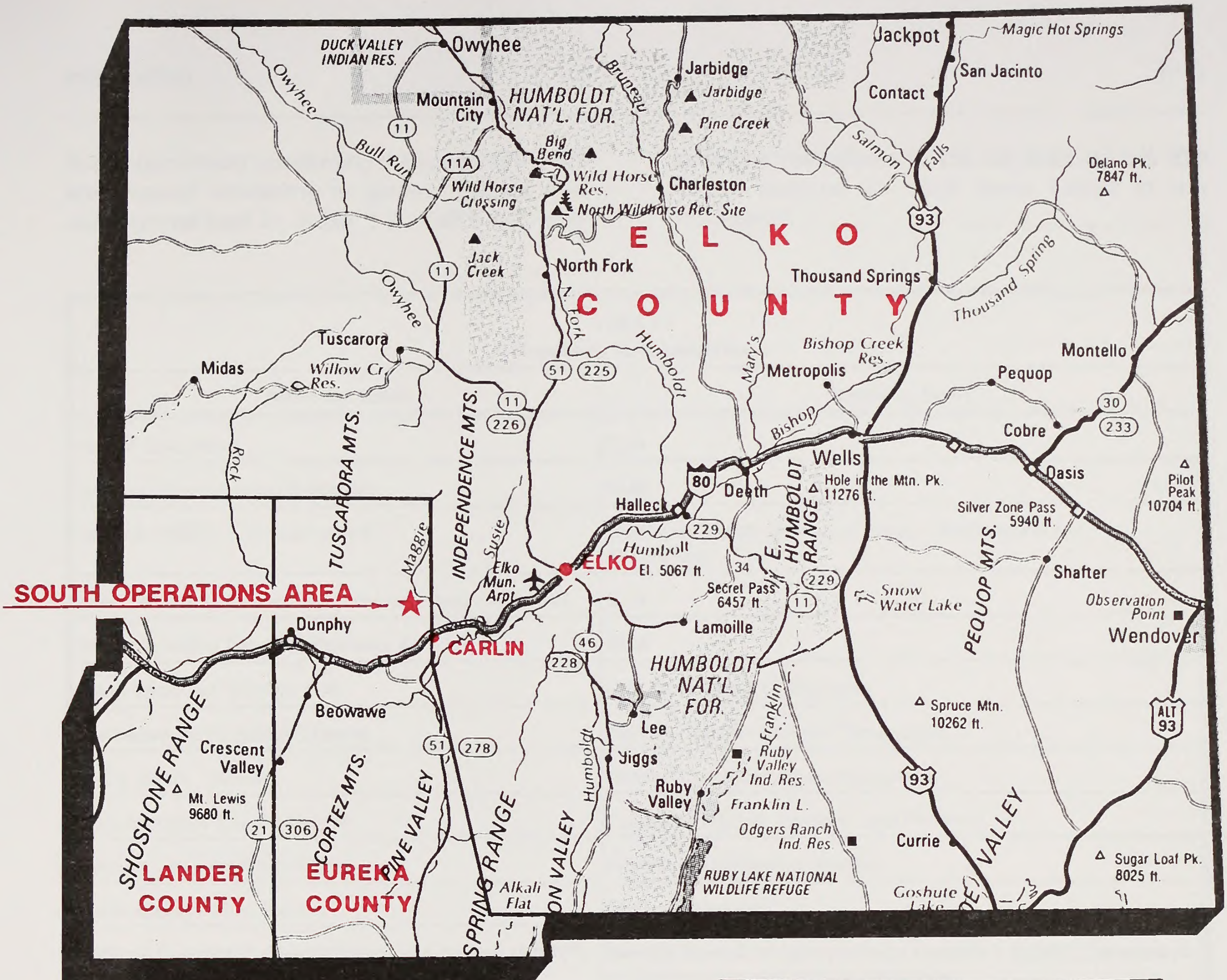
The South Operations Area amended Plan of Operations has been reviewed for compliance with BLM policies, plans, and programs. The proposal is in conformance with the minerals decisions in the Record of Decision, Elko Resource Area, Resource Management Plan, approved in March 1987. Through the EIS process, the proposed South Operations Area Project is being evaluated for conformance with existing land use restrictions by the State of Nevada and Elko and Eureka counties.

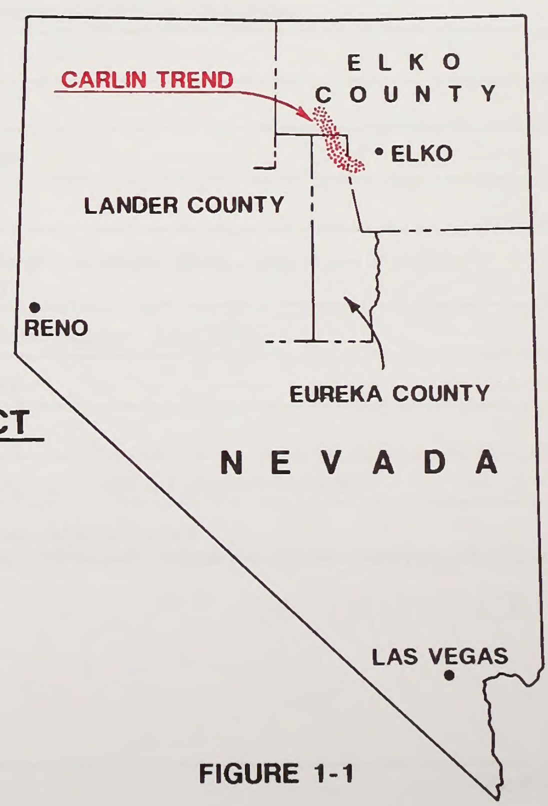
PUBLIC SCOPING

To allow an early and open process for determining the scope of significant issues related to the Proposed Action (40 CFR 1510.7), a public scoping period was provided by BLM. A Notice of Intent to prepare the EIS was published in the Federal Register on February 14, 1992. Publication of this notice in the Federal Register initiated a 67-day public scoping period for the Proposed Action that provided for acceptance of written comments through April 24, 1992.

The BLM mailed a scoping package that included a project summary and maps to 370 individuals and organizations. In addition, the scoping package was distributed at public meetings. The amended Plan of Operations for the proposed action was provided on request. Concurrent with these actions, BLM issued a news release to two radio stations and 18 news organizations with coverage in the surrounding geographical regions in Nevada, Idaho, and Utah.

Public scoping meetings were held by BLM in Elko (April 7, 1992) and Reno (April 8, 1992). Separate meetings were held for the Elko and Eureka county commissioners. The scoping meetings were attended by 114 people in Elko and 24 people in Reno. During the meetings, seven people presented oral comments. Written responses were received from 517 individuals and groups. Of the 517 individuals and groups, 448 signed a petition concerning recreational use of the reservoir proposed for construction within the Maggie Creek Basin.





SOUTH OPERATIONS AREA PROJECT

General Location Map

FIGURE 1-1

Public comments concerning the scope of the EIS are grouped according to general subject area and summarized in Table 1-2. Table 1-2 also provides references to the sections of this EIS which respond to each issue raised in the comments.

TABLE 1-1
Regulatory Responsibilities

Authorizing Action	Regulatory Agency
Plan of Operations	BLM
National Environmental Policy Act	BLM
National Historic Preservation Act	BLM and Nevada Division of Historic Preservation and Archaeology
Native American Graves Protection and Repatriation Act	BLM
American Indian Religious Freedom Act	BLM
Clean Water Act (Section 404)	U.S. Army Corps of Engineers
Microwave Radio Station License	Federal Communications Commission
Radio Station License	Federal Communications Commission
High Explosive License/Permit	Bureau of Alcohol, Tobacco, and Firearms
Industrial Artificial Pond Permit	Nevada Department of Wildlife
Water Appropriation Permits	Nevada State Engineer
National Pollutant Discharge Elimination System (NPDES) Permit	Nevada Division of Environmental Protection (NDEP), Department of Conservation and Natural Resources
Air Quality Registration Certificates and Permits to Operate	NDEP
Water Pollution Control Permit	NDEP
Mine Reclamation Permit	BLM/NDEP
Solid Waste Disposal Permit	NDEP
Potable Water	Nevada Division of Health (NDH), Department of Human Resources
Tailing Impoundment - Construction Permit	Nevada State Engineer - Dam Safety
Sewer System Approvals	NDH, NDEP
Radioactive Materials License	NDH
Safety Plan	Mine Safety and Health Administration (MSHA)
Threatened and Endangered Species Act	U.S. Fish and Wildlife Service

TABLE 1-2
Issues and Concerns Identified in Scoping

Issue	EIS Document Section(s)
Mine Dewatering	
Disruption of surface water and groundwater hydrology and impacts on water quality.	Chapter 3 - Water Resources (see p. 3-19 through 3-49) Chapter 4 - Water Resources (see p. 4-8 through 4-51)
Potential impacts of the cone of depression created by dewatering on fish and wildlife dependent on aquatic and riparian habitats.	Chapter 4 - Wetlands - Direct and Indirect Impacts (see p. 4-67 through 4-78) Chapter 4 - Aquatic Habitat and Fisheries - Direct and Indirect Impacts (see p. 4-84 through 4-88)
Potential effects of reduced flows in upper Maggie Creek on possible reintroduction of Lahontan cutthroat trout.	Chapter 4 - Threatened, Endangered, and Candidate Species - Direct and Indirect Impacts (see p. 4-88 through 4-89)
Potential for the cone of depression from dewatering to impact the Carlin water supply.	Chapter 4 - Water Resources - Direct and Indirect Impacts (see p. 4-23)
Mine Water Disposal	
Potential impacts of water discharge on channel stability of Maggie Creek and the Humboldt River.	Chapter 4 - Water Resources - Direct and Indirect Impacts (see p. 4-37)
Potential impacts of changes in water quality and quantity on fish, wildlife, and stockwater.	Chapter 4 - Aquatic Habitat and Fisheries - Direct and Indirect Impacts (see p. 4-84 through 4-88) Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-79 through 4-84) Chapter 4 - Livestock Grazing - Direct and Indirect Impacts (see p. 4-91 through 4-94)
Potential to manage Maggie Creek Ranch Reservoir for recreation and fisheries.	Chapter 2 - Opportunities (see p. 2-63)
Potential for increased flows in the Humboldt River to affect water rights or use by irrigators.	Chapter 4 - Water Resources, Land Use and Access (see p. 4-23 through 4-37; p. 4-105 and 4-106)
Potential for removal of groundwater from the basin to conflict with water rights and water management policy.	Chapter 3 - Water Resources; Land Use and Access (see p. 3-19 through 3-29; 3-97 and 3-98) Chapter 4 - Water Resources; Land Use and Access (see p. 4-8 through 4-51; p. 4-105 and 4-106)
Wildlife, Fisheries, and Aquatic Communities	
Potential impacts of cyanide, and mine drainage, and other toxic materials on wildlife and aquatic communities.	Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-79 through 4-84) Chapter 4 - Aquatic Habitat and Fisheries - Direct and Indirect Impacts (see p. 4-84 through 4-88)
Potential impacts of noise from mining on wildlife.	Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-81)

TABLE 1-2 (continued)
Issues and Concerns Identified in Scoping

Issue	EIS Document Section(s)
Potential impacts on breeding, nesting cover, and foraging habitat.	Chapter 4 - Wetlands - Direct and Indirect Impacts (see p. 4-67 through 4-78) Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-79 through 4-84) Chapter 4 - Threatened, Endangered, and Candidate Species - Direct and Indirect Impacts (see p. 4-88 through 4-91)
Potential impacts of Maggie Creek Ranch Reservoir and open-flow channel on wildlife, such as winter range of mule deer and antelope.	Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-81 through 4-88)
Need for additional studies on amphibians and mollusks in the Humboldt River and Maggie Creek drainages.	Chapter 3 - Aquatic Habitat and Fisheries (see p. 3-69 and 3-70) Chapter 4 - Aquatic Habitat and Fisheries - Direct and Indirect Impacts (see p. 4-84 through 4-88)
Land Use	
Restoration of pre-mining land uses following mining.	Chapter 2 - Reclamation (see p. 2-37 through 2-54)
Loss of grazing capacity of land supporting wild horses.	Chapter 3 - Introduction (see p. 3-1)
Toxic and Hazardous Chemicals	
Potential for workers to be exposed to cyanide and other toxic chemicals.	Chapter 2 - Human Health and Safety (see p. 2-21 and 2-37) Chapter 2 - Hazardous Materials (see p. 2-17 and 2-36)
Use of tanks for cyanide leaching rather than heap leaching.	Chapter 2 - Alternatives Eliminated from Further Consideration (see p. 2-62)
Inclusion in EIS of Occupational Safety and Health Administration (OSHA) 200 logs and Mining Safety and Health Administration (MSHA) 7000-1 forms.	Beyond scope of this document. See pages 2-17 and 2-18 for description of hazardous materials and wastes.
Discussion in EIS of environmental fate of cyanide after use in mine process.	Chapter 4 - Water Resources (see p. 4-44)
Socioeconomic Considerations	
Stress on community services from nonlocal workers.	Chapter 4 - Social and Economic Resources - Direct and Indirect Impacts; Cumulative Impacts (see p.4-110 through 4-112)
Social and economic benefits from continuation of mining.	Chapter 4 - Social and Economic Resources - Direct and Indirect Impacts; Cumulative Impacts (see p. 4-110 through 4-112)
Air Quality	
Potential impact of particulates and dust emissions from mining and ore processing on air quality.	Chapter 3 - Air Resources - Air Quality (see p. 3-17 and 3-18) Chapter 4 - Air Resources - Direct and Indirect Impacts (see p. 4-6 and 4-7)

TABLE 1-2 (continued)
Issues and Concerns Identified in Scoping

Issue	EIS Document Section(s)
Potential effects of regional air pollution on human health, wildlife, and vegetation.	Chapter 3 - Air Resources - Air Quality (see p. 3-13, 3-17, and 3-18) Chapter 4 - Air Resources - Direct and Indirect Impacts; (see p. 4-6 and 4-7)
Discussion in EIS of National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD).	Chapter 3 - Air Resources - Air Quality (see p. 3-17 and 3-18) Chapter 4 - Air Resources - Direct and Indirect Impacts (see p. 4-6 through 4-8)
Past air quality violations of Newmont.	Beyond scope of this document.
Permits and Regulatory Compliance	
Need for a wastewater permit for dewatering discharge, an Army Corps of Engineers (COE) 404 Permit, and a State of Nevada Reclamation Permit.	Chapter 1 - Table 1-2 (see p. 1-5)
Discussion in EIS of compliance with Resource Conservation and Recovery Act (RCRA) regulations and the Migratory Bird Treaty Act.	Chapter 2 - Hazardous Materials (see p. 2-17 and 2-36)
Solicitation of comments from the U.S. Environmental Protection Agency (EPA) Region IX.	EPA will have opportunity to review document.
Alternatives	
Possible alternatives to cyanide use.	Chapter 2 - Alternatives Eliminated from Further Consideration (see p. 2-62)
Alternative methods of storing process solutions, such as smaller ponds and enclosed storage tanks, to prevent wildlife poisoning.	Chapter 2 - Alternatives Eliminated from Further Consideration (see p. 2-62) Chapter 4 - Terrestrial Wildlife - Direct and Indirect Impacts (see p. 4-81)
Partial or complete backfilling of pits.	Chapter 2 - Alternatives Considered in Detail - Alternative 2 (see p. 2-55)
Discussion of nonmining alternative.	Chapter 2 - No Action Alternative (see p. 2-56)
Delay mining pending development of improved reclamation technologies.	Chapter 2 - Alternatives Eliminated from Further Consideration (see p. 2-62)
Alternative sites for locating major facilities, limiting pit size, and reducing groundwater flows.	Chapter 2 - Alternatives Eliminated from Further Consideration; Alternatives Considered in Detail - Alternative 3; No Action Alternative (see p. 2-55 through 2-64)
Alternative means of disposing of dewatering flows.	Chapter 2 - Alternatives Eliminated from Further Consideration; Alternatives Considered in Detail - Alternative 3 (see p. 2-55 through 2-64)
Alternatives to heap leach treatment, such as use of vats or tanks.	Chapter 2 - Mining and Ore Processing in the Carlin Trend; Alternatives Eliminated from Further Consideration (see p. 2-62)

TABLE 1-2 (continued) Issues and Concerns Identified in Scoping	
Issue	**EIS Document Section(s)**
Operations	
Separation of subeconomic ore from waste material and its storage at a separate area for future processing if gold prices or process technology improve.	Chapter 2 - Waste Rock Disposal - Existing and Proposed Operations (see p. 2-6 and 2-29) Chapter 4 - Geology and Minerals - Direct and Indirect Impacts (see p. 4-2 through 4-4)
Placement of overburden, tailing, leach pad, and other facilities in areas void of future recoverable mineral resources.	Chapter 2 - Proposed Action (see p. 2-22 through 2-54) Chapter 4 - Geology and Minerals - Direct and Indirect Impacts (see p. 4-2 through 4-4)
Potential loss of mineral resources beneath disposal sites.	Chapter 4 - Geology and Minerals - Direct and Indirect Impacts (see p. 4-2 through 4-4)
Cumulative Effects	
Discussion in EIS of "entire Humboldt system" extending downstream to the Humboldt Sink.	Chapter 4 - Cumulative Effects - Water Resources (see p. 4-120 through 4-125)
Potential cumulative impacts of dewatering activities of mines along the Carlin Trend.	Chapter 4 - Cumulative Effects - Water Resources; Riparian Areas and Wetlands (see p. 4-120 through 4-127)
Potential cumulative impacts of past and anticipated mine expansions within the Elko District and Humboldt National Forest.	Chapter 4 - Cumulative Effects (see p. 4-113 through 4-138)
Mitigation	
Land exchanges to mitigate loss of public lands.	Chapter 4 - Terrestrial Wildlife - Potential Mitigation and Monitoring Measures (see p. 4-82 and 4-83)
Measures to avoid, reduce, or compensate for direct and indirect habitat losses and other potential impacts on fish and wildlife.	Chapter 4 - Aquatic Habitat and Fisheries - Potential Mitigation and Monitoring Measures (see p. 4-87 and 4-88) Chapter 4 - Terrestrial Wildlife - Potential Mitigation and Monitoring Measures (see p. 4-82 and 4-83)
Monitoring	
Monitoring potential indirect impacts on the Humboldt River and tributaries.	Chapter 3 - Water Resources (see p. 3-19 through 3-49) Chapter 4 - Water Resources - Potential Mitigation and Monitoring Measures (see p. 4-47 through 4-50)
Reclamation	
Description in reclamation plan for use of lake created by the water-filled pit.	Chapter 2 - Proposed Action - Reclamation (see p. 2-44) Chapter 4 - Water Resources - Direct and Indirect Impacts (see p. 4-41 and 4-42)
Discussion in EIS of potential failure of reclamation.	Chapter 4 - Soils - Direct and Indirect Impacts (see p. 4-51 through 4-63) Chapter 4 - Vegetation - Direct and Indirect Impacts (see p. 4-63 through 4-67)

TABLE 1-2 (continued)
Issues and Concerns Identified in Scoping

Issue	EIS Document Section(s)
Discussion in EIS of cleanup, monitoring, and reclamation following closure.	Chapter 2 - Proposed Action - Reclamation (see p. 2-36 through 2-54) Chapter 4 - Potential Mitigation Measures
Coordination of site-specific closure plan with reclamation plan.	Chapter 2 - Proposed Action - Reclamation (see p. 2-37 through 2-54)
Inclusion in EIS of State of Nevada reclamation plan.	Chapter 2 - Proposed Action - Reclamation (see p. 2-37 through 2-54)
Use of native species, indigenous to the area, in reclamation.	Chapter 2 - Proposed Action - Reclamation (see p. 2-38 and 2-39) Chapter 4 - Vegetation - Direct and Indirect Impacts (see p. 4-63 through 4-67)

CHAPTER 2

DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

INTRODUCTION

This chapter provides a description of Newmont Gold Company's (Newmont) existing operations in the South Operations Area, Newmont's proposed action to continue and expand operations in the South Operations Area, and reasonable alternatives to the proposed action. Alternatives considered in the environmental impact statement (EIS) are based on issues identified by the Bureau of Land Management (BLM) and public comments received during the public scoping process and are intended to reduce or minimize potential impacts associated with the Proposed Action.

Detailed discussions of the following topics are presented in Chapter 2:

- History of mineral exploration and mining in the Carlin Trend and South Operations Area.
- Newmont's existing operations in the South Operations Area.
- Newmont's Proposed Action/amended Plan of Operations for the South Operations Area.
- Alternatives to the Proposed Action including the No Action Alternative and alternatives considered but dismissed from detailed analysis.
- Opportunities for establishing uses of excess water generated by Newmont's dewatering program.

HISTORY OF EXPLORATION AND MINING

The area of active gold mine development in the vicinity of Carlin, Nevada, is known as the Carlin Trend (Figure 2-1). This area, which extends from Newmont's Rain Mine approximately 10 miles southeast of Carlin to Newmont's Hollister Mine approximately 38 miles to the northwest, has experienced mining activity for the past 120 years. The majority of this activity has taken place since 1980.

GOLD MINERALIZATION

The following primary geologic occurrences have led to present-day gold mining in the Carlin Trend: (1) deposition of marine sedimentary rocks that presently host the gold mineralization, (2) faulting that disrupted these rocks and created pathways for movement of mineralizing fluids and openings for deposition of gold, (3) deposition of gold from mineralizing fluids associated with igneous activity, and (4) surface erosion that exposed the mineralized rocks.

As gold-bearing fluids migrated upward along faults and fractures, they permeated the disrupted rocks throughout the area. This resulted in widespread dissemination of gold particles and sulfide minerals throughout large volumes of rock, creating the large-tonnage, low-grade disseminated gold deposits known among geologists as a "Carlin-type" deposit. Disseminated gold deposits are typically composed of submicron-sized gold particles often visible only with a scanning electron microscope. Over 20 ore deposits have been identified in the

Carlin Trend since exploration for disseminated gold was initiated.

Geologic and mineralization processes resulted in the formation of two disseminated ore types in the Carlin Trend. The uppermost or near-surface ore type is known as oxide ore. This type of ore occurs at shallow depths where oxygen and precipitation percolating through the subsurface have combined to leach sulfide minerals from the rock. The natural leaching process leaves gold in the rock but removes sulfidic minerals.

A second ore type is unoxidized ore that typically occurs at greater depths at or below the ground-water table where water is low in oxygen. Unoxidized ore is commonly referred to as refractory ore. Refractory ore is further broken down into two subclassifications: (1) silica-sulfide ore, in which gold is locked within sulfide and quartz minerals, and (2) carbon-sulfide ore, in which gold occurs with carbonaceous and sulfidic minerals. Refractory ore is not readily amenable to the use of conventional cyanide solutions to extract gold. Refractory ores require additional processing to allow recovery of gold.

MINING AND ORE PROCESSING IN THE CARLIN TREND

Exploration activities in the Carlin Trend began in the early 1870s with staking of the Good Hope claims in the Maggie Creek district (Coope 1991). These claims produced mainly lead and silver, with minor amounts of barite and gold. The first significant gold discovery was made on Lynn Creek in 1907, approximately 1.5 miles north of the present Carlin Mine. Placer gold discoveries followed in Sheep, Rodeo, and Simon creeks (Figure 2-1).

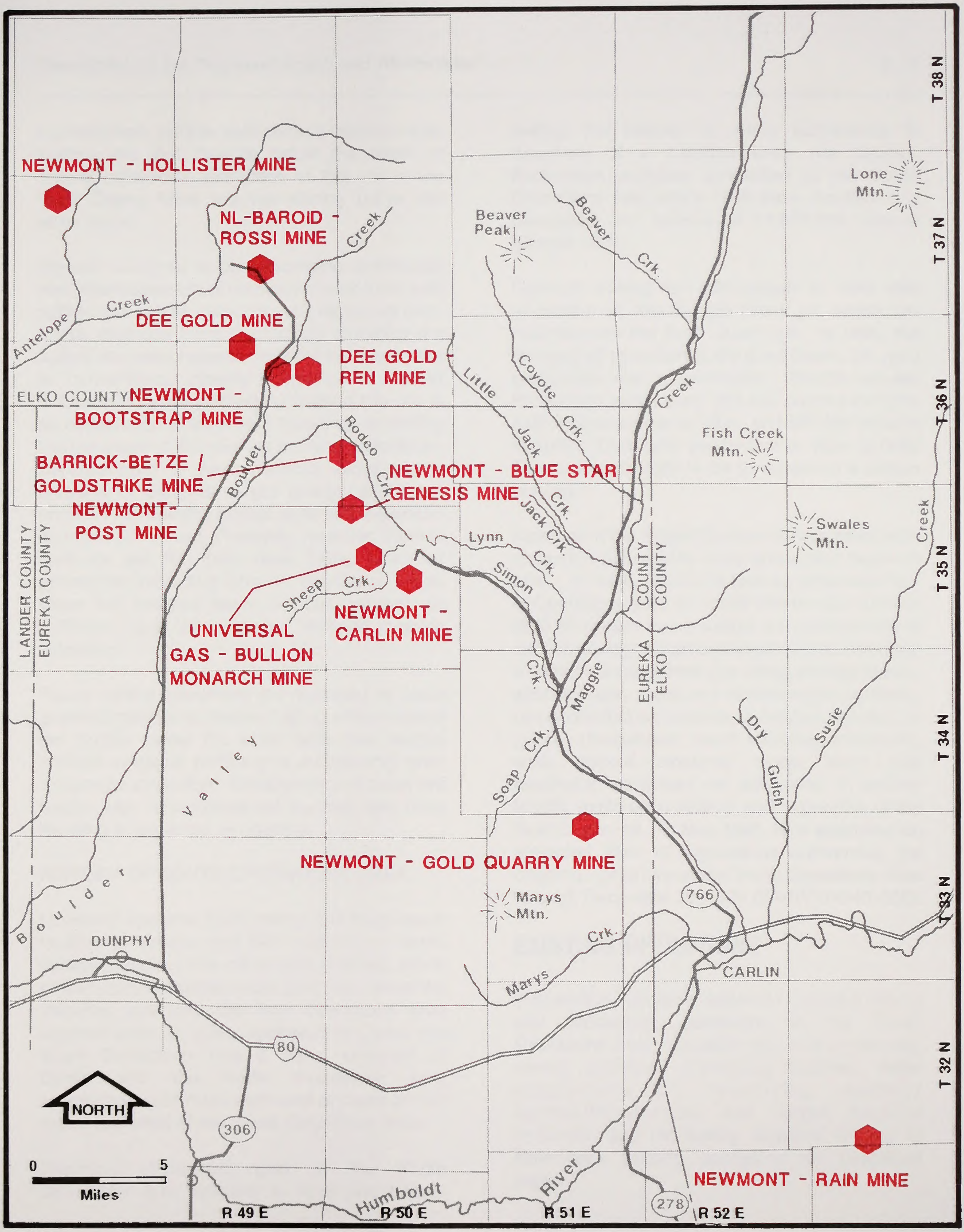
Early hard rock mining focused on small, rich ore deposits of copper, lead, and barite and minor concentrations of gold and silver. Tunnels (adits) and shafts were used to access and remove the ore, creating a historically interesting but relatively inconsequential overall surface disturbance.

In the 1960s, economical mining and extraction methods for low-grade disseminated gold were developed. This involved open-pit mining methods to excavate large amounts of near-surface oxide ores. Early mines in the area relied on milling and vat leaching to recover gold from the ore. This involved grinding the rock to a fine sandy texture (milling) and mixing the ground rock with cyanide solution in tanks for removal of gold (vat leaching). Oxidized ore low in carbon could be directly leached, while unoxidized carbonaceous ore was pre-treated with chlorine prior to extraction. This method was economically viable for the richer ores, but was not effective for low-grade ores.

Development of heap leaching for gold recovery from low-grade oxide ore soon followed, allowing further expansion of the regional mining industry. Heap leaching involves placing the low-grade oxide ore in large heaps and sprinkling the heaps with a weak cyanide solution. The cyanide solution percolates through the heaps, dissolving gold from the ore. The bases of the heaps are lined with impervious materials and are designed to channel gold-bearing solution to holding ponds. Gold is removed from the cyanide solution by adsorption to carbon. The carbon is then processed to remove the gold, which is shipped to specialty smelters for further refinement.

The effectiveness of cyanide leaching is greatly decreased by presence of carbonaceous material or sulfide in the ore; sulfide selectively absorbs the cyanide and the natural carbon adsorbs the gold from the cyanide solution. For this reason, mining in the Carlin Trend initially focused on disseminated gold contained in the near-surface oxidized rock rather than on deeper refractory ores containing sulfide or carbonaceous material.

In the late 1980s, geologists discovered relatively rich gold deposits at greater depth where the oxidation of sulfide minerals had not taken place. Geologically, these deep-sulfide refractory ores typically occur in feeder zones through which the original mineralizing fluids migrated to permeate the upper host rocks. These deep feeder zones



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Major Mines in the Carlin Trend
SOUTH OPERATIONS AREA PROJECT

typically have a richer gold content than the near-surface ore, but they lie below the depth of natural oxidation. Extraction of this ore in the Gold Quarry Mine requires mining below the water table.

Several advances in ore-processing technology now afford economical recovery of gold from both sulfide and sulfidic-carbonaceous refractory ores. These methods involve artificially oxidizing the sulfide and carbonaceous material in the ore prior to conventional cyanide extraction. Artificial oxidation is accomplished by heating the ore in an oxygen-rich environment (roasting) or adding high pressure to the roasting process (autoclave). Because both of these methods require large amounts of electrical or gas energy, efforts are underway to develop biological or less expensive chemical processes. Presently, however, thermal methods are the only ones being used for processing refractory ores in the Carlin Trend. Once the ore has been oxidized naturally or artificially, gold is recovered through cyanide extraction.

Future mining operations are expected to place greater emphasis on deeper, high-grade refractory ore bodies below the water table that require artificial oxidation (roasting or autoclaving) prior to cyanide extraction. Development of oxide ore bodies with conventional vat leaching and heap leaching is expected to continue.

HISTORY OF SOUTH OPERATIONS AREA

Newmont operates both milling and heap leach facilities in Eureka and Elko counties in north-central Nevada. The mines and facilities, which process predominantly oxide gold ores, are at the following locations: the Rain Operations Area approximately 10 miles southeast of Carlin; the South Operations Area 6 miles northwest of Carlin; and the North Operations Area approximately 21 miles northwest of Carlin and 15 miles northwest of the South Operations Area.

Newmont discovered gold at the South Operations Area property in 1978 and began drilling the deposit in 1980, culminating in discovery of a 1-million-ounce ore deposit. Exploration activities conducted at the South Operations Area since 1985 have resulted in a calculated ore reserve of 10,058,000 ounces (Coope 1991).

Open-pit mining for gold began in 1980 with excavation of the Maggie Creek pit, which has now become the Gold Quarry pit. In 1985, the first year of operation at the Gold Quarry pit, gold production was approximately 106,000 ounces. Production levels were 939,800 ounces in 1990, 1.02 million ounces in 1991, and 927,800 ounces in 1992. Total gold production to date at Gold Quarry is estimated to be in excess of 4 million ounces.

Activities in the South Operations Area have been expanded periodically since production began in 1985. In 1990, Newmont filed an amended Plan of Operations (N16-81-009P) with the Elko District BLM to secure authorization for construction of various mining and processing facilities, including: a combined waste rock and tailing storage facility, access roads, slurry and reclaim water pipelines, power distribution systems, underdrainage reclaim ponds, downstream cutoff trenches, monitoring wells, topsoil stockpile areas, leach pad expansion, refractory ore stockpiles, a sanitary landfill, exploration drilling, and expansion of the Gold Quarry pit. In May 1991, BLM approved an amended Plan of Operations authorizing the ongoing operations at the South Operations Area through December 30, 1994 (EA-NV-010-91-055).

EXISTING OPERATIONS

This section describes Newmont's existing mining and processing operations in the South Operations Area. Location and land ownership, mining activities, processing facilities, water supply/mine pit dewatering, ancillary facilities/infrastructure, and current resource protection and monitoring activities relating to Newmont's existing operations are described below.

LOCATION AND LAND OWNERSHIP

The South Operations Area is located at the eastern edge of the Tuscarora Mountains in the Maggie Creek Basin northwest of Carlin, Nevada. The facilities are located on an estimated 3,353 acres of private land and 824 acres of public (BLM) land in Township 33 North, Range 51 East; Township 33 North, Range 52 East; Township 34 North, Range 51 East; and Township 34 North, Range 52 East. Gold Quarry is the only active mine in the South Operations Area. Figure 2-2 depicts surface ownership of lands within the South Operations Area, and Table 2-1 shows the acreage of public and private lands disturbed under current authorization for each facility in the South Operations Area.

CURRENT MINING OPERATIONS

The South Operations Area encompasses approximately 4,177 acres disturbed by mining, ore processing, and other related facilities (Figure 2-3 and Table 2-1). These disturbance areas include the Gold Quarry pit, haul roads, access roads, tailing storage facilities, waste rock disposal areas, heap leach facilities, water storage reservoir, mill buildings, and shop and office complexes. Figure 2-4 is a simplified schematic of the existing South Operations Area showing primary material handling, ore processing, and water distribution systems.

Gold Quarry Mine

Newmont currently mines oxide ore and small quantities of sulfidic ore from the Gold Quarry open pit under the existing Maggie Area Plan of Operations (N16-81-009P). Peak production rate at Gold Quarry is 220,000 tons per day of waste rock and ore, or approximately 80 million tons of waste rock and ore per year.

Ore and waste rock are drilled and blasted in sequential benches to facilitate loading and hauling. Benches are established at approximately 25-foot intervals and are 10 to several hundred feet in width. Blasted ore and waste rock are loaded onto end-dump haul trucks by use of hydraulic shovels or front end loaders. Large, off-road haul trucks transport ore and waste rock to waste rock disposal areas, heap leach pads, refractory ore stockpiles, or the mill complex. Haul trucks move within the pit using temporary roads on the surface of each bench with ramps extending between two or more benches. The destination of each load of rock depends on assay results of rock samples from each round of drilling (Newmont 1992a). Once haul trucks leave the pit they travel on main haul roads to their destination.

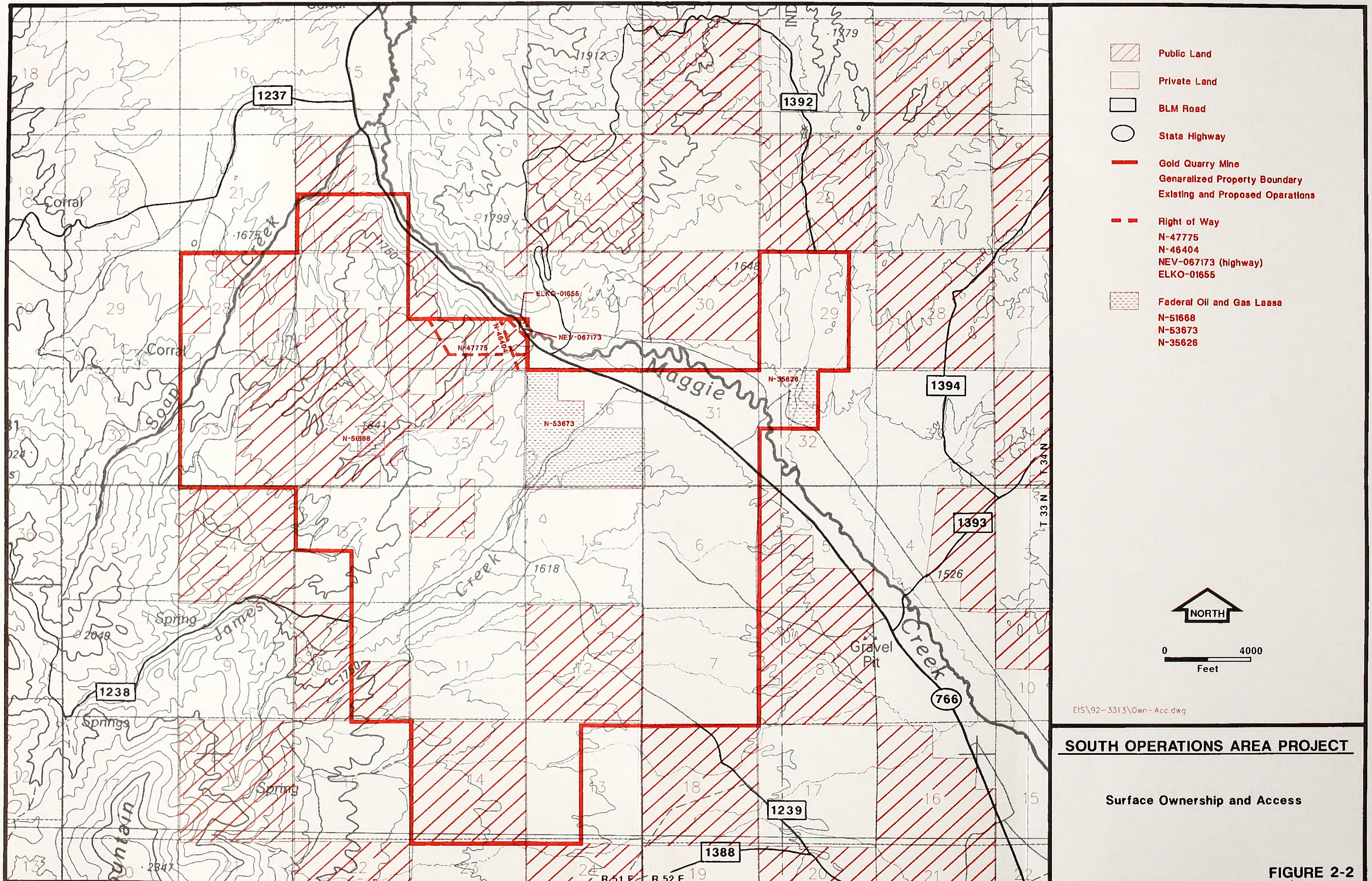
The Gold Quarry Mine pit encompasses approximately 618 acres, of which 165 acres are public land and 453 acres are private land owned or controlled by Newmont. The pit will reach a final depth of 955 feet below the pre-mining surface. At the end of 1994, pit diameter will be in excess of 6,000 feet, with the north-south axis slightly longer than the east-west axis. Operation of the currently permitted mine pit is described in the Environmental Assessment (EA) prepared for the Gold Quarry Mill 2/5 Tailing Storage Facility (BLM 1991a).

Waste Rock Disposal Areas and Refractory Ore Stockpiles

Approximately 50 million tons of waste rock are generated at the South Operations Area annually. This waste rock is transported via haul trucks to two waste rock disposal sites, the North Waste Rock Disposal Area and the South Waste Rock Disposal Area (Figure 2-3). Waste rock is end-dumped down an advancing face or placed in successive horizontal lifts varying in height from 10 to 100 feet. Outslopes are established at the natural angle of repose.

North Waste Rock Disposal Area

The North Waste Rock Disposal Area, located northeast of the Gold Quarry Mine pit, is currently authorized to disturb approximately 413 acres and hold 216 million tons of waste rock, with the highest face rising to a maximum height of 150 feet. The disposal area appears flat with the northeast-southwest axis extending approximately



SOUTH OPERATIONS AREA PROJECT

Surface Ownership and Access

FIGURE 2-2

TABLE 2-1
Existing Disturbance Area at the South Operations Area

Development Activity	Incremental Disturbance Acreage (acres)		
	Acreage Public	Acreage Private	Total
Mill 2/5 Complex/Administration/Ancillary Facilities	0	193	193
Maggie Creek Ranch Reservoir/Pipeline/Access	0	116	116
Gold Quarry Leach Pad	0	413	148
South Area Leach Property	0	390	390
South Area Leach Nonproperty	0	387	390
North Waste Rock Disposal Area	0	413	413
South Waste Rock Disposal Area	217	396	613
Maggie Creek Waste Rock Disposal Area	0	46	46
Gold Quarry Pit	165	453	618
James Creek Tailing Storage Facility	[illegible]	387	390
Mill 2/5 Tailing Storage Facility	419	379	798
Pregnant Solution Ponds	0	18	18
Underdrain Collection Ponds	0	1	1
Haul Roads	20	83	103
TOTAL DISTURBANCE	**824**	**3,353**	**4,177**

Source: Newmont Gold Company and Shepherd Miller, Inc. 1992.

6,000 feet and the northwest-southeast axis in excess of 3,000 feet. The North Waste Rock Disposal Area lies entirely on private land owned or controlled by Newmont.

South Waste Rock Disposal Area

The South Waste Rock Disposal Area, located approximately one-half mile south of the Gold Quarry Mine pit, is currently authorized to disturb 613 acres and hold 76 million tons of waste rock, with the highest face rising to a height of approximately 80-90 feet. The south and east slopes of the disposal area form the north and west embankments of the Mill 2/5 Tailing Storage Facility. The South Waste Rock Disposal Area appears flat with the north-south axis extending approximately 6,000 feet and the east-west axis exceeding 8,000 feet at its widest point. The area lies on approximately 217 acres of public land and 396 acres of pricate land owned or controlled by Newmont.

Refractory Ore Stockpiles

Refractory ore is being temporarily stockpiled in anticipation of processing under the proposed action. Two refractory ore stockpiles are currently being used: (1) a 28-acre site north of the South Area Property leach pad, and (2) a 22-acre site along the west side of the North Waste Rock Disposal Area (Figure 2-3). Both sites are located on private land owned or controlled by Newmont.

Ore-Processing Operations

The ore-processing facilities at the South Operations Area provide recovery of gold from high-grade oxide ore through milling and cyanide extraction, and recovery of gold from low-grade oxide ore through cyanide heap leaching processes. Ore-processing facilities at the South Operations Area consist of the Mill 2/5 complex, the James Creek Tailing Storage Facility, the Mill 2/5 Tailing Storage Facility, and oxide ore heap leach pads. These facilities operate under previously issued authorization from both BLM and Nevada Division of Environmental Protection (NDEP).

Mill 2/5 Complex

Mill 2 and Mill 5 are two independent oxide mill facilities located at a single site (Mill 2/5 complex) in the South Operations Area. The milling process is essentially the same at both facilities. Crushing and grinding throughout the milling system generates a consistent ore particle size (silt and very fine sand) that results in more efficient gold recovery. The Mill 2/5 complex is capable of processing 30,000 tons of ore per day. Run-of-mine ore is first transferred from stockpiles to primary crushers, which reduce the ore rock to less than 6 inches in diameter. The crushed ore is moved on conveyors to the Mill 2/5 stockpiles and then transferred via conveyor to the mills where it is ground into finer material. Lime, dilute cyanide solution, and water are added during the grinding process. The ground material is then passed through a vibrating screen to separate out material larger than 3/8 inch in diameter; this material is transferred to a cone crusher for further size reduction and returned to the grinding circuit.

Dissolution of gold by cyanide solutions in the milling circuit results in a gold-rich aqueous solution that is separated from the ore material by use of thickener tanks. This solution (overflow) is decanted from the thickener tank system and pumped to carbon-adsorption columns. Thickener tank underflow is transferred to carbon-in-leach or carbon-in-pulp tanks. Activated carbon contained in these systems adsorbs the dissolved gold from solution. Carbon impregnated with gold is periodically removed from the circuits and transferred via pipeline to the stripping/refining facility, where gold is separated from the carbon. Barren process solution, the solution resulting after adsorption of gold onto carbon, is recycled back into the process system.

The stripping/refining facility consists of carbon-stripping circuits, electrowinning circuits, retort furnaces, and carbon regeneration kilns. Gold contained in the gold-bearing solution or electrolyte resulting from stripping the activated carbon is transferred to electrowinning cells, where the gold is plated onto steel wool. Gold is then recovered from the steel wool using acid digestion, retorted with flux to remove mercury and residual impurities, and cast into gold (doré) bars for shipment.

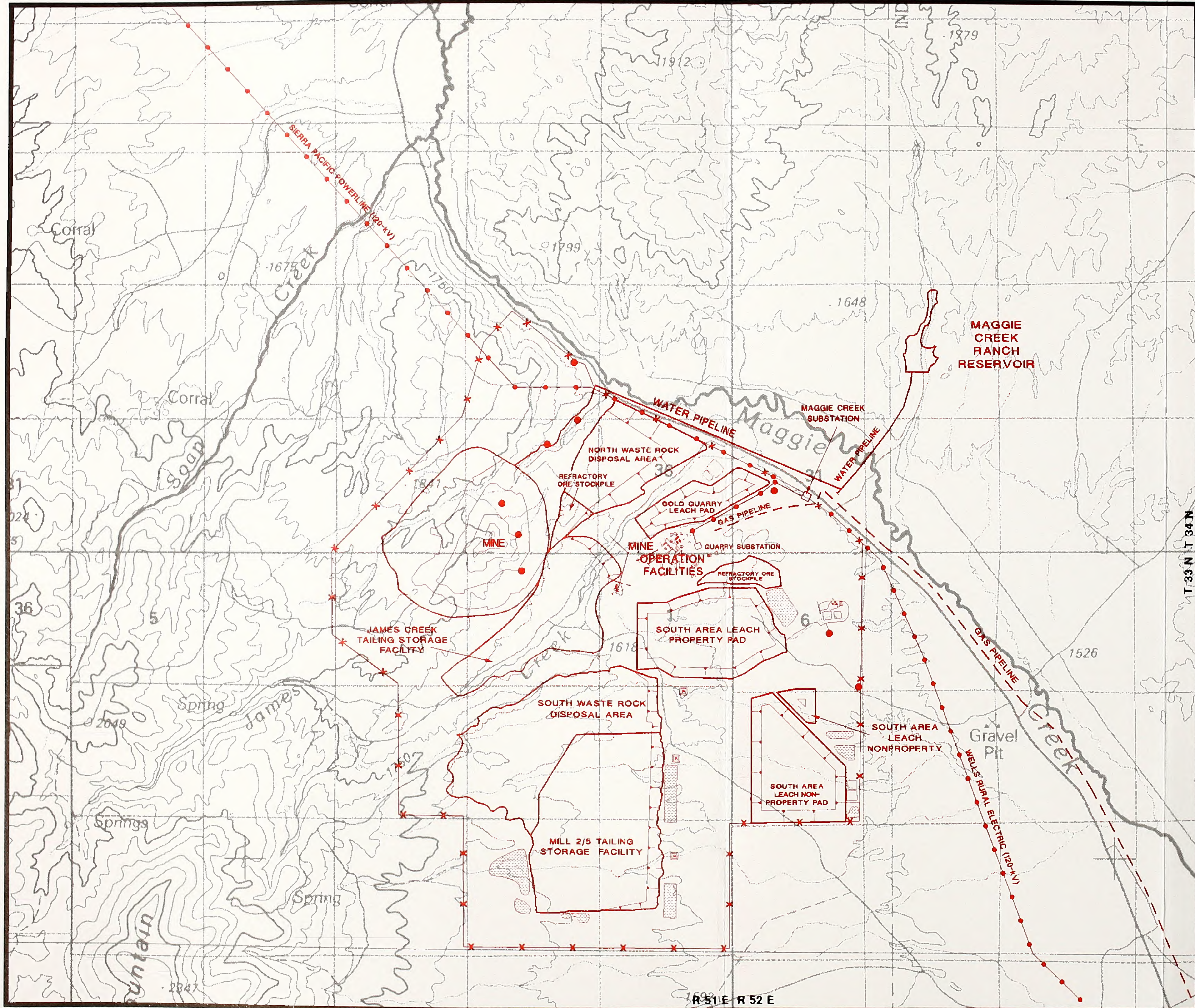
Water makeup requirement for the Mill 2/5 complex is 700 gallons per minute (gpm). This water is supplied by groundwater wells located in the South Operations Area.

Tailing Storage Facilities

Tailing is the silt and very fine sand waste generated by the milling process. It is mixed with water to form a slurry that is pumped to tailing storage facilities. These facilities are earthen dams specially designed and constructed to impound tailing. Excess water from the slurry is recycled to the mill. At present, tailing is stored at two facilities in the South Operations Area. The James Creek Tailing Storage Facility is the original disposal site for tailing generated by the Mill 2/5 complex. This facility is scheduled to be phased out as the other facility, the Mill 2/5 Tailing Storage Facility, becomes fully operational. This new tailing storage facility began receiving tailing in the fall of 1992 from the Mill 2/5 complex.

James Creek Tailing Storage Facility

The James Creek Tailing Storage Facility is



Topsoil Stockpile

Gold Quarry Dewatering or Production Well

Fence

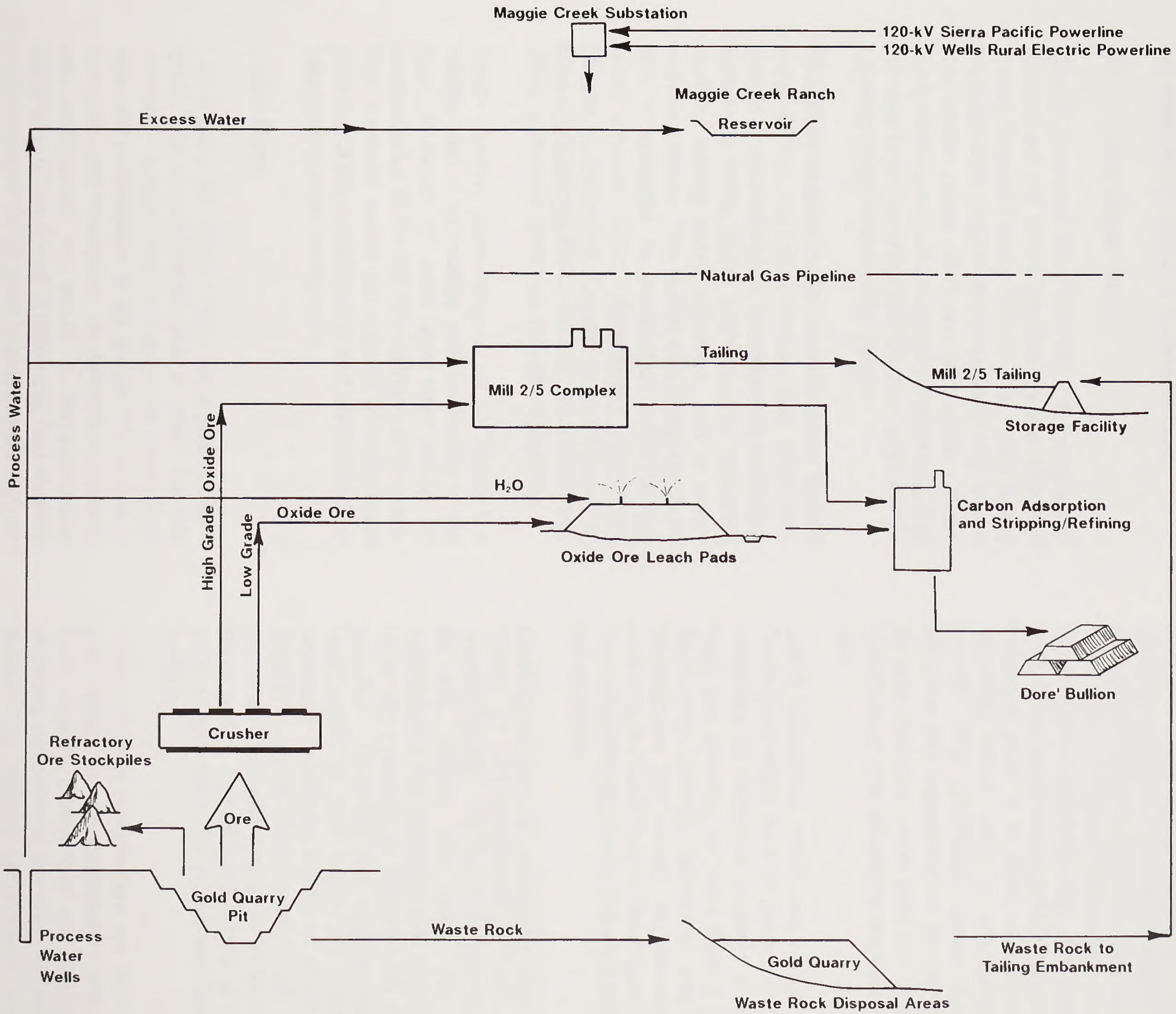
NORTH

0 4000
Feet

SOUTH OPERATIONS AREA PROJECT

Existing Operations

FIGURE 2-3



Schematic of Existing Operations
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-4

located adjacent to the southeast corner of the Gold Quarry Mine pit and covers approximately 390 acres (3 acres public land and 387 acres private land). The James Creek facility is reaching capacity (estimated 46 million tons) and will begin initial stages of closure in 1993.

Mill 2/5 Tailing Storage Facility

Tailing generated from the Mill 2/5 complex is transported via slurry pipeline to the Mill 2/5 Tailing Storage Facility (Figure 2-3). The tailing impoundment, which encompasses 798 acres (419 acres public land and 379 acres private land), will attain an ultimate embankment height of 100 feet under existing authorization with a total capacity of 32 million cubic yards.

The tailing storage facility consists of an earthfill embankment, an impermeable clay liner with overlying protective layer, an underdrain collection system, a tailing water (supernatant) collection system, tailing slurry pipelines, and a water reclaim system. The facility was designed, built, and is operated in compliance with Nevada Administrative Code, Regulations Governing Design, Construction, Operation and Closure of Mining Operations (NAC 445.242-445.24388), and other applicable state and federal regulations.

Under existing authorizations an estimated 8.4 million tons of potentially acid-producing waste rock produced in 1993 and 1994 would be encapsulated in the Mill 2/5 tailing embankment. This material would be placed in designated portions of the embankment and surrounded by neutralizing oxide waste rock.

Leach Pads

Leach pads are areas where large piles of low-grade ore are sprinkled with a weak cyanide solution. Leach pads in the South Operations Area are constructed in six stages: (1) topsoil is removed and stockpiled; (2) remaining subsoils are compacted to attain a low-permeable subgrade; (3) an 80-mil (0.080-inch), high-density polyethylene (HDPE) pond liner is installed; (4) an 18-inch-thick, fine-grained gravel material is placed over the liner as a protective layer; (5) an additional 18-inch-thick coarse rock layer is added for drainage purposes; and (6) ore is placed in successive lifts on top of this prepared base. After the ore is in place, a cyanide leach solution is applied to the ore by continuous drip emitter or sprinkler systems. The leach solution migrates through the ore pile, dissolves the gold contained in the ore, and drains to a central collection point at the bottom of the ore pile. The leach solution containing the dissolved gold is pumped from the collection point to a series of activated carbon columns, where gold is adsorbed onto the carbon. The gold-laden carbon is periodically removed and transported to the stripping facility for gold recovery. After gold has been removed from solution, the solution is recycled to the leach pad.

Leach operations, which are conducted in the South Operations Area on private land owned or controlled by Newmont consists of three active leach pad systems: the Gold Quarry (148 acres), South Area Property (390 acres), and South Area Nonproperty (330 acres). No new ore has been added to the Gold Quarry leach pad since 1989. The remaining two leach pads are receiving new ore routinely.

Leach-grade ore is excavated from the Gold Quarry pit and transferred via haul trucks to a crushing facility. As the ore is crushed to reduce its size, cement and water are added to agglomerate fine particles that would otherwise have the potential to impede the flow of the solution. Crushed and agglomerated ore is transported to the leach ore stockpile and eventually hauled by trucks to either the South Area Property or Nonproperty leach pads. The ore is dumped and spread in 30-foot lifts on the leach pads. The ultimate height of these leach pads ranges from 200 to 300 feet above ground surface.

Water makeup requirement for the heap leach pad system is approximately 1,800 gpm, with most losses attributable to evaporation and moisture retention of the ore. Makeup water is supplied by existing groundwater wells located within the South Operations Area.

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Water makeup requirement for the heap leach pad system is approximately 1,800 gpm, with most losses attributable to evaporation and moisture retention of the ore. Makeup water is supplied by existing groundwater wells located within the South Operations Area.

Water Supply/Mine Pit Dewatering

Newmont operates six water production wells to provide water for ore milling, oxide ore leaching, environmental emissions control equipment, dust control, potable water supply, and mine dewatering. Three additional wells have been constructed to dewater the Gold Quarry pit in order to keep water levels below the elevation of the working pit floor. Cumulative production from these nine wells averages approximately 5,000 gpm. Current water right permits allow for maximum annual average of 6,609 gpm from all wells combined for mining and milling purposes.

In 1992, Newmont constructed the Maggie Creek Ranch Reservoir to receive water produced during aquifer drawdown tests. The reservoir has a capacity of 2,700 acre-feet and encompasses approximately 116 acres. During drawdown tests of dewatering wells, water pumped to the reservoir is retained and allowed to infiltrate into the subsurface and/or evaporate. The reservoir periodically receives flows from aquifer drawdown tests.

Haul Roads

Approximately 17 miles of existing haul roads are utilized to deliver waste rock to the North and South waste rock disposal areas and ore to the Mill 2/5 complex and heap leach pads in the South Operations Area. These roads are bermed and maintained on a regular basis to ensure safe and efficient hauling operations and to minimize particulate dust emissions. Permanent or fixed haul roads currently account for approximately 103 acres (20 acres public land and 83 acres private land) of disturbance.

Ancillary Facilities and Infrastructure

The ancillary facilities and infrastructure of the South Operations Area include water and solution pipelines; water quality monitoring wells; surface water control ditches; downstream cutoff trenches; power distribution systems; two analytical laboratories; mining and equipment maintenance shops; administrative offices; fueling areas; and shipping and receiving complexes. The Mill 2/5 complex and associated infrastructure occupies approximately 193 acres of private land owned or controlled by Newmont.

Water and Solution Pipelines

Facilities within the South Operations Area complex are linked by pipeline systems both for distribution of makeup water and potable water, and transportation of tailing and ore-processing solutions. These pipeline systems provide service to the office complex, shop and maintenance facilities, Mill 2/5 complex, dewatering and production wells, heap leach pads, tailing disposal facilities, and Maggie Creek Ranch Reservoir.

Water Control Ditches

Water control ditches in the South Operations Area divert water resulting from precipitation around tailing storage facilities, heap leach pads, waste rock disposal facilities, and shop/office/parking areas. Stream bypass channels divert water from local watersheds around the James Creek Tailing Storage Facility and the Mill 2/5 Tailing Storage Facility.

Energy Distribution System

The energy distribution systems used in the South Operations Area consist of electrical power grids and a gas pipeline. The power distribution system involves the use of three substations which relay power from regional powerlines to the project area. The substations then transfer power through smaller distribution lines to various facilities within the project area. The gas pipeline was built to serve the ore-processing facilities.

Two 120-kV power distribution lines have been constructed to transport electricity to the South Operations Area. The powerline that presently provides all the power to the project runs from the town of Carlin northwest to the Maggie Creek Substation. This powerline is operated by Wells Rural Electric Company. The second powerline, constructed by Sierra Pacific Power Company in

1988, is not energized at this time (Figure 2-3). It connects the Maggie Creek Substation with the Bazza Substation approximately 15 miles north in the Little Boulder Basin. The existing powerlines have the capacity to transport substantially more electricity than the 34 megawatts used in the South Operations Area at this time.

Three substations have been constructed in the South Operations Area: Maggie Creek, Quarry, and North Well Pump. The Maggie Creek Substation functions as the principal facility to transfer power from the regional distribution system to the project area. The Quarry Substation's function is to provide power to most of the ore-processing facilities. The North Well Pump Substation, located in the Gold Quarry pit, serves the pit's dewatering pumps.

Natural gas service to the project area consists of a 6-inch pipeline system from Carlin, Nevada, to the South Operations Area.

Buildings

Existing buildings in the South Operations Area include: the Mill 2/5 complex, two analytical laboratories, shop and maintenance buildings, and administrative offices. All buildings are located on land owned or controlled by Newmont.

Resource Monitoring

Air Quality

Newmont must sample ambient air for particulates 10 microns or smaller (PM-10) and monitor and record meteorological conditions at the sampling site as specified by the Nevada Bureau of Air Quality. Emissions from existing operations are reduced through use of fogging sprays, wet scrubbers, and baghouses. Sampling and monitoring have been conducted from the beginning of construction at the South Operations Area (1979) and will continue until reclamation of the project is complete. Findings are reported to the Nevada Bureau of Air Quality within 60 days of the end of each quarter of the calendar year.

Air quality levels at the South Operations Area currently meet Nevada and federal standards

Water Resources

Water resources in the South Operations study area are monitored within three hydrographic basins: Maggie Creek, Marys Creek, and Susie Creek. The current monitoring program addresses groundwater, springs/seeps, and streams/rivers. The purpose of hydrologic monitoring is to establish baseline data and report changing conditions as the mine operation continues and expands. Water quality, levels, and flows are measured periodically by Newmont at designated monitoring wells, springs/seeps, and surface water stations. The U.S. Geological Survey also collects groundwater and surface water data in the study area. Additional details on the hydrologic monitoring program at the South Operations Area are included in Chapter 3, Water Resources.

Potentially Acid-Producing Rock

Precipitation and snowmelt infiltrating refractory material could become acidic, thereby leaching and dissolving metals to the environment. Monitoring of stockpiled ore and waste rock with acid-producing potential is required by NDEP. A draft monitoring plan, " Refractory Stockpile and Waste Rock Dump Monitoring Plan" (Newmont 1993a), has been prepared and will be submitted to NDEP for approval in the near future. The plan requires that all refractory ore stockpiles be placed on compacted clay pads that drain to seepage containment ponds. Any stockpile not in use for over 2 years would be capped with an impervious layer for temporary closure.

Hazardous Materials

The term "hazardous materials" is defined in 49 CFR 172.101; hazardous substances are defined in 40 CFR 302.4 and the Superfund Amendments and Reauthorization Act (SARA) Title III. Hazardous materials and hazardous substances that are transported, stored, or used on-site in quantities greater than the Threshold Planning

Quantity (TPQ) designated by SARA Title III for emergency planning, are summarized in Table 2-2. Hazardous materials are transported to the South Operations Area by U.S. Department of Transportation (DOT)-regulated transporters and stored on-site in DOT-approved containers (Newmont 1992b). Spill containment structures are provided for storage containers. All hazardous materials are stored on private land.

The following hazardous materials and substances may be transported, stored, and used at the South Operations Area in quantities less than the TPQ designated by SARA Title III for emergency planning. The TPQ for these substances is 10,000 pounds.

Acetone	Gasoline	Potassium permanganate
Ammonium hydroxide	Lead acetate	Sodium hydroxide solution
Calcium hypochlorite	Methyl ethyl ketone	Sodium hypochlorite
Mercury	Methyl chloroform	Solid sodium hydroxide
Freon	Methyl isobutyl ketone	Toluene

This list was derived from the Gold Quarry Emergency Response Plan (BLM 1991a) and from other information provided by Newmont. Small quantities of hazardous materials not included in the above list may also be managed at the South Operations Area. These materials are contained in commercially produced paints, office products, and automotive maintenance products.

Hazardous Waste

The South Operations Area currently operates as a Large Quantity Generator of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). A RCRA Large Quantity Generator is a facility that generates more than 1,000 kilograms per month of RCRA-regulated hazardous waste (40 CFR Part 262). RCRA-regulated hazardous wastes generated at the South Operations Area and in associated management practices are included in Table 2-3. Information for this summary was obtained from the EPA Hazardous Waste Report Forms IC, GM, and OI for years 1990 and 1991. These forms were submitted by Newmont to NDEP.

Tailing Composition

The Mill 2/5 complex generates approximately 30,000 tons per day of tailing which is pumped via slurry pipeline to the Mill 2/5 Tailing Storage Facility. Table 2-4 presents pH, metal, and cyanide concentrations in the South Operations Area tailing. These values are based on an average of metal concentrations for the Mill 2 and Mill 5 solid tailing and average cyanide concentrations and pH values for the Mill 2 and Mill 5 liquid tailing for the period of February 1991 through February 1992.

TABLE 2-2
Hazardous Materials Management

Substance	Rate of Use	TPQ[1] (pounds)	Use	Amount Stored (typical)	Storage Method	Waste Management
Sodium cyanide	4,800,000 lbs/year	100	Gold recovery process	400,000 pounds	Bulk tank solid	Portions are recycled or neutralized and left in place
Sulfuric acid	214,000 lbs/year	500	Refinery acid digestion process	3,160 gallons	Bulk tank	Neutralized in a totally enclosed treatment facility
Hydrochloric acid	175,000 gal/year	10,000	Mill processing	4,600 gallons	Bulk tank	Neutralized in a totally enclosed treatment facility
Hydrochloric acid	4,000 lbs/year	10,000	Assay laboratory	21 gallons	One-gallon bottles	Transported to an off-site TSD[2] facility
Nitric acid	4,800 lbs/year	1,000	Assay laboratory	12 gallons	One-gallon bottles	Transported to an off-site TSD facility
N-butyl acetate	175 gal/year	10,000	Assay laboratory	15 gallons	Five-gallon cans	Transported to an off-site TSD facility
Diesel fuel	900,000 gal/month	10,000	Equipment fuel	115,000 gallons	Bulk tanks	Spill containment

[1] TPQ = extremely hazardous substance threshold planning quantity designated by SARA, Title III.
[2] TSD = treatment, storage, or disposal facility regulated under the Resource Conservation and Recovery Act.

Source: Newmont 1992b.

TABLE 2-3
Hazardous Waste Inventory and Management

Waste Type	EPA[1] Hazardous Waste Code	Generation Rate (lbs/year)[2]	Waste Description	Final Disposition
Lead-bearing solid waste	D008	199,620	Cupels, crucibles, slag	USPCI[4], Clive, Utah
Lead-bearing mixed waste	D002	10,748	Off-spec flux, lab baghouse dust	USPCI, Clive, Utah and Rollins Environ. Services, Baton Rouge, Louisiana
Corrosive liquid waste	D002	2,080	Mixture of water, n-butyl acetate, nitric acid, HCl, and thiourea	Rollins Environ. Services, Baton Rouge, Louisiana
Lab clean-out chemical waste		79	Various chemical wastes	Rollins Environ. Services, Baton Rouge, Louisiana
Lead acetate	D008	500[3]	Lab clean-out product	OPC[5], Los Angeles, California
Solvents w/petroleum naptha	D001 F003	30,468	Combustible degreaser with tetrachloroethylene	Safety-Kleen Corp., Salt Lake City, Utah
Solvents w/1,1,1 tri-chloroethane	F002 D001	340[3]	Ignitable degreaser	Rollins Environ. Services, Baton Rouge, Louisiana
Grease/solvent mix	D001 F003	100	Ignitable waste with xylenes	Petroleum Recycling Corp., Signal Hill, California
Oil/solvent mix	D001 F003	1,900	Ignitable waste with xylenes	Petroleum Recycling Corp., Signal Hill, California
Mercury-bearing soil	D009	350[3]	Spill clean-up product	Rollins Environ. Services, Baton Rouge, Louisiana

[1] EPA = U.S. Environmental Protection Agency.

[2] 1991 rate of generation unless otherwise noted.

[3] 1990 rate of generation (no waste generated in 1991).

[4] USPCI = United States Pollution Control, Inc., a commercial hazardous waste treatment, storage, and disposal facility.

[5] OPC = A subsidiary of Rollins Environmental Services, Inc.

TABLE 2-4
Concentrations[1] of Trace Elements in Mill Tailing at South Operations Area

Solids				Liquids	
Parameters	µg/g[2] (ppm)	Parameters	µg/g (ppm)[3]	Parameters	mg/L[4] (ppm)
Arsenic	230	Sodium	300	pH (pH units)	10.9
Antimony	220	Thallium	11	Specific Conductance (µmhos/cm)	1,900
Barium	2,120	Strontium	330	Cyanide, WAD[5]	47
Beryllium	8	Tin	6	Cyanide, Free	37
Boron	31	Titanium	400	Cyanide, Total	39
Cadmium	4.7	Vanadium	900		
Chromium	65	Zinc	120		
Cobalt	3.8	Mercury	1.5		
Copper	65	Uranium	10		
Lead	90	Thorium	10		
Magnesium	170	Gold	3.0		
Manganese	33	Chlorine	11		
Molybdenum	48	Tungsten	10		
Nickel	81	Lithium	6.2		
Silver	5.2	Hafnium	10		
Selenium	240	Lutetium	.47		
Thulium	.67	Ytterbium	3.8		

[1] Concentrations are based on the average concentration of trace elements in Mill 2/5 tailing.
[2] µg/g = micrograms per gram (solids measurement unit).
[3] ppm = parts per million.
[4] mg/L = milligrams per liter (liquid measurement unit).
[5] WAD = weak acid dissociable cyanide.

Source: Newmont 1993b.

Human Health and Safety

General Requirements

The South Operations Area is subject to the Federal Mine Safety and Health Act of 1977 (MSHA), which sets forth mandatory safety and health standards for surface metal and nonmetal mines, including open-pit mines. The purpose of these standards is the protection of life, promotion of health and safety, and prevention of accidents. Regulations promulgated under MSHA are codified under 30 CFR Subchapter N, Part 56.

Health and Safety Training Programs

All new employees at the South Operations Area are required by Newmont to receive training outlined in Table 2-5.

Employment

Newmont presently employs approximately 916 people at the South Operations Area. In addition, Newmont has employed 50 to 150 temporary employees in the project area using mostly contractor personnel.

Reclamation

In response to recent changes in reclamation requirements promulgated by BLM and NDEP, Newmont filed a reclamation plan addressing mining activities in the South Operations Area (Newmont Gold Company and Shepherd Miller, Inc. 1992). This reclamation plan encompasses existing disturbances and disturbances that would result from the Proposed Action (see Chapter 2, Reclamation section under Proposed Action).

TABLE 2-5
South Operations Area Health and Safety Training Programs

Course	Personnel	Frequency	Duration	Instruction
New-hire training	All new hires exposed to mine hazards	Once	24 hours	Employee rights Supervisor responsibilities Self-rescue Respiratory devices Transportation controls Communication systems Escape and emergency evacuation Ground control hazards Occupational health hazards Electrical hazards First aid Explosives Toxic materials
Task training	Employees assigned to new work tasks	Before new assignments	Variable	Task-specific health and safety procedures Supervised practice in assigned work tasks in nonproductive duty Supervised operation of assigned work tasks in productive duty
Refresher training	All employees who received new-hire training	Yearly	8 hours	Required health and safety standards Transportation controls Communication systems Escapeways, emergency evacuations Fire warning Ground control hazards First aid Electrical hazards Accident prevention Explosives Respirator devices
Hazard training	All employees exposed to mine hazards	Once	Variable	Hazard recognition and avoidance Emergency evacuation procedures Health standards Safety rules Respiratory devices

PROPOSED ACTION

PROPOSED MINING OPERATIONS

Under the Proposed Action/amended Plan of Operations, Newmont would continue open-pit mining through year 2001 with refractory ore milling and gold recovery continuing until year 2009 (Figure 2-5). Ore would be mined from expansion of the existing Gold Quarry pit and development of two smaller open-pit mines (MAC and Tusc) near the Gold Quarry pit. Waste rock from all three mine pits would be disposed of in new or expanded waste rock disposal facilities. Figure 2-6 is a schematic of the existing and proposed expansion at the South Operations Area showing primary material handling, processing, and water distribution systems.

Oxide ore from the Gold Quarry, MAC, and Tusc mine pits would be processed in Newmont's existing mill facilities or heap leach pads using a cyanide leaching solution. High-grade refractory ore from the Gold Quarry pit would be processed in a proposed treatment facility utilizing roaster ovens to oxidize the ore prior to cyanide leaching in the mill. High-grade refractory ore from Newmont's property in the North Operations Area would also be processed in the new roaster facility, and a haul road would be constructed to transport this ore to the South Operations Area. Low-grade refractory ore would undergo bio-oxidation and cyanide heap leaching on four newly constructed pads. Gold would be recovered from the cyanide solution using existing carbon adsorption, stripping, and refining processes. Waste material or tailing from the mill operations would be transported to the Mill 2/5 Tailing Storage Facility.

Continued operation of the Gold Quarry Mine would require changes in the existing groundwater pumping system. Dewatering would allow Newmont to extract ore from below the water table in the Gold Quarry pit. Excess water not used for mining and milling purposes would be treated and discharged directly to Maggie Creek via pipeline. During high streamflow periods in Maggie Creek, however, excess mine water would be stored temporarily in the Maggie Creek Ranch Reservoir. This reservoir would be expanded from its present capacity of 2,700 acre-feet to a proposed capacity of 6,000 acre-feet.

Continuation and expansion of operations in the South Operations Area would result in an additional 1,573 acres of disturbance. Of this amount, 810 acres are on public land and 763 acres are on private land (Table 2-6).

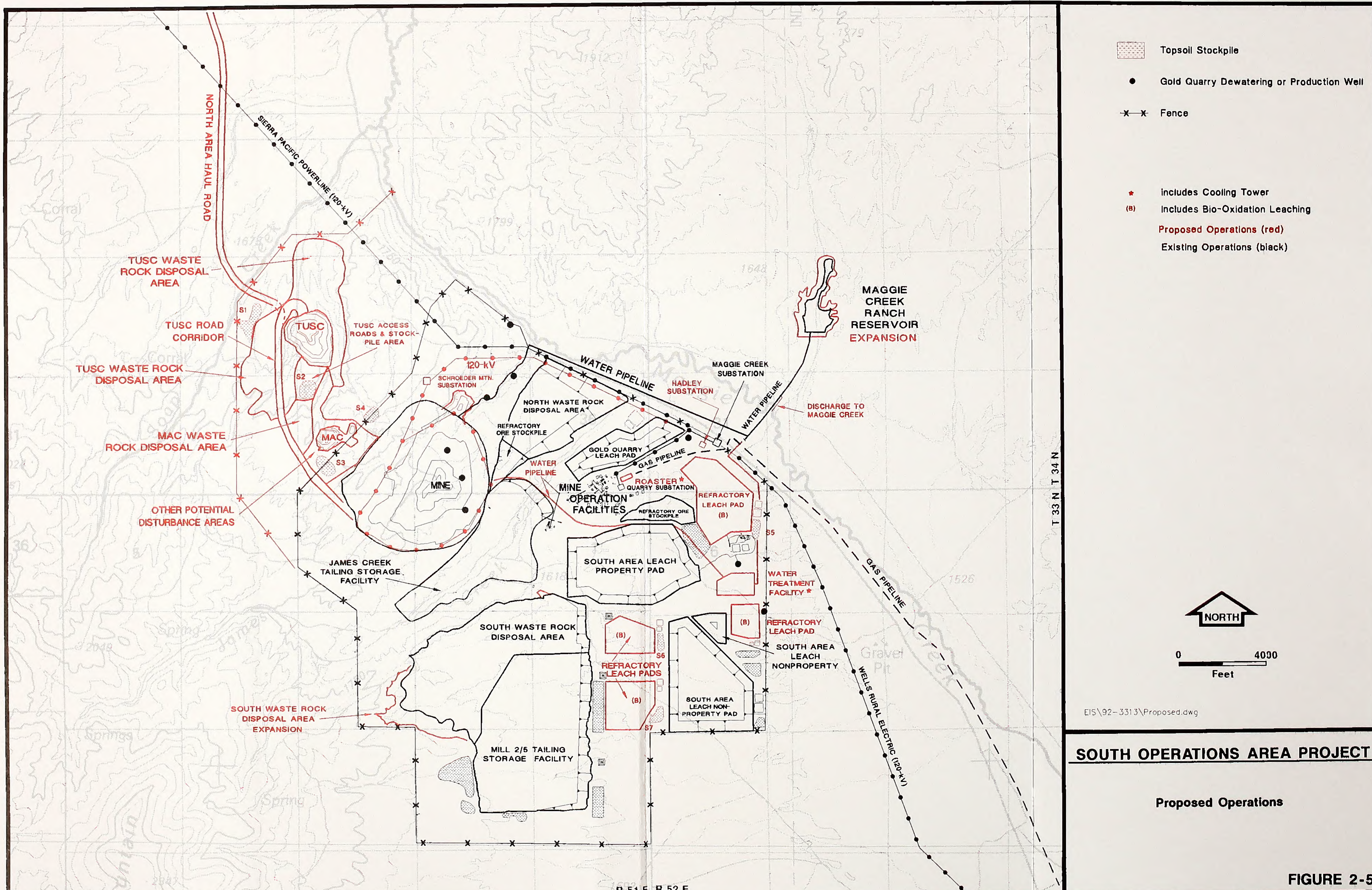
Open-Pit Mines

Mining under the proposed South Operations Area amended Plan of Operations would consist of: (1) expansion of the existing Gold Quarry Mine to a greater depth, (2) development of the new MAC Mine, and (3) development of the new Tusc Mine. Table 2-7 shows ore and waste rock tonnages for the three mine pits through year 2001. Table 2-7 also displays the tonnages of specific types of ore and waste rock materials that would be produced through year 2001 from the three mine pits. Ore mined from the MAC and Tusc pits would be processed in the South Operations Area.

Gold Quarry Pit

Continued mining of the Gold Quarry pit would result in removal of approximately 60 million tons of ore and waste rock in 1995, with production decreasing each year by an average of 10.5 million tons through year 2001. Estimated production rates from 1995 until the end of mine life are presented in Table 2-7.

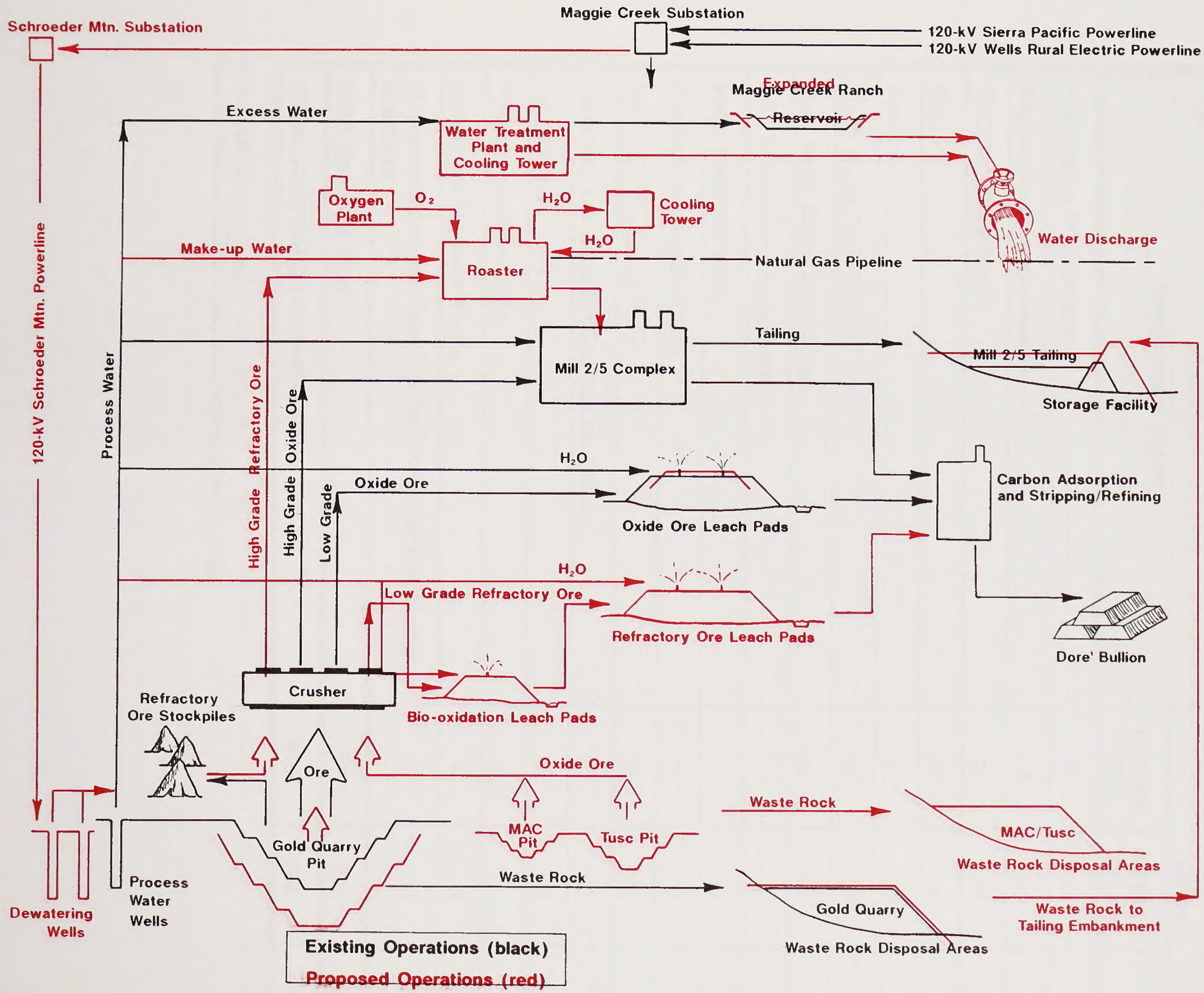
To reach deeper refractory ore, Newmont proposes to extend the Gold Quarry Mine pit approximately 800 feet below currently authorized



SOUTH OPERATIONS AREA PROJECT

Proposed Operations

FIGURE 2-5



Schematic of Existing and Proposed Operations
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-6

TABLE 2-6
Proposed Disturbance Area at the South Operations Area

Development Activity	Incremental Disturbance Acreage (acres)		
	Acreage Public	Acreage Private	Total
Gold Quarry Pit Expansion	[illegible]7	1[illegible]	4[illegible]
Maggie Creek Ranch Reservoir	10	40	50
MAC/Tusc Haul Roads	223	14	26[illegible]
MAC Pit	40	0	40
Tusc Pit	87	2[illegible]	112
South Waste Rock Disposal Area	24	26	50
Tusc Waste Rock Disposal Area	140	128	268
MAC Waste Rock Disposal Area	47	0	47
Water Treatment Plant	0	35	35
Pipelines and Access Roads	0	[illegible]	7
Refractory Ore Leach Pads	152	226	378
Refractory Ore Beneficiation Facilities (Roaster)	0	50	50
Oxygen Plant	0	15	4[illegible]
Pregnant Solution Ponds	0	14	14
Underdrain Collection Ponds	[illegible]	[illegible]	6
Schroeder Substation/Quarry Substation Expansion, Hadley Substation	0	3	3
North Area Haul Road	56	133	189
TOTAL PROPOSED DISTURBANCE	**810**	**763**	**1,573**

Note: Acreages include topsoil stockpile areas.
Source: Newmont Gold Company and Shepherd Miller, Inc. 1992.

TABLE 2-7
Combined Production Schedule for Gold Quarry, Tusc, and MAC Pits

Production Year	Ore (tons)						Waste Rock (tons)						Annual Ore and Waste Production (tons)	Disposition of Potentially Acid Generating Waste Rock (tons)	
	Oxide & Mill Refractory			Bio-Oxidation Refractory			Not Potentially Acid Generating			Potentially Acid Generating				To Mill 2/5 TSF[2]	To Dumps
	GQ	MAC	Tusc	GQ	MAC	Tusc	GQ	MAC	Tusc	GQ	MAC	Tusc			
1994[1]	*	2,391,409	259,111	*	0	0	*	2,823,190	4,994,462	*	0	0	10,468,172	0	*
1995	25,038,362	2,371,785	908,378	4,528,097	0	0	24,339,672	3,636,661	13,260,769	6,268,517	0	0	80,352,241	6,268,517	0
1996	19,118,466	0	1,363,934	5,240,303	0	0	18,086,048	0	13,776,000	5,817,595	0	0	63,402,346	0	5,817,595
1997	18,563,279	0	2,097,663	4,405,378	0	0	10,322,991	0	14,216,000	5,510,867	0	0	55,116,178	0	5,510,867
1998	11,523,888	0	3,549,164	7,473,348	0	0	5,590,323	0	10,434,000	7,948,399	0	0	46,519,122	0	7,948,399
1999	9,094,721	0	1,490,069	6,623,855	0	0	1,857,513	0	4,683,000	7,074,958	0	0	30,824,116	0	7,074,958
2000	5,209,875	0	1,634,355	8,731,583	0	0	734,593	0	2,900,000	9,920,081	0	0	29,130,487	0	9,920,081
2001	4,187,804	0	2,090,444	3,178,467	0	0	4,205,923	0	736,000	1,718,328	0	0	16,116,966	0	1,718,328
SUB-TOTAL	**92,736,395**	**4,763,194**	**13,393,118**	**40,181,031**	**0**	**0**	**65,137,063**	**6,459,851**	**65,000,231**	**44,258,745**	**0**	**0**	**331,929,628**	**6,268,517**	**37,990,228**
TOTAL	**110,892,707**			**40,181,031**			**136,597,145**			**44,258,745**			**331,929,628**	**44,258,745**	
GRAND TOTAL	**151,073,738**						**180,855,890**						**331,929,628**	**44,258,745**	

1 Production year 1994 figures are for MAC and Tusc pits only.

2 Construction of the Mill 2/5 Tailing Storage Facility would be completed in 1995; TSF = tailing storage facility.

* Waste rock and ore production from Gold Quarry (GQ) pit for 1994 is authorized under the Mill 2/5 Record of Decision (BLM 1991b) and therefore is not included in Table 2-7 ore and waste rock tonnages.

Source: Newmont 1993c.

depths. The pit would approach 1,755 feet in depth as measured from the pre-mining surface (pit bottom elevation would be 4,075 feet above mean sea level) and would disturb an additional 45 acres of land surface (27 acres public land and 18 acres private land). At completion of mining, the Gold Quarry pit would extend approximately 7,500 feet northeast to southwest and 6,500 feet east to west.

MAC Pit

Newmont proposes to extract ore from the MAC deposit, a near-surface satellite ore body located 0.5 mile northwest of the Gold Quarry Mine. Ore reserves at the MAC Mine, estimated to be 4.7 million tons, would be removed using open-pit methods. The proposed MAC Mine pit would extend approximately 1,000 feet in a north-south direction and 1,000 feet in an east-west direction, reaching an ultimate depth of 400 feet. Development of the MAC Mine pit would disturb approximately 40 acres of public land.

Tusc Pit

Newmont proposes to develop the Tusc Mine, located 1.5 miles northwest of the existing Gold Quarry Mine. Current ore reserves in the Tusc Mine are estimated to be 13.4 million tons. Newmont proposes mining the Tusc deposit using open-pit methods to obtain the near-surface oxide ore reserves. The proposed mine pit would extend for approximately 2,500 feet along a north-south axis and 2,000 feet along an east-west direction, reaching an ultimate depth of 500 feet. The proposed mine pit would disturb approximately 112 acres (87 acres public land and 25 acres private land).

Proposed Waste Rock Disposal Areas and Refractory Ore Stockpiles

Continued mining of the Gold Quarry Mine and development of the MAC and Tusc mines would produce approximately 181 million tons of waste rock. Waste rock from the Gold Quarry Mine would be placed in the South Waste Rock Disposal Area. Two new waste rock areas would be developed to dispose of MAC and Tusc waste rock.

South Waste Rock Disposal Area

Newmont proposes to expand the South Waste Rock Disposal Area, which is currently authorized to disturb 613 acres and contain 76 million tons of waste rock, so that it could accommodate an additional 85 million tons of waste rock from the Gold Quarry Mine between 1995 and 2001. Expansion of this facility would disturb an additional 50 acres (24 acres public land and 26 acres private land). The expanded facility would reach a maximum height of approximately 230 feet.

MAC Waste Rock Disposal Area

The MAC pit would generate approximately 6.5 million tons of oxide waste rock, which Newmont would dispose of along the north and west sides of the MAC pit. Storage of waste rock in this location would disturb 47 acres of public land, with the waste rock disposal area reaching a maximum height of 150 feet.

Tusc Waste Rock Disposal Area

Mining of the Tusc ore body would necessitate disposal of approximately 65 million tons of oxide waste rock. Newmont proposes constructing two waste rock disposal areas adjacent to the Tusc Mine pit, resulting in disturbance of 268 acres (140 acres public land and 128 acres private land). Height of these areas would vary, but would not exceed 150 feet.

Refractory Ore Stockpiles

Stockpiling of refractory ore for the period 1995 through 2001 would be at existing refractory ore stockpile locations (Figure 2-3).

Potentially Acid-Producing Rock

Newmont estimates that a portion (approximately 44.3 million tons) of the approximately 109 million tons of waste rock produced from the Gold

Quarry Mine between 1995 and 2001 may be potentially acid producing. A portion of this waste rock (6.3 million tons) would be encapsulated in the Mill 2/5 tailing dam in 1995 (see Table 2-7). The remaining 38 million tons of potentially acid-producing waste rock would be transported to the South Waste Rock Disposal Area. This waste rock would be placed on compacted, low-permeable base materials to facilitate drainage to containment areas, and would be surrounded by a thick rind of carbonate, oxide, or neutral waste rock (Newmont 1993a). Refractory ore, which also has the potential to be acid producing, would be handled as discussed in the Refractory Ore Stockpiles section under Existing Operations in this chapter.

Proposed Ore-Processing Operations

Continued operation and expansion of the South Operations Area would produce approximately 111 million tons of oxide ore and 40 million tons of refractory ore from mining the Gold Quarry, Tusc, and MAC ore bodies. High-grade oxide and high-grade refractory ores would be processed in the modified Mill 2/5 complex, while low-grade oxide and low-grade refractory ores would undergo a heap leaching process. In addition, Newmont proposes to process 16.5 million tons of high-grade refractory ore from the Post Mine, a private ore deposit in the North Operations Area. Newmont would transport this ore to the South Operations Area via the proposed North Area Haul Road.

Mill 2/5 Complex

Mills 2 and 5 are two independent milling circuits located in the same building. Newmont proposes to modify Mill 2 to process refractory ores. This mill, which would be designated Mill 6 once modifications are complete, would have a throughput capacity of 8,500 tons per day. Mill 5 would continue to process high- grade oxide ores and would maintain a throughput capacity of approximately 20,000 tons per day. Operation of these facilities would continue through 2009.

Roaster/Oxygen Plant

The modification of Mill 2 to Mill 6 as discussed previously would create the capability to artificially oxidize refractory ore through the use of a roaster plant. Higher grade refractory ore would first be crushed to optimum size and heated (with natural gas) to 400°F in the roaster to remove residual moisture. Dried ore then would be heated to 1,020°F in the roaster to oxidize sulfidic and carbonaceous minerals. Oxidation of sulfidic compounds in the ore would fuel the roasting process in an oxygen-rich environment. Natural gas from an existing pipeline would be used to provide supplemental heat. Oxygen would be supplied from a newly constructed oxygen plant.

Oxidation of the sulfidic and carbonaceous minerals would result in the formation of sulfur dioxide (SO_2), sulfur trioxide (SO_3), and carbon dioxide (CO_2) gases. Gases and heat produced during the oxidization process would be circulated through the roaster circuit. The roaster plant would use baghouse systems and an acid plant to control air emissions.

Following oxidation, the ore would be cooled to approximately 104°F and slurried to tanks. Next, the ore would enter the existing carbon-in-leach process for recovery of gold. Following gold recovery, the waste material (tailing) would be slurried to the Mill 2/5 Tailing Storage Facility.

The roaster facility would be cooled through operation of a closed-circuit cooling tower constructed adjacent to the roaster. Once the cooling tower system is filled, water makeup requirements for the system are estimated at 300 gpm with most losses resulting from evaporation. The roaster facility and cooling tower would operate through year 2009. Construction of the roaster facility/cooling tower and oxygen plant would result in disturbance of 50 and 15 acres of private land, respectively.

Tailing Storage Facility

Expansion of the Mill 2/5 Tailing Storage Facility would be accomplished by raising the height of the existing embankment. Proposed expansion of this facility would increase the embankment height from 100 feet to 230 feet, resulting in additional storage capacity of 35 million cubic yards. The total capacity of the expanded disposal facility would be 67 million cubic yards. Waste rock produced at the Gold Quarry Mine would be utilized to construct the embankment. In 1995, approximately 24.6 million tons of waste rock would be used to complete the tailing storage facility embankment. Because the original facility design provided for expansion of storage capacity, raising the embankment to 230 feet would not require additional land disturbance.

Leach Pads

A bio-oxidation process would be used to oxidize lower grade refractory ores, including both sulfidic and carbonaceous-sulfidic ore. This process involves application of an aqueous solution containing naturally occurring bacteria to oxidize the sulfidic (mainly pyrite) materials. These bacteria are most effective in acid conditions at pH below 4. This same oxidation occurs in nature, where bacteria oxidize the iron in pyrite and form an acidic solution containing high concentrations of dissolved iron.

The lower grade refractory ores would be stacked on a pad and the bacteria-containing solution applied to the heap by drip emitters similar to a heap leaching process. During the oxidizing process, the pyritic material dissolves, preparing the ore so that it is amenable to conventional cyanide leaching processes. Following oxidation, the low-grade ore is neutralized with an aqueous solution containing lime to increase pH in anticipation of cyanide leaching. The ore is removed from the bio-oxidation pads and placed on other pads for heap leaching. The heaps are then leached and gold recovered using a dilute cyanide solution.

A total of four new leach pads would be constructed to bio-oxidize and leach refractory ores (Figure 2-5). These leach pads would be constructed in the same manner as those currently permitted, in accordance with specifications outlined by NDEP (see Chapter 2, Leach Pads under Existing Operations). Acreage disturbed by construction of the new leach pads would be 226 acres of private land and 152 acres of public land, for a total of 378 acres.

Water Supply/Mine Pit Dewatering

Continued mining of the Gold Quarry Mine to depths below the groundwater table would result in direct groundwater inflow to the pit. Newmont proposes to install a dewatering system consisting of sumps in the mine pit floor and pumping wells located in the mine pit and north and northeast of the pit. An estimated 20 to 30 dewatering wells would be required to keep water levels below the mine pit floor. Estimates of combined pumping rates necessary for dewatering the pit are shown in Table 2-8. Dewatering of the Gold Quarry Mine pit also would require construction of powerlines in and around the mine pit to supply electricity to the wells (Figure 2-5).

TABLE 2-8
Gold Quarry Mine Pit Dewatering Flow Rates

Year	Flow Rate (gpm)
1993 through 1994	< 10,000
1994 through 1995	10,000 - 25,000
1996 through 1997	25,000 - 32,000
1998 through 1999	32,000 - 37,000
2000 through 2001	37,000 - 42,000
2002 through 2009	2,500 - 3,000[1]

[1] This groundwater withdrawal would be used for ore processing and reclamation, not dewatering.
Source: Hydrologic Consultants, Inc. 1992a.

Some water removed during mine pit dewatering would be used to replace water lost in the ore-processing circuit. Makeup water demand for existing and proposed activities typically ranges from about 3,000 to more than 6,000 gpm. Peak demand would occur during summer months when dust control on roads is needed. Additional water would also be used for mining operations as described in the Water Supply/Mine Dewatering section of Existing Operations in this chapter.

Newmont proposes to treat excess mine water to State of Nevada standards and pump the treated water directly to Maggie Creek for discharge and ultimate flow to the Humboldt River. During periods of high flow in Maggie Creek, mine water would be pumped to the Maggie Creek Ranch Reservoir for temporary storage. When high flows recede, stored water would be discharged to Maggie Creek so the reservoir would be available to receive mine water as needed. Figure 2-5 shows locations of the treatment plant, reservoir, and discharge point into Maggie Creek. Through a combination of flow monitoring on Maggie Creek and reservoir management, flows in Maggie Creek would be maintained below flood stage except when natural flooding in the creek occurs.

Maggie Creek Ranch Reservoir would be expanded from its existing 2,700 acre-foot capacity to provide approximately 6,000 acre-feet of storage. Expansion of the reservoir would require raising the earthen dam 30 feet to a final height of approximately 120 feet. The disturbed area associated with the reservoir would increase from 116 acres to approximately 166 acres, 10 of which would be public land. At a maximum flow rate of 42,000 gpm, the expanded reservoir could store water for approximately 4 weeks.

Dewatering of the Gold Quarry Mine would cease at the end of year 2001; however, ore processing would continue in the South Operations Area through 2009. Approximately 2,500 gpm of process makeup water would be obtained from existing water supply wells for years 2002 through 2009.

Haul Roads

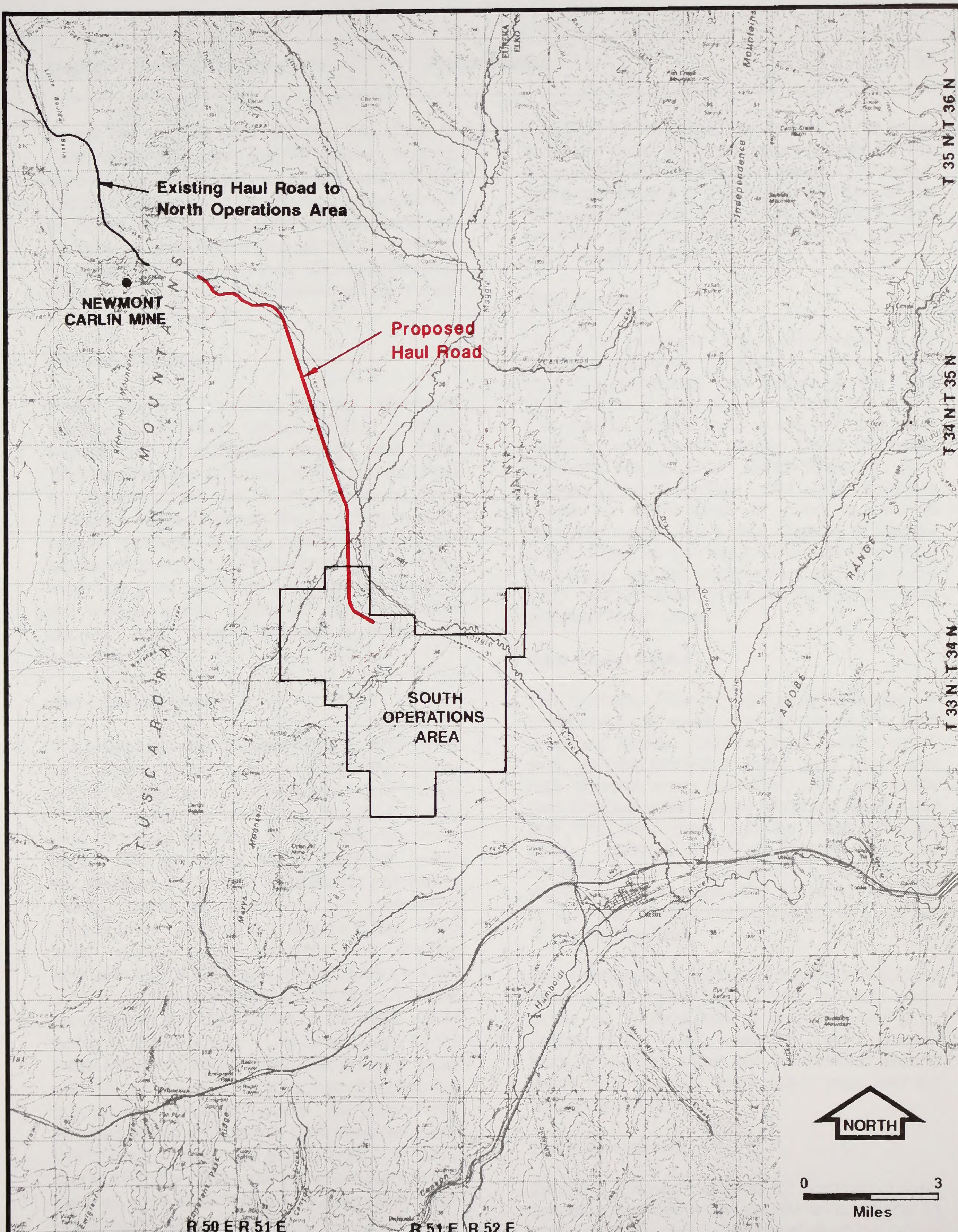
MAC and Tusc

Access to the MAC and Tusc ore bodies would require constructing or upgrading access and haul roads. The proposed location for the road corridor is shown in Figure 2-5. Haul roads would be 150 feet wide with 7-foot-high wheel berms and constructed in accordance with Mining Safety and Health Administration (MSHA) standards. In addition to haul road construction, pipelines may be built within the road corridor for dust control in lieu of water trucks. Road construction and upgrading within this corridor would disturb an estimated 206 acres (165 acres public land and 41 acres private land). An additional 58 acres of public land would be disturbed to bring existing low areas to grade and for control of surface runoff.

North Area Haul Road

Refractory ore is presently being excavated from Newmont's Post Mine in the North Operations Area. Newmont proposes to construct a new haul road to the South Operations Area connecting with an existing haul road located near the Carlin Mine, a distance of approximately 9.1 miles (Figure 2-7). The haul road would be 150 feet wide with 7-foot-high wheel berms and constructed to MSHA standards for 150- to 190-ton off-road dump trucks. Newmont estimates that three truckloads of refractory ore per hour would be transported on this road to the South Operations Area on a year-round basis. A total of 16.5 million tons would be transported over the life of the operation. The proposed haul road would disturb approximately 189 acres (56 acres public land and 133 acres private land).

The proposed haul road will include provisions to minimize impacts on migrating mule deer. The segment of the haul road which passes through Section 13, T35N, R50E and Section 19, T35N, R51E, will be built either on a ridgetop or in a valley bottom. Cut and fill slopes generally will be less than 50 percent. Where this slope cannot be achieved, diagonal ramps at least 5 feet wide will



Proposed North Area Haul Road
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-7

be cut into the cut or fill slopes. The slope of these ramps will be less than 50 percent. A ramp on one side of the road will have a ramp on the opposite side of the road. Ramps will be placed no more than 100 yards apart and maintained as necessary. Road berms through this area will be constructed to have less than 50 percent slopes. Gaps 3 to 5 feet wide in the berms will be placed at intervals of 50 yards.

Ancillary Facilities

Under current operating plans, Newmont anticipates continued use of existing ancillary facilities and infrastructure through year 2009. Additional facilities proposed in the amended Plan of Operations for the South Operations Area include: a water treatment plant/cooling system, topsoil stockpile areas, pipeline system for transporting excess mine dewatering flows to the treatment plant and from the treatment plant to the Maggie Creek discharge point, diversion ditches, and power distribution lines and substations.

Water Treatment Facility

The proposed water treatment system would treat excess water produced by the dewatering system prior to discharge. Water treatment would involve routing dewatering flows from the Gold Quarry Mine through pipelines to a water treatment facility. The proposed water treatment facility would utilize a chemical precipitation process to reduce metal concentrations in dewatering effluent to be discharged to Maggie Creek. Four lined ponds, each capable of treating approximately 10,000 gpm, would be constructed adjacent to the water treatment facility. Chemical precipitation and clarification of the water would occur in these ponds. Chemicals used in the water treatment facility would be stored in tanks prior to use. Sludge resulting from the chemical precipitation process would be periodically pumped from the bottom of each treatment pond into trucks and disposed of in the Mill 2/5 Tailing Storage Facility. The water treatment plant would meet all applicable State of Nevada effluent and water quality standards.

A cooling system would be installed at the water treatment plant when necessary to reduce the temperature of treated discharge waters such that water temperature of the Humboldt River at the Palisade gage would be maintained within 2° C of ambient water temperature (State of Nevada water quality standard).

Water Pipelines

Under the proposed action, Newmont would construct additional pipelines to convey water from the dewatering well system in the Gold Quarry Mine area to the water treatment plant. The pipeline system also would link the water treatment plant to the Maggie Creek discharge point and Maggie Creek Ranch Reservoir. The Maggie Creek discharge point outlet structure would be constructed of concrete with a riprapped outfall into a side channel of Maggie Creek. Pipelines also would be constructed along haul roads for dust suppression, and to provide water to the refractory ore leach pads and bio-oxidation leach pads.

Water Control Ditches

The amended Plan of Operations provides for construction of water control ditches for each proposed facility. Ditches would collect runoff from ore piles located on leach pads, new waste rock disposal areas (i.e., MAC and Tusc waste rock disposal areas), North Area Haul Road, Tusc and MAC haul road, and the roaster/oxygen plant. Existing diversion ditches would be maintained in accordance with NDEP requirements. Acreages that would be disturbed by diversion ditches are included in descriptions of relevant facilities.

Best management practices for control of surface erosion and sedimentation from disturbed areas would be implemented at the mine site (e.g., netting, straw bales, sediment control ponds). Flow of surface water will be directed around waste rock disposal areas, leach pads and the tailing impoundment.

Energy Requirements

Electrical demands created by dewatering wells and other facilities would require an additional 51 megawatts of power. Additional electrical power would be provided by energizing an existing Sierra Pacific Power Company 120-kV powerline that connects the Maggie Creek Substation with the Bazza Substation. This transmission line was built in 1988, but has not been energized. Distribution of additional power within the South Operations Area would require construction of 2.4 miles of 120-kV line connecting Maggie Creek Substation with a new Schroeder Mountain Substation, expansion of the existing Quarry Substation, and construction of Hadley Substation adjacent to Maggie Creek Substation (Figure 2-5). Powerlines and substations would be constructed on private land and would disturb about 3 acres.

Proposed operations would require 2,500 standard cubic feet per minute of natural gas for roaster plant operation. This gas would be supplied by the existing natural gas pipeline that extends to the South Operations Area from Carlin, Nevada.

Resource Monitoring

Air Quality

Air resource monitoring would continue pursuant to current permits and regulations as discussed in Resource Monitoring under Existing Operations.

Water Resources

Hydrologic monitoring of groundwater, springs/seeps, and streams/rivers in the study area would continue under the proposed Plan of Operations. The Maggie Creek Basin Monitoring Plan (Newmont 1991a) would provide a means of evaluating potential impacts during and after the Gold Quarry Mine operations, including monitoring wells for water levels and/or water quality. Spring and seep surveys are currently being conducted to evaluate changes in flow and water quality, and surface water monitoring is being conducted on six streams and the Humboldt River. Monitoring of water resources would continue after cessation of mining activities in the South Operations Area. Because the Carlin "Cold" Springs are the primary source of water for the town of Carlin, Newmont has agreed to maintain an adequate supply of potable water should any deficiency occur due to dewatering activities.

As a result of the combined groundwater drawdown effects area between the South Operations Area Gold Quarry and North Operations Area Betze mines, several streams north of the South Operations Area that are tributary to Maggie Creek could be affected by flow reductions (see Chapter 4, Cumulative Effects). Therefore, a cooperative monitoring program would be established for the two mines to evaluate potential impacts to these streams.

Potentially Acid-Producing Rock

Monitoring of waste rock and sulfide ore stockpiles would continue according to existing permits and regulations, as discussed in Resource Monitoring under Existing Operations. As described in that section, Newmont has developed a draft plan for monitoring refractory ore stockpiles and waste rock disposal areas for potentially acid-producing rock (Newmont 1993a).

Hazardous Materials

Newmont does not anticipate an increase in the present levels or types of hazardous materials transported, stored, used, treated, recycled, or disposed of on-site at the South Operations Area. Hazardous material management is described in Human Health and Safety under Existing Operations in this chapter.

Tailing Composition

The proposed action is expected to generate tailing from two sources: the existing Mill 5 and the proposed Mill 6. Mill 5 would continue to generate tailing composed primarily of finely ground rock and weak cyanide aqueous solution. Mill 6 would generate a tailing similar to that of Mill 5. The combined tailing would also receive a small volume of waste material generated by the carbon stripping and refining facilities. These wastes would contain a solution of 2% hydrochloric acid from the carbon filters and sulfuric acid used to digest gold-plated steel wool during the final stages of the extraction process. Because the mill slurry would be alkaline (Table 2-4) due to the addition of lime during the milling process, acids present in the liquid waste will be neutralized when added to the tailing and mixed with Mill 6 tailing material. The combined tailing and acid wastes would be similar in composition to the tailing generated by current operations.

The proposed Mill 6 operations are expected to generate approximately 8,500 tons per day of tailing material. Most solution would be reclaimed from the tailing and reused in the leaching process.

Human Health and Safety

Human health and safety programs and requirements would be the same as those described in Human Health and Safety under Existing Operations in this chapter.

Employment

Newmont presently employs approximately 916 people at the South Operations Area. No change in size of the permanent work force is anticipated as a result of the proposed amended Plan of Operations. In addition, Newmont has employed 50 to 150 temporary employees in the project area using mostly contractor personnel. Newmont expects that up to 758 temporary employees would be needed during peak construction periods, mainly for construction of the roaster. The majority of these workers would be employed during the second half of 1993 and the first half of 1994 (Table 2-9).

Reclamation

Reclamation activities described in this section address both existing mine lands and lands included in the proposed expansion at the South Operations Area. These reclamation procedures and plans were developed by Newmont in response to recent regulations adopted by BLM and NDEP. The BLM Elko District's reclamation and revegetation goal for the area is as follows: leave areas disturbed by mining in a stable configuration that will withstand erosion and slump failure; to the extent feasible and reasonable, slope mining disturbances to blend and match the surrounding topography; establish self-renewing plant communities that at least equal or exceed the value of vegetation that existed at the site before mining; and utilize three to four plant seed mixes planted in a mosaic pattern with each seed mix adapted to a different geomorphic and environmental setting. Table 2-10 presents reclamation sequences for the South Operations Area.

Reclamation activities include closure of tailing and heap leach facilities, pit fencing, removal of structures not needed after cessation of operations, regrading of disturbed areas (including waste rock piles and roads) drainage control, selective replacement of salvaged soils, revegetation, closure of groundwater wells not needed after cessation of operations, and reclamation monitoring. Figure 2-8 is a key to reclamation proposed at the South Operations Area.

TABLE 2-9
Temporary Workers Needed for South Operations Area Construction[1]

	1993	1994
1st Quarter	51	695
2nd Quarter	124	348
3rd Quarter	494	71
4th Quarter	758	0

[1] Numbers do not include Newmont Gold Company employees.
Source: Newmont 1993d.

Soil Salvage

Newmont has salvaged topsoil from previously authorized disturbance areas and would continue to salvage topsoil in areas to be disturbed by proposed activities. Most previously salvaged topsoil has been stockpiled for use in later reclamation although some topsoil has been used in ongoing reclamation at the mine. Topsoil stockpiles are located throughout the South Operations Area in proximity to sites that eventually would be reclaimed. Newmont reports approximately 1.8 million cubic yards of topsoil currently in stockpiles at the South Operations Area (Newmont 1992c). Major topsoil stockpiles are shown in Figure 2-5. Topsoil stockpiles are protected from wind and water erosion through establishment of vegetative cover.

Newmont proposes stripping an average of 12 inches of topsoil from newly disturbed mine areas, resulting in a volume of approximately 2.5 million cubic yards. Volume of topsoil to be redistributed in the South Operations Area would be approximately 4.3 million loose cubic yards. Based on this amount, Newmont would cover all existing and proposed disturbances with approximately 6 inches of topsoil.

Newmont has identified seven stockpile locations for the Proposed Action. These topsoil stockpiles will cover approximately 48 acres of public land and 30 acres of private land. These acreage figures have been included within the 'Incremental Disturbance Acreage' figures outlined in Table 2-6. The seven topsoil stockpiles will have the capacity to store up to 2.5 million cubic yards of material at an average height of 19 feet adjacent to the respective disturbance areas.

Test Plots

A test-plot program would be implemented to evaluate and select successful, site-specific reclamation measures that would modify Newmont's proposed reclamation plan. The emphasis of this program would be on developing three or four plant species mixes that would be adaptable to different geomorphic settings expected within the reclaimed project area. These settings would include different aspects and soil types. Various surface preparation practices would also be evaluated for their success in promoting plant establishment and resistance to soil erosion. The reclamation studies would be developed in cooperation with BLM, NDEP, and Nevada Department of Wildlife. Based on the results, the BLM, as lead agency, would select the plant mixtures and cultivation practices to be used in reclaiming disturbed areas.

Fertilization

Soils, tailing, and waste rock would be sampled prior to revegetation and fertilizer amendments would be incorporated into reclaimed surfaces as necessary.

Mulching

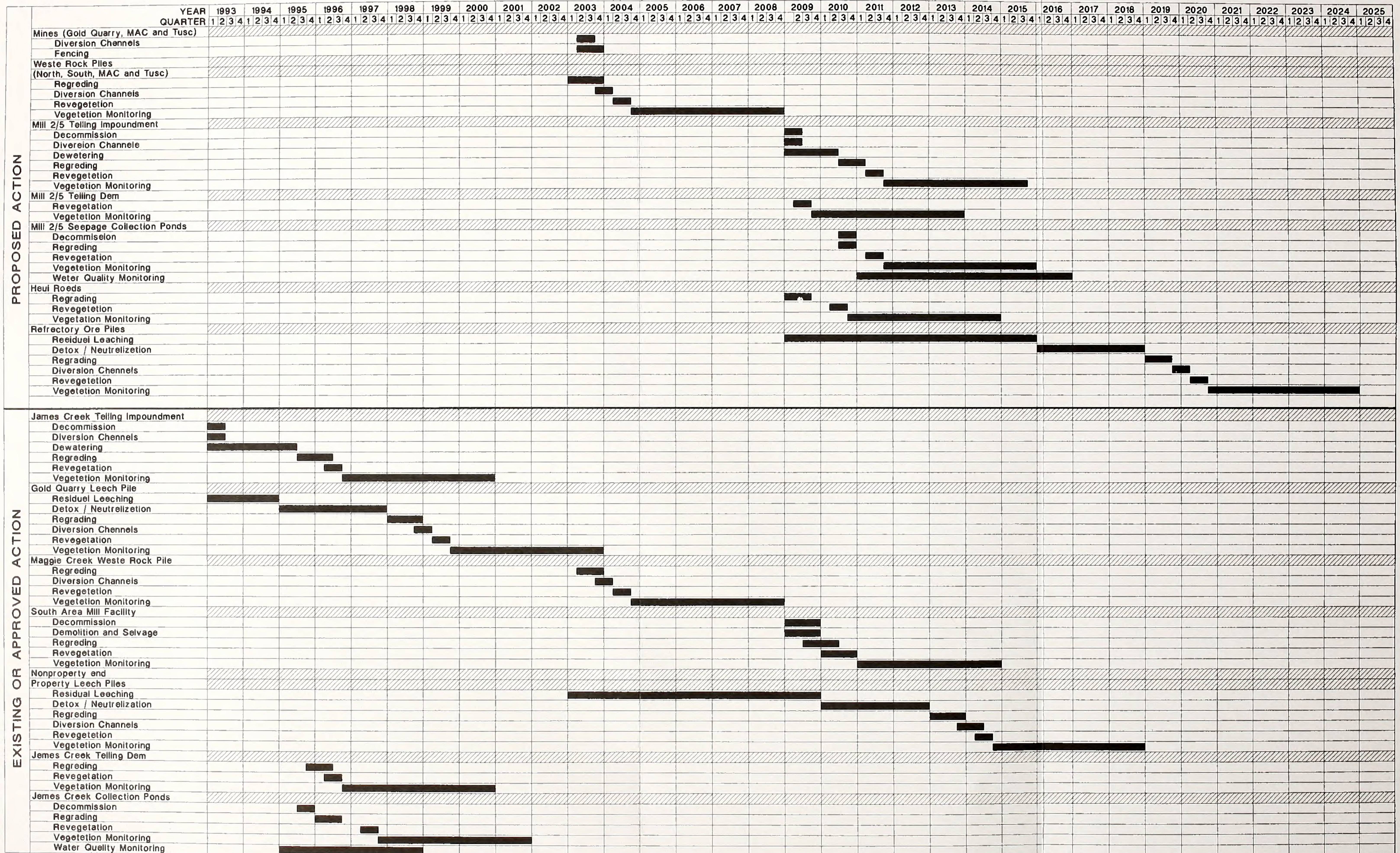
Weed-free mulch consisting of straw or hay would be applied in various amounts, depending on the surface to be reclaimed. Rates of application for mulch are described in the mining component sections that follow. Mulch would be crimped into the soil using mechanical equipment where slopes permit. On steeper slopes, mulch would be held in place by chemical tackifiers. When mechanical equipment is employed, mulch would be applied and crimped after seeding.

Organic amendments would be used to supplement available topsoil. Amendments may include straw, manure, sludge, or composed plant material.

Seed Mixtures

Newmont is presently proposing to use two seed mixtures on the property: a dry-site and a mesic-site mixture (Table 2-11). As part of the test-plot program, additional seed mixtures would also be developed so that a mosaic pattern of three to four seed mixtures could be seeded on mine disturbances.

TABLE 2 - 10 RECLAMATION SCHEDULE



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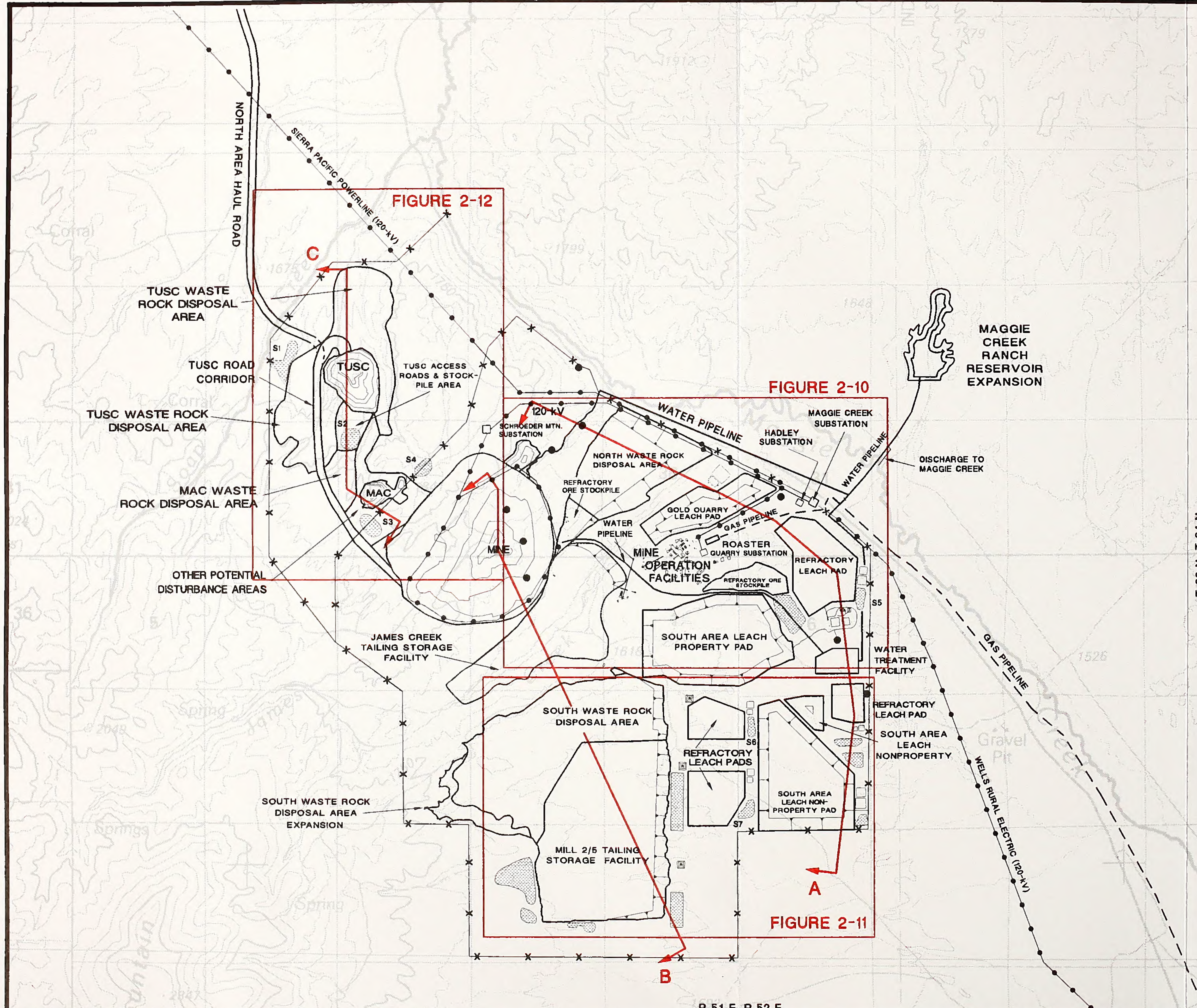


Topsoil Stockpile
Post Contour Figure
Cross Section (See Figure 2-9)
Gold Quarry Dewatering or Production Well
Fence

SOUTH OPERATIONS AREA PROJECT

Reclamation Key

FIGURE 2-8

TABLE 2-11
Seed Mixture for Dry and Mesic Sites - South Operations Area

Species	Seeds/ pounds	Dry Site		Mesic Site	
		Seeds/ sq.ft.	Lbs/Acre (PLS[1])	Seeds/ sq.ft.	Lbs/Acre (PLS[1])
Bluebunch wheatgrass[2] *Agropyron spicatum*	140,000	7	2.17	6	1.87
Crested wheatgrass *Agropyron cristatum*	250,000	5	0.90	--	--
Pubescent wheatgrass *Agropyron intermedium trichophorum*	85,000	6	3.07	--	--
Indian ricegrass[2] *Oryzopsis hymenoides*	162,000	4	0.90	6	--
Sheep fescue[2] *Festuca ovina*	600,000	4	0.29	7	0.29
Basin wildrye[2] *Elymus cinereus*	145,000	5	1.55	6	1.74
Streambank wheatgrass[2] *Agropyron dasystachyum riparium*	170,000	--	--	7	1.79
Sandberg bluegrass[2] *Poa secunda*	925,000	--	--	6	0.20
Prostrate kochia *Kochia prostrata*	500,000	4	0.35	3	0.26
Cicer milkvetch *Astragalus cicer*	145,000	3	0.90	4	1.20
Small burnet *Sanguisorba minor*	85,000	3	2.37	7	3.16
Gooseberryleaf globemallow[2] *Sphaeralcea grossulariifolia*	925,000	3	0.26	3	0.29
Rubber rabbitbrush[2] *Chrysothamnus nauseosus*	600,000	4	0.29	7	0.29
Basin big sagebrush[2] *Artemisia tridentata tridentata*	2,500,000	--	0.21	--	0.20
Fourwing saltbush[2] *Atriplex canescens*	55,000	6	4.75	8	6.33
TOTAL	--	**66**	**18.15**	**66**	**17.63**

[1] PLS = pure live seed drilling rate (broadcast = 1.5 x drilling rate).

[2] Native species.

Source: Newmont Gold Company and Shepherd Miller, Inc. 1992.

Mine Pits

Reclamation activities for the pits would include constructing diversion channels to minimize surface water runoff into the pits, fencing, and posting warning signs to identify potential safety hazards. The MAC and Tusc pit perimeters would each be enclosed by a four-strand barbed wire fence; the Gold Quarry pit perimeter would have an 8-foot chainlink fence installed. A cross-section of the proposed Gold Quarry Mine pit topography at closure is shown in Figure 2-9.

Waste Rock Disposal Areas

Waste rock piles would be graded to a minimum 2.3H:1V (43 percent) slope with benches (a minimum of 10 feet wide) about every 50 feet of height. This would result in an overall slope of 2.5H:1V (40 percent). The tops and benches would be sloped (not to exceed 2 percent) to promote runoff. Figures 2-10, 2-11, and 2-12 depict conceptual reclaimed topography for the North, South, MAC, and Tusc waste rock disposal areas. The Maggie Creek Waste Rock Disposal Area was graded to a 3.5H:1V (33 percent) slope during 1992. Figure 2-9 illustrates cross-sections of all waste rock disposal areas.

Approximately 6 inches of topsoil would be redistributed on waste rock piles following fertilization. Organic amendments (at 15 to 20 tons per acre) and inorganic fertilizer would be incorporated to a depth of 12 to 18 inches to provide a plant growth medium on the tops of the waste rock piles. Compacted areas would be scarified as necessary to prepare a seedbed.

Sideslopes and tops would be broadcast seeded with the dry-site seed mixture (Table 2-11) and lightly harrowed to cover the seed. Sideslopes would be mulched as necessary with straw or hay at 2 tons per acre crimped into the surface after seeding.

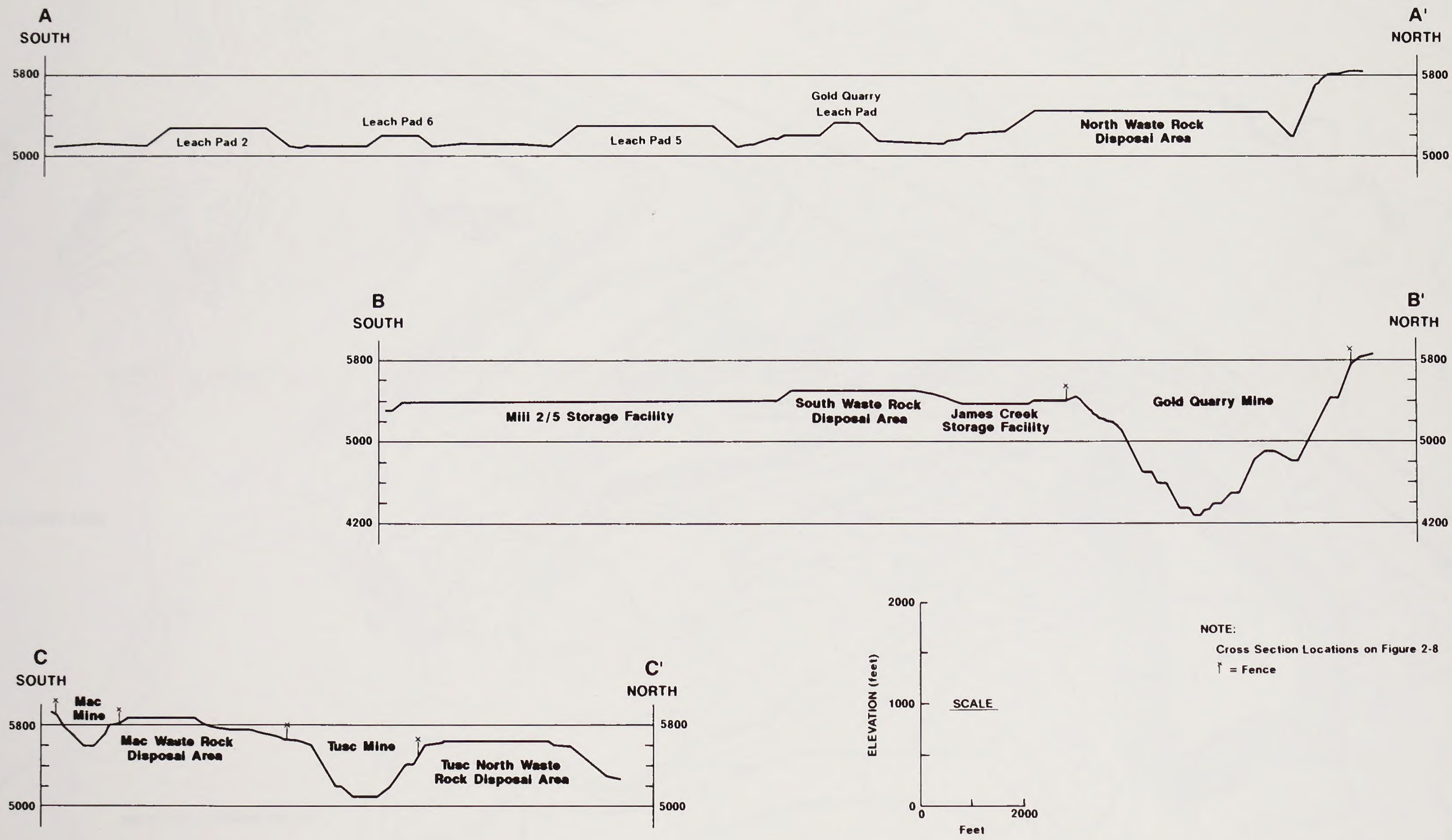
Tailing Storage Facility

Figure 2-11 depicts proposed reclaimed topography for the Mill 2/5 Tailing Storage Facility. It is anticipated it would take at least 10 months following cessation of tailing storage for water to drain or evaporate sufficiently to permit reclamation activities. Once the surface is capable of supporting equipment, it would be graded to reduce irregularities with a final slope of less than 1 percent toward the southwest as shown in Figure 2-11. A closed basin would then be formed in the southwest corner of the tailing facility that would pond water following spring melt-off and short-duration, high-intensity storms. Diversion channels upslope of the disposal facility would limit water run-on to the surface of the tailing facility.

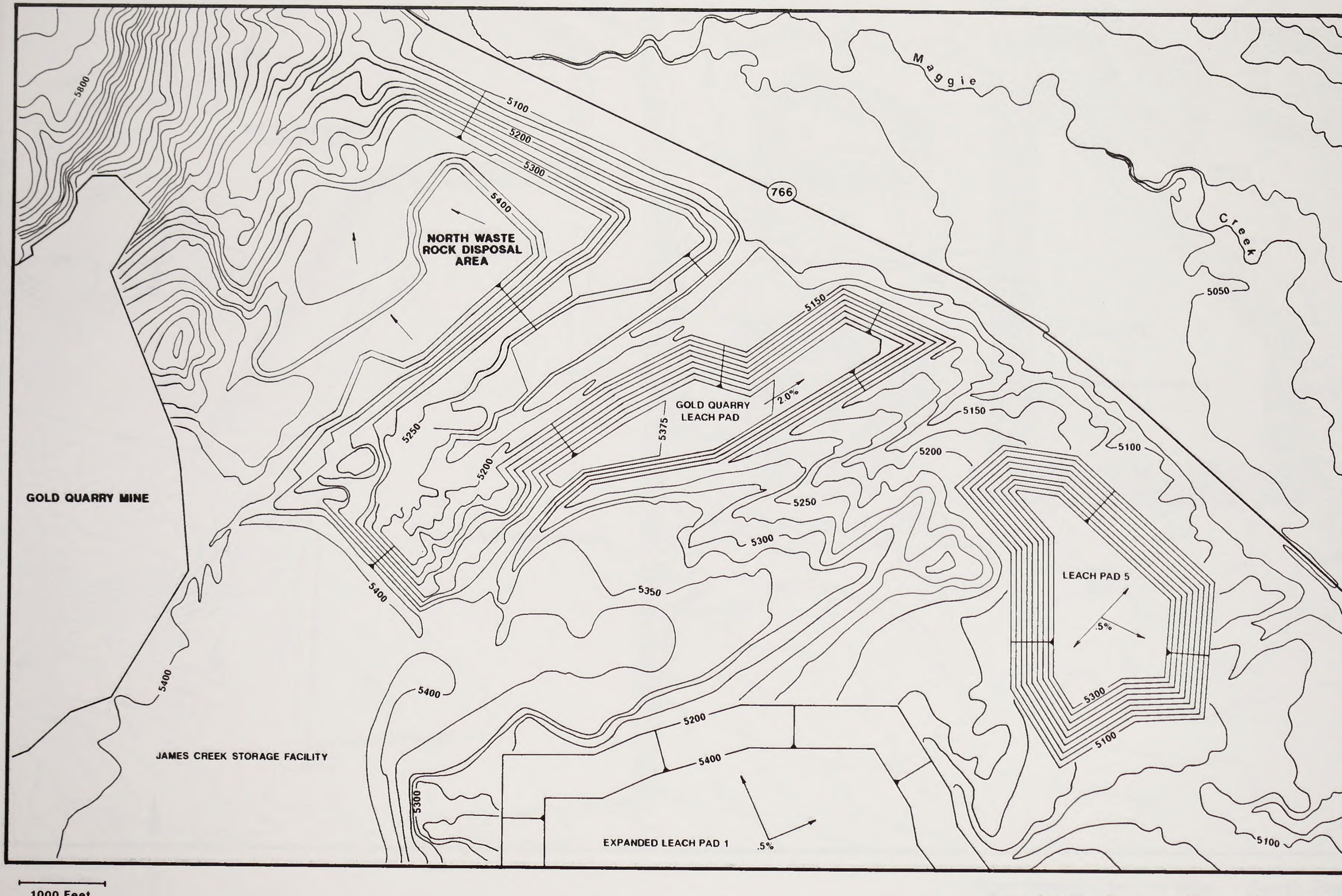
The sideslopes for the storage facility would be fertilized and covered with 6 inches of previously salvaged topsoil. Topsoil and sideslope material would be ripped on the contour to a depth of 12 to 18 inches.

After seedbed preparation by discing or harrowing, the tailing storage facility would be broadcast seeded with the dry-site seed mixture of native and introduced species (Table 2-11). The replaced soil would be seeded, fertilized, and mulched using straw and hay at 2 tons per acre crimped into the soil surface.

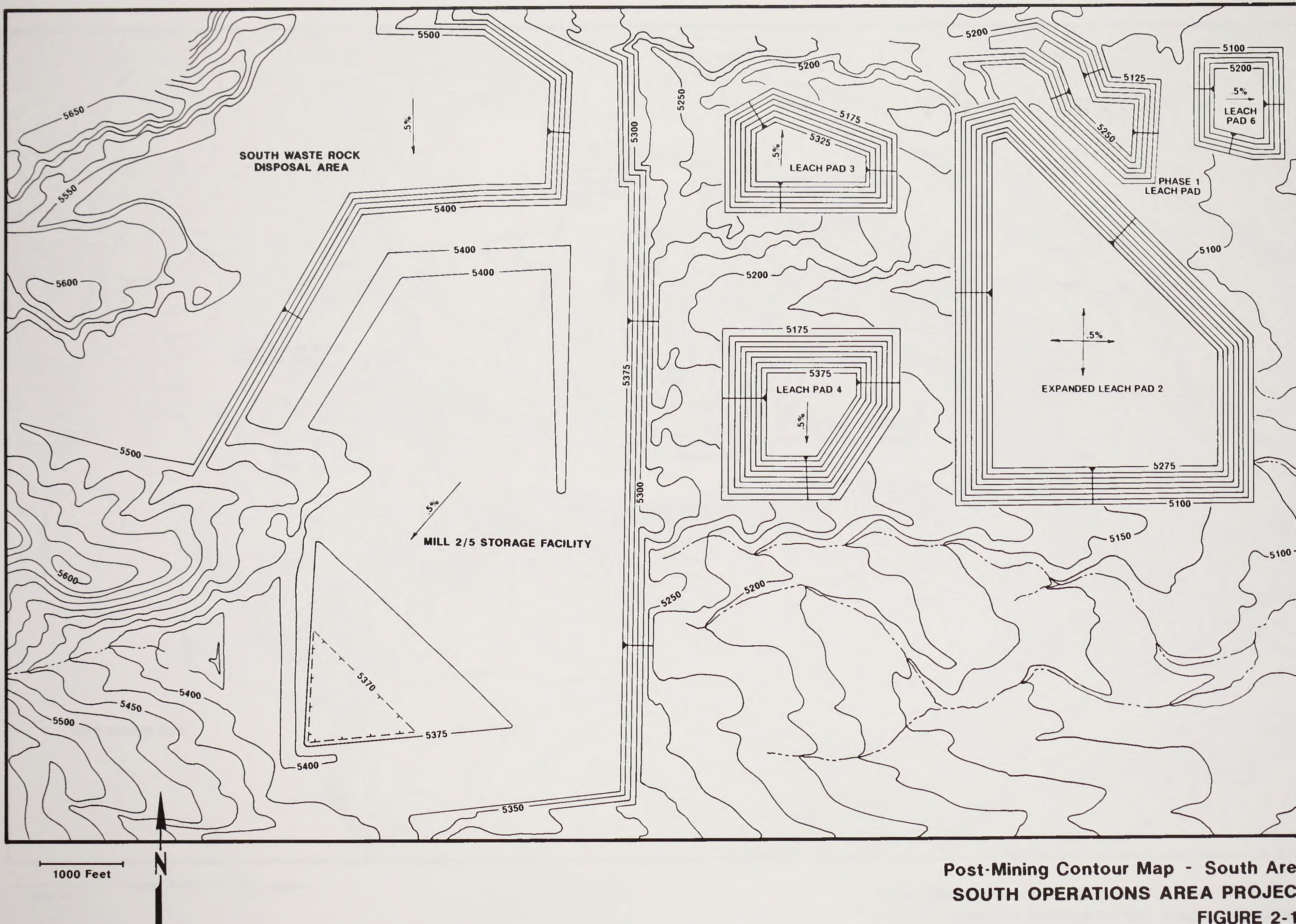
Cyanide effluent from the Mill 2/5 Tailing Storage Facility underdrainage collection system would undergo neutralization and detoxification as soon as the facility is removed from service. Residual water in the tailing storage facility would both evaporate and seep through the tailing material to the underdrain system of the tailing pond. All seepage would be collected and pumped to a leaching facility or back to the tailing storage facility. It is expected that continuous seepage of residual tailing solution would cease approximately 7 years after tailing deposition is halted (Newmont Gold Company and Shepherd Miller, Inc. 1992); final closure and remaining reclamation could then be completed. It is estimated that approximately 15 gpm of seepage from infiltrating precipitation would continue to discharge from the underdrain system of the reclaimed tailing facility (Newmont Gold Company and Shepherd Miller, Inc. 1992); however, by this



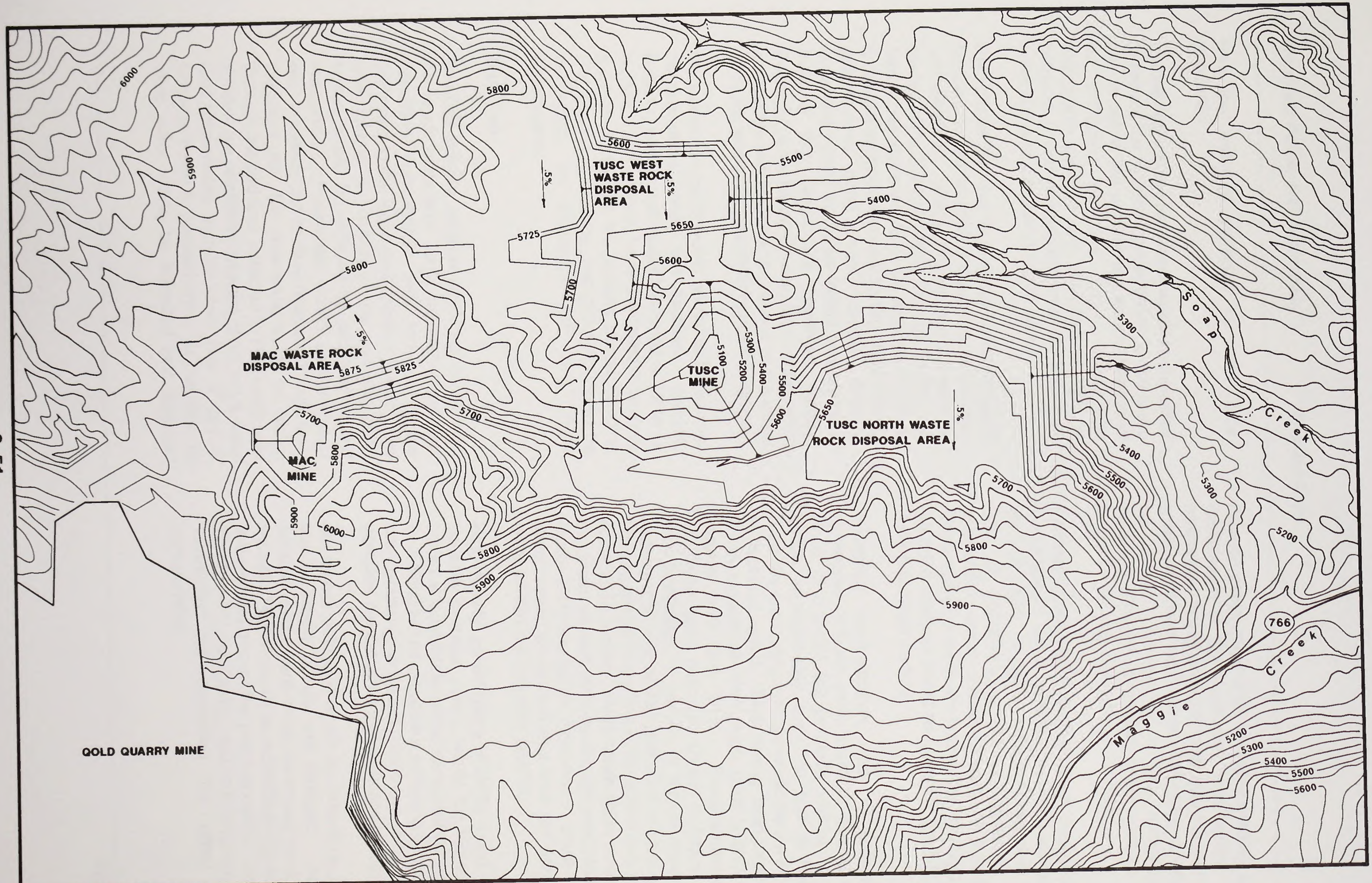
Post-Mining Contour Cross Sections
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-9



Post-Mining Contour Map - North Area
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-10



Post-Mining Contour Map - South Area
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-11



Post-Mining Contour Map - MAC and Tusc Area
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-12

time the water is expected to meet State standards.

Natural degradation processes would be expected to reduce the cyanide concentration in the seepage to below the present regulatory criterion of 0.2 milligrams per liter (mg/L) weak acid dissociable cyanide and sta-bilize the pH at between 6 and 9 standard units. At that time, collection and circulation would cease.

Precipitates forming on seepage collection pond bottoms would be analyzed prior to reclamation and disposal. Nonhazardous waste would be placed in the Mill 2/5 Tailing Storage Facility; any hazardous waste would be transported off-site to a hazardous waste disposal facility. High-density polyethylene pond liners beneath seepage collection ponds would be folded and buried at least 5 feet below the backfilled surface. Backfilling would establish a surface configuration compatible with adjacent terrain and, to the extent possible, reestablish pre-disturbance topography.

Six inches of topsoil would be redistributed over the backfilled ponds and fertilized. Backfill, fertilizer, and topsoil would be ripped to 12 to 18 inches. Topsoil would be redistributed to achieve a 6-inch depth over the process ponds. Seeding (Table 2-11), harrowing, and mulching would be conducted as discussed for other mine components.

Leach Pads

Residual cyanide solution would be rinsed from the leach pads and would be neutralized and detoxified concurrently with those solutions contained in the leach pad solution ponds. The total volume of solution in the pad and pond system would be reduced by recirculation and evaporation. Freshwater would be introduced onto the leach pad to rinse residual cyanide from the spent ore. The rinse water would be cycled through the pad and collected in the ponds until it meets the regulatory criterion of 0.2 mg/L weak acid dissociable cyanide and has a pH of between 6 and 9 standard units. At that time, all rinse water would be collected and disposed through evaporation prior to final regrading and reclamation of the leach pad and ponds. If freshwater rinsing does not meet cyanide and pH goals, additional neutralization techniques would be utilized. According to the reclamation schedule (Table 2-10), rinsing would continue for 3 years following cessation of leaching.

Process ponds associated with leach pads would be reclaimed following leach pad neutralization/detoxification. Water or solution present at the end of operations would be disposed by evaporation and by circulation within each facility. Once the leach pads are neutralized, precipitates on pond bottoms would be placed in the Mill 2/5 Tailing Storage Facility.

Following neutralization and detoxification, sideslopes of leach pads would be graded to a slope of 2.3H:1V (43 percent), with a 10-foot bench approximately every 50 feet of height. Benches and leach pad tops would be out-sloped to facilitate runoff. Post-mining topography of South Operations Area leach pads is shown in Figures 2-10 and 2-11. Cross-sections of reclaimed leach pads are shown in Figure 2-9. After fertilization, 6 inches of topsoil would be redistributed over the top and sides of each heap. The top of each heap would be ripped to a depth of 12 to 18 inches. Heap leach pads would be broadcast seeded with the dry-site seed mixtures (Table 2-11) and lightly harrowed to cover seed. Mulch would be applied at 2 tons per acre and crimped into the soil after seeding.

High-density polyethylene (HDPE) pond liners beneath process ponds would be folded and buried at least 5 feet below the backfilled surface. Backfilling would establish a surface configuration compatible with adjacent terrain and, to the extent possible, reestablish pre-disturbance topography.

Six inches of topsoil would be redistributed over the backfilled ponds and fertilized. Backfill, fertilizer, and topsoil would be ripped to 12 to 18 inches. Topsoil would be redistributed to achieve a 6-inch depth over the process ponds. Seeding (Table 2-11), harrowing, and mulching would be conducted as discussed for other mine components.

Haul Roads

Haul roads associated with waste rock disposal areas or heap leach pads would be reclaimed concurrently with closure of the respective sites. The North Area Haul Road would be reclaimed following completion of ore hauling.

The roads would be graded to reestablish pre-disturbance topography and drainage. Fertilizer would be applied prior to resoiling with 6 inches of topsoil. After resoiling, roads would be ripped to a depth of 12 to 18 inches. The dry-site mixture (Table 2-11) would be seeded and lightly harrowed to bury seed. Roads would be mulched as previously discussed for other disturbances.

Pending consultation with BLM, the main access road from State Highway 766 to the South Operations Area may be retained to provide site access. If the main access road is removed, reclamation would be conducted as discussed for other roads.

Ancillary Facilities

Buildings

The mill, ancillary buildings, and other structures would be dismantled and removed following cessation of operations. Nonsalvageable material (e.g., HDPE liner, scrap building material, concrete) would be buried on-site or disposed of off-site in compliance with NDEP regulations. Concrete foundations, basements, walls, and sumps would be flattened and buried. Materials that had been in contact with cyanide or other toxic chemicals would be decontaminated prior to disposal.

Disturbed areas would be graded to blend with adjacent topography. Graded surfaces would be fertilized, resoiled with 6 inches of topsoil, and ripped to a depth of 12 to 18 inches. Seeding (Table 2-11), harrowing, and mulching would occur as previously discussed.

Reservoir

The expanded Maggie Creek Ranch Reservoir embankment would remain in place. Disturbed areas would be graded to blend with adjacent topography. Graded surfaces would be fertilized, resoiled with 6 inches of topsoil, and ripped to a depth of 12 to 18 inches. Seeding (Table 2-11), harrowing, and mulching would occur as previously discussed.

Other Facilities

Ancillary facilities including parking lots, powerlines, and pipelines would be removed and lands associated with these facilities would be regraded to contour. Runon and runoff control ditches would remain as part of the reclamation program to control sediment loss from the site.

Monitoring/Evaluation of Reclamation Success

Qualitative erosion monitoring would be conducted annually to assess effectiveness of erosion control structures, overall stability, and effectiveness of drainage channels. Appropriate measures would be implemented to correct any erosion problems.

Revegetation monitoring would be conducted annually for at least 5 years to assess vegetative cover, production, and woody plant density. Revegetation success would be evaluated based on comparison with undisturbed reference areas selected in consultation with the BLM. Revegetation would be considered successful if total vegetative cover and herbaceous production are within 75 percent of that found in the respective reference area. Reclaimed areas not meeting these standards would be evaluated and corrective actions implemented. Proposed criteria for revegetation success may be modified pending standards under consideration by BLM and NDEP.

PROJECT ALTERNATIVES

This section describes alternatives to the Proposed Action including the No Action Alternative, features common to all alternatives, alternatives eliminated from detailed analysis, a description of the resource opportunities available as a result of the Proposed Action, and the Agency Preferred Alternative. Alternatives selected by BLM for consideration in this EIS are based on potential impacts associated with the Proposed Action and issues, including those identified by the public during the scoping process. The BLM is required to analyze environmental effects resulting from the Proposed Action and to identify reasonable alternatives that would mitigate or eliminate potential impacts. The BLM is also required to analyze the No Action Alternative, which describes the environmental consequences that would result if the proposed project is not implemented.

Newmont's proposed amended Plan of Operations involves continuation of existing operations, construction and operation of various new facilities, and expansion of some existing facilities. Components of the planned operations, their respective functions, and potential environmental effects are also considered in delineation of alternatives.

Several alternatives concerning water disposal were determined to be beyond the scope of the EIS but are presented in a separate section identified as Opportunities. These alternatives identify possible beneficial uses for the excess water produced as a result of the Proposed Action.

ALTERNATIVES CONSIDERED IN DETAIL

Alternative 1: Operation of the cooling tower system at the water treatment plant to ensure that discharge water, when mixed with Maggie Creek (when flowing) and\or Humboldt River water, would be maintained within 2°C (State of Nevada water quality standard) of Humboldt River ambient temperature at a point one-half mile downstream from the confluence with Maggie Creek.

Issue: Discharge of groundwater at a temperature of approximately 25°C has the potential to affect biological communities in Maggie Creek and the Humboldt River.

Alternative 1 includes all components of Newmont's proposed Plan of Operations with operation of the water treatment plant cooling tower such that all excess groundwater produced during dewatering would be discharged into Maggie Creek at temperatures which, when mixed with Maggie Creek (when Maggie Creek has flow) and/or Humboldt River water, would maintain an ambient temperature within 2°C of Humboldt River water temperature at a point one-half mile below the confluence with Maggie Creek. This alternative would reduce the potential thermal impacts to the Humboldt River by 9.5 miles of river length (distance from Palisade gage to one-half mile below mouth of Maggie Creek). The cooling tower facility would be constructed on private land. No additional acreage would be disturbed by this alternative.

Alternative 2: Backfilling of the MAC open-pit mine with waste rock from the Tusc open-pit mine.

Issue: Consistent with Nevada Administrative Code (NAC 519A.250) concerning solid minerals reclamation standards and policy statements outlined in the Federal Land Policy Management Act (PL-94-579, 43 USC 1701), this document will evaluate the feasibility of sequential backfilling of open pits.

Alternative 2 includes components of the Proposed Action and would require Newmont to modify the mine plan to complete the MAC open pit development prior to completion of the Tusc open-pit development. Once mining has been completed at the MAC pit, it would be backfilled with waste rock from the Tusc Mine. This would reduce the disturbance area associated with the MAC pit by 40 acres and would reduce the height of portions of the Tusc Waste Rock Disposal Area by approximately 10 feet. The restored surface would be reclaimed according to procedures outlined in the Reclamation Section.

Alternative 3: Discharge of excess groundwater via pipeline to the Humboldt River.

Issue: Discharge of treated groundwater to Maggie Creek could increase sedimentation and change channel geometry in Maggie Creek. Discharges could ultimately increase sediment loads in the Humboldt River and form a delta at the mouth of Maggie Creek. These impacts could result in deleterious effects on aquatic life in Maggie Creek and/or the Humboldt River system.

This alternative encompasses all elements of the Proposed Action and would modify the point of discharge for treated groundwater from Maggie Creek to a point on the Humboldt River near Carlin (Figure 2-13). This alternative would require construction of a pipeline connecting the existing Maggie Creek Ranch Reservoir pipeline and the water treatment plant pipeline with the Humboldt River discharge point. The approximate corridor for the pipeline is shown in Figure 2-13. The pipeline would be approximately 6 miles in length from the connection point with the existing pipeline system to the Humboldt River. An additional 56 acres would be disturbed by construction of the pipeline, which would be designed to transport flows of at least 104 cfs (46,500 gpm).

As with the Proposed Action, Alternative 3 would require construction of a cooling system associated with the water treatment plant such that water temperature of the Humboldt River at Palisade would be maintained within 2° C of ambient water temperature of the river.

Pipeline construction would involve excavation and burial of the pipe in alluvium adjacent to Maggie Creek. The construction sequence would include salvage of available topsoil, excavation and stockpiling of subsoil materials, placement of the pipe, backfilling subsoil materials, and replacement of topsoil. The disturbed area would be regraded, topsoiled, and seeded with an approved seed mix.

Water in the pipeline system would discharge to an engineered outlet structure located near the mouth of Maggie Creek. The outlet structure would consist of a stilling basin, a spillway, and a riprapped apron to dissipate energy and deliver water into the Humboldt River. Design parameters would minimize erosion and sediment discharge to the Humboldt River.

Upon cessation of dewatering activities at the Gold Quarry Mine, Newmont would reclaim lands disturbed by the pipeline system. If Newmont determines the pipeline has no salvage value, the pipeline would remain buried and both ends would be sealed. The outlet structure would be removed and the surface area regraded, topsoiled, and seeded with an approved seed mixture. Should the pipeline be removed, the resulting trench would be backfilled with subsoil materials and reclaimed according to procedures outlined in the Reclamation section.

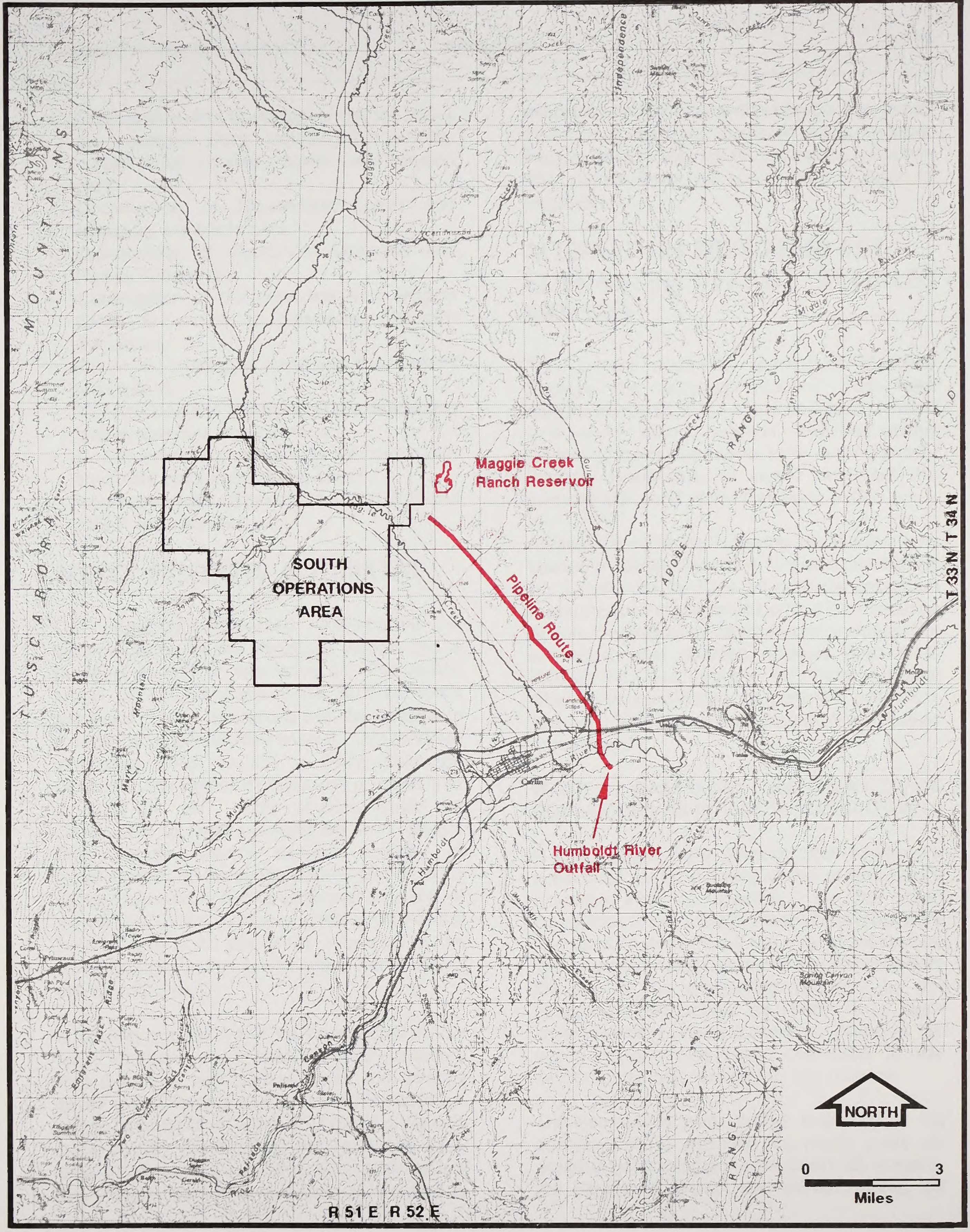
NO ACTION ALTERNATIVE

Currently, Newmont has authorization from BLM to operate mining facilities on federal lands in the South Operations Area as provided in the Mill 2/5 Decision Record. Under the No Action Alternative, BLM would not authorize the proposed Plan of Operations and further disturbance of federal land would not occur.

FEATURES COMMON TO ALL ALTERNATIVES

The following components of Newmont's proposed Plan of Operations are common to Alternatives 1, 2, and 3:

- Continued mining and expansion of the Gold Quarry Mine pit.
- Expansion of the South Waste Rock Disposal Area.
- Expansion of the Maggie Creek Ranch Reservoir.
- Vertical expansion of the Mill 2/5 Tailing Storage Facility.
- Construction and operation of the North Area Haul Road.
- Mining development of the MAC and Tusc ore bodies.
- Development of the MAC and Tusc waste rock disposal facilities.



Alternative 3
Pipeline Route
SOUTH OPERATIONS AREA PROJECT
FIGURE 2-13

- Construction and operation of the refractory ore treatment plant, including the roaster, closed-circuit cooling tower, and oxygen plant.
- Construction of bio-oxidation pads and refractory ore leach pads.
- Construction of Schroeder Mountain and Hadley substations.
- Construction of the powerline from Maggie Creek Substation to Schroeder Mountain Substation.
- Expansion of Maggie Creek and Gold Quarry substations.
- Construction and operation of the dewatering well system and cooling tower.
- Construction and operation of the water treatment plant and cooling tower.
- Reclamation of facilities according to BLM and NDEP requirements.

AGENCY PREFERRED ALTERNATIVE

The Agency Preferred Alternative is implementation of the Proposed Action and a modified version of Alternative 3. This action would include all components of Newmont's proposed Plan of Operations with the addition of a modified version of Alternative 3. This modified alternative would include a direct discharge pipeline to the Humboldt River with a capacity of at least 24 cfs. This pipeline would be constructed to handle dewatering flows greater than Maggie Creek's bankfull capacity of approximately 80 cfs during the last several years of the Proposed Action or as necessary. Use of the Maggie Creek discharge point such that the bankfull rate of 80 cfs is not exceeded in the creek as described in the Proposed Action would still be authorized.

A cooling system would be constructed at the water treatment facility when necessary to ensure that discharge water, when mixed with Maggie Creek (when flowing) and/or the Humboldt River, would be maintained within 2° C (State of Nevada water quality standard) of the Humboldt River ambient temperature at Palisade. Modification of the Maggie Creek channel would be required to minimize erosion and sedimentation that would occur as a result of increased flows in lower Maggie Creek. This would necessitate a Section 404 permit from the U.S. Army Corps of Engineers.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

This section describes alternatives identified through the scoping process that were considered by BLM but dismissed from detailed analysis for various reasons described below. Generally, these alternatives were not technically feasible, reasonable, or would not meet the purpose and need of the Proposed Action.

Although none of the following alternatives were studied in detail, the water disposal alternatives are considered by BLM as potential mitigation measures for impacts resulting from the Proposed Action. Consequently, alternatives considered but eliminated from detailed analysis have been divided into two groups: (1) water disposal alternatives considered as potential mitigation, and (2) alternatives eliminated from further consideration.

WATER DISPOSAL ALTERNATIVES CONSIDERED AS POTENTIAL MITIGATION

A wide array of water disposal alternatives were considered by BLM during review of Newmont's amended Plan of Operations for the South Operations Area. Initially, these alternatives were evaluated to determine if the total 500,000 acre-feet of excess water that would be produced over the life of the dewatering program by the Proposed Action could be utilized in a more environmentally effective manner. None of the water disposal alternatives discussed in this section could fully respond to this criterion.

The alternatives were further evaluated in the context of: (1) retaining as much water as possible within Maggie Creek Basin, (2) reducing the degree of impact on riparian habitat, (3) reducing the amount of groundwater loss to local communities near the project area, and (4) reducing the area of impact resulting from the groundwater cone of depression associated with project activities. Water disposal alternatives reviewed that reduced impacts to one or more of these issues include the following:

- **Reinjection of all excess water into bedrock in Maggie Creek Basin** - Feasibility of mine water disposal by well-injection into bedrock was evaluated using a numerical groundwater flow model developed for the Gold Quarry Mine dewatering (Hydrologic Consultants, Inc. (HCI) 1992b). The flow model was used to simulate groundwater conditions resulting from the advancement of the mine including simultaneous mine dewatering and injection of water produced by dewatering wells. Three potential injection sites in the Maggie Creek Basin were selected for the model simulation, all in fractured carbonate bedrock material.

  Results of model simulations show that residual passive inflows into the Gold Quarry Mine could increase by 2,000 to 10,000 gpm if mine water is injected into one or all three of the injection sites (HCI 1992b). Increased groundwater levels at the injection sites could result in seepage of injected water to the land surface. If one-third of the mine water is injected at a single site and two-thirds is discharged to Maggie Creek, residual passive inflow to the mine pit would increase by less than 2,000 gpm (HCI 1992b).

  Ancillary pipelines and power corridors to support one or more injection well fields would create additional surface disturbance in the project area. In addition, recycling of mine water, injection well inefficiencies, potential pit wall instability, and localized groundwater mounding resulting in surface seeps substantially lessens the feasibility of this alternative.

- **Infiltration of excess water into the shallow alluvial system in Maggie Creek Basin** - Alluvium in Maggie Creek Basin could store and transmit mine water added to the basin using infiltration ponds. This capacity is limited due to relatively low permeability of the alluvium and a high water table. In addition, infiltration water would raise the local water table and likely result in increased dewatering rates at the Gold Quarry Mine if the water disposal sites were within the area of influence of groundwater withdrawal. Some infiltration of mine water would occur at Maggie Creek Ranch Reservoir and existing irrigation fields and along lower Maggie Creek as a result of Newmont's proposed action. This would reduce the capacity of the alluvium to store excess water.

  Newmont evaluated lower Maggie Creek Basin as a potential disposal site using infiltration. This assessment shows that for a valley floor area of 4 square miles, the alluvium has a maximum storage capacity of 36,000 acre-feet (Stone 1991). Infiltration ponds with total surface area of about 100 acres would be required to allow infiltration of the 45,000 gpm discharge into alluvium in Maggie Creek Basin (Stone 1991). Evapotranspiration and groundwater flow in the alluvium would disperse less than 1,500 gpm of the infiltration water (Stone 1991), thus limiting disposal capacity after the ground has been saturated.

- **Use of excess waters to irrigate lands in Maggie Creek Basin** - Newmont currently owns part of the Maggie Creek Ranch and plans to utilize mine water on existing irrigated lands in the lower Maggie Creek Basin. Approximately 268 acres of land adjacent to Maggie Creek have historically been irrigated during the growing season. An additional 1,650 acres could potentially be developed for irrigation in lower Maggie Creek Basin with a total irrigation diversion of approximately 5,500 gpm for a 6-month irrigation season (Keller-Bliesner Engineering 1991). Newmont also evaluated upper Maggie Creek Basin and determined that potentially irrigable lands would be limited to about 1,345 acres with a disposal capacity of 3,340 gpm continuous flow during a 6-month period (Keller-Bliesner

Engineering 1991). Therefore, total potential irrigation using mine water in Maggie Creek Basin could be approximately 8,840 gpm during a 6-month period each year.

♦ **Construction of East Cottonwood Creek Reservoir** - BLM evaluated several new reservoir sites in the vicinity of the project area for their potential to retain excess water from the proposed action. Of the sites considered, the East Cottonwood Creek Reservoir site located approximately 1 mile east of the confluence of East Cottonwood Creek and Maggie Creek was identified as the area most likely to avoid substantial impacts to the existing environment. The reservoir could potentially hold 10,000 acre-ft or more of water. It was further determined that releases of cool water from the reservoir to the middle and upper reaches of Maggie Creek could help compensate for water loss associated with dewatering caused by the proposed action.

ALTERNATIVES ELIMINATED FROM FURTHER CONSIDERATION

North Area Ore Transport

Several options to transport ore from the North Operations Area were considered by BLM, in addition to construction of a roaster facility in the North Operations Area. These alternatives were developed in an attempt to reduce or eliminate potential impacts resulting from creation of a physical barrier (North Area Haul Road) to migrating mule deer.

♦ **Haul road constructed adjacent to State Highway 766** - This alternative would involve construction of a standard 150-foot-wide haul road immediately adjacent to State Highway 766. The haul road would follow Highway 766 from the Carlin Mine in the North Operations Area to the South Operations Area. Haul truck traffic would involve three one-way trips per hour with 150- to 190-ton off-road haul trucks.

♦ **Third lane added to Highway 766** - This alternative would include construction of a third lane to State Highway 766. Over-the-highway belly-dump haul trucks would be utilized to transport refractory ore from the Post Mine to the South Operations Area. Loaded haul trucks would move in the third lane to the South Operations Area and would return to the North Operations Area via the highway. This would result in one-way traffic on the constructed third lane.

Neither of these haul road alternatives offers advantages for migrating mule deer compared with the proposed action. The construction of a full-width haul road immediately adjacent and parallel to State Highway 766 would result in cuts and fills equal to or greater than those associated with the proposed North Area Haul Road. Such a haul road would also require placing fill in Simon Creek and either rerouting the creek around the fill material or channeling it through a culvert covered by fill. Construction of a third lane to State Highway 766 would require substantial cuts and fills in the upper reaches of Simon Creek that would impede migration of mule deer.

Haul truck traffic in the third lane with return traffic on the existing highway would result in passage of approximately one truck every 6 minutes, 24 hours per day, 7 days per week, 365 days per year, for a 9-year period. The combination of cut-and-fill slopes and traffic volume associated with this haul road option was deemed unacceptable.

♦ **Conveyor System and Rail Transport** - BLM reviewed the use of conveyor systems or rail transport to move refractory ore from the North Operations Area to the South Operations Area. The use of a conveyor system would result in less surface disturbance but the cost of construction, operation, and maintenance was determined to be unreasonable. Conveyor operations would require construction of a crushing facility in the North Operations Area and loading and unloading facilities at end points. The conveyor would pose barriers to mule deer movements similar to those of the proposed action.

Use of rail transport was eliminated from further analysis primarily for reasons of cost. The use of a rail system to transport refractory ore would require construction of a roadbed, installation of track, construction of loading and unloading facilities, and purchase of an engine and haul cars. This option would also pose barriers to mule deer migration.

Construction of a Roaster Facility in the North Operations Area

This alternative would involve construction of an additional roaster facility to process refractory ores mined in the North Operations Area. This alternative would eliminate construction of the North Area Haul Road. The cost of a second roaster was estimated to be in excess of $75 million (Newmont 1992d). This estimate does not include costs associated with the infrastructure (natural gas pipeline, tailing storage facility, powerlines) needed to support the roaster. BLM determined that costs associated with this alternative were unreasonable.

Alternative to Cyanide Use

Cyanide extraction is the only commercially viable chemical extraction process presently in use in the gold mining industry. Other chemicals have been investigated (e.g, thiourea and bromide), but they have not proven to be economically successful. In addition, the existing extraction facilities are designed to use cyanide and it is considered unreasonable to require a change to an unproven technology.

Extensive research concerning the chemical properties of cyanide strongly suggest that with proper handling, the use of cyanide for gold extraction is environmentally sound. In general, mining companies have made significant improvements in reducing wildlife mortalities associated with cyanide use.

Alternative to Process Solution Storage

The size of process solution storage facilities is dictated by solution volume requirements of the leaching facility and flood storage requirements to prevent overtopping of ponds. Typically, storage volumes are sufficiently large to make tankage an uneconomical alternative.

Wildlife mortality associated with ponded process solution is discussed in Chapter 4. Mortality monitoring procedures are in effect and mitigation to reduce mortality will be undertaken if a site contributes to substantial wildlife mortality.

Postponement of Mining

Reclamation planning is in place and is discussed in the EIS. There have been no substantial environmental impacts attributed to the lack of reclamation technology. Delay of the project on this basis is functionally equivalent to the No Action Alternative.

Reduction in Mine Size and Change in Facility Location

Limiting pit size to reduce groundwater dewatering requirements is equivalent to the No Action Alternative.The siting of facilities identified in the proposed Plan of Operations, such as the South Waste Rock Disposal Area and the refractory ore treatment plant, is directly related to the location of existing facilities. Alternatives to these facility locations would increase impacts associated with the proposed action. In addition, major facilities identified in the proposed action were reviewed by BLM resource discipline specialists to determine if the proposed locations resulted in identifiable impacts that could be mitigated by relocation. Of all the proposed facilities, only the point of discharge of dewatering water met this criterion. This alternative relocation is evaluated as Alternative 3.

Alternative Methods for Ore Processing

Heap leach technology is the only economically viable extraction method for low-grade ore. Tank or vat leaching and the associated milling processes are more costly and are only economically justifiable for higher grade ores. Elimination of heap leaching would reduce the recovery of the geologic resource. This is discussed in Chapter 2, Mining and Processing in the Carlin Trend.

OPPORTUNITIES

A wide range of public comments received by BLM during the public scoping process identified uses of excess water from Newmont's proposed Plan of Operations. The BLM has determined that alternatives for end-uses of excess water that do not mitigate identified environmental impacts are not within the scope of this EIS. These end-uses deviate significantly from the Proposed Action and also are outside of the BLM's jurisdiction to implement. Many of these alternatives would require transporting mine water to locations outside of areas potentially impacted by the Proposed Action. Alternatives identified that would store water in Eureka or Elko counties could result in significant environmental impacts in and of themselves and would require supplemental environmental analysis. Consequently, they have not been brought forward for detailed analysis.

It is BLM's intent to acknowledge that opportunities for beneficial end-uses of water resulting from this action do exist. In addition, BLM has determined that none of the alternatives previously selected for detailed consideration would preclude public or private entities from securing the necessary authorizations to develop optional end-uses of excess mine water.

- **Operational reservoir locations and reservoir capacities** - Options included in this category include using water from Newmont's water treatment plant to develop new reservoirs at locations in the Elko/Carlin area. These reservoirs could be constructed to provide lake fisheries and recreational uses such as boating, water skiing, and swimming. In addition, these reservoirs could provide water to local communities whose groundwater reserves have been depleted.

  BLM and public comments also include a range of capacities associated with the reservoir(s). Interest was expressed in developing reservoir(s) having the capacity to store all excess water produced by Newmont's dewatering system during mine expansion, a capacity equalling approximately 500,000 acre-feet.

- **Municipal water supply** - This option would include developing pipeline systems and securing water rights and various authorizations to use excess mine water generated by Newmont to supply water to the communities of Elko, Carlin, Spring Creek, Battle Mountain, Winnemucca, Lovelock, and/or the Reno-Sparks area. The quality of groundwater discharged from the project area would meet drinking standards after treatment as described in the proposed action.

- **Irrigation projects** - Several public comments were received regarding the use of excess mine water to support existing irrigation projects or develop large-scale irrigation projects outside of Maggie Creek Basin. Suggested irrigation projects included conveying waters from the South Operations Area water treatment plant to the Boulder Valley and to areas along the Humboldt River.

- **Reinjection** - Projects involving reinjection were identified for areas outside of Maggie Creek Basin. These projects could mitigate groundwater losses associated with existing mining or irrigation projects, or augment groundwater discharge to surface water thereby enhancing surface water flow. Reinjection methods were suggested for areas in the Boulder Valley.

- **Excess water contribution to Rye Patch Reservoir/Humboldt Sink** - Excess mine water discharged could be utilized to fill Rye Patch Reservoir and/or contribute water to the Humboldt Sink. This type of "in-stream reservation" would preclude use of excess waters to satisfy existing water demands in the Humboldt River system that are not presently being met. Present water usage in the Humboldt River would be controlled so that the volume of flow contributed by the proposed discharge would be available to augment storage in Rye Patch Reservoir and/or the Humboldt Sink.

- **Water replacement** - Water replacement would include temporary transfer of existing senior water rights of downstream users to junior water right holders operating existing reservoirs or proposed reservoirs in the Elko-Carlin areas. Senior water right users involved with this program would then be given preference for use of discharged water resulting from dewatering activities. The South Fork Reservoir and the proposed Rock Creek Reservoir are sites that might be considered for this opportunity.

In addition, suggestions were made regarding transfer of water rights associated with Marys River such that excess mine water would be used in lieu of existing diversion of Marys River water. Excess water transported from the proposed treatment plant would supplement normal water supplies in reservoirs and/or streams to maintain in-stream biological demands while still satisfying existing water rights for irrigation.

CHAPTER 3

AFFECTED ENVIRONMENT FOR PROPOSED ACTION AND ALTERNATIVES

INTRODUCTION

Studies have been conducted to characterize environmental resources in the proposed project area. Figure 3-1 shows the general study areas for most environmental resources. Study areas for socioeconomics, recreation, and air quality extend outside of the boundaries shown in Figure 3-1. The socioeconomic study area encompasses Elko and Eureka counties, and includes the communities of Elko, Carlin, Spring Creek, and the Elko Band Colony. The study area for recreation is Elko County in its entirety and the northern portions of Eureka, Lander, and White Pine counties. The air quality study area includes the immediate South Operations and Betze mining areas, the city of Carlin, and the city of Elko.

Study areas for various disciplines were based on where direct and indirect impacts would likely occur. Wild horses and prime farmlands are not addressed in this EIS because these resources are not present in the study areas and thus, would experience no direct or indirect impacts as a result of the proposed action.

This chapter provides a summary of environmental baseline information. In the following sections, "project area" refers to the area surrounding project components associated with the proposed action. Within the project area are the "mine area" or "disturbance area".

GEOLOGY AND MINERALS

A general description of geology and its relationship to mining in the South Operations Area and throughout the Carlin Trend is presented in Chapter 2.

This section contains a more detailed account of the geologic evolution of the project site. Table 3-1 presents an outline of the geologic history of the South Operations Area and is generally representative of the Carlin Trend. Figure 3-2 represents the general stratigraphic section of rock units at the South Operations Area, Figure 3-3 is a geologic map of the project area, and Figure 3-4 is a representative cross-section through the project area (Rota 1991).

AREA SEISMICITY

The project site is located at the northern edge of the Basin and Range Province, a region covering most of Nevada and parts of adjoining states. This area, characterized by northerly trending mountain ranges bounded by faults, displays moderately high rates of seismic activity. A search of recorded earthquakes within 70 kilometers (44 miles) of the site revealed 10 events with magnitudes between 3.6 and 5.1 on the Richter Scale for the period 1901 through 1979 (Slemmons 1983).

Active fault systems, those with evidence of movement within the past 12,000 years, have been recognized to the west and south of the site. No active faults have been identified on the project site. Three active fault systems located nearby have been identified as possible sources of seismic activity shaking for the project site: (1) Northern Reese River-Argenta Rim-Boulder Valley fault system, the northern end of which is located 9 miles west of the site; (2) Dry

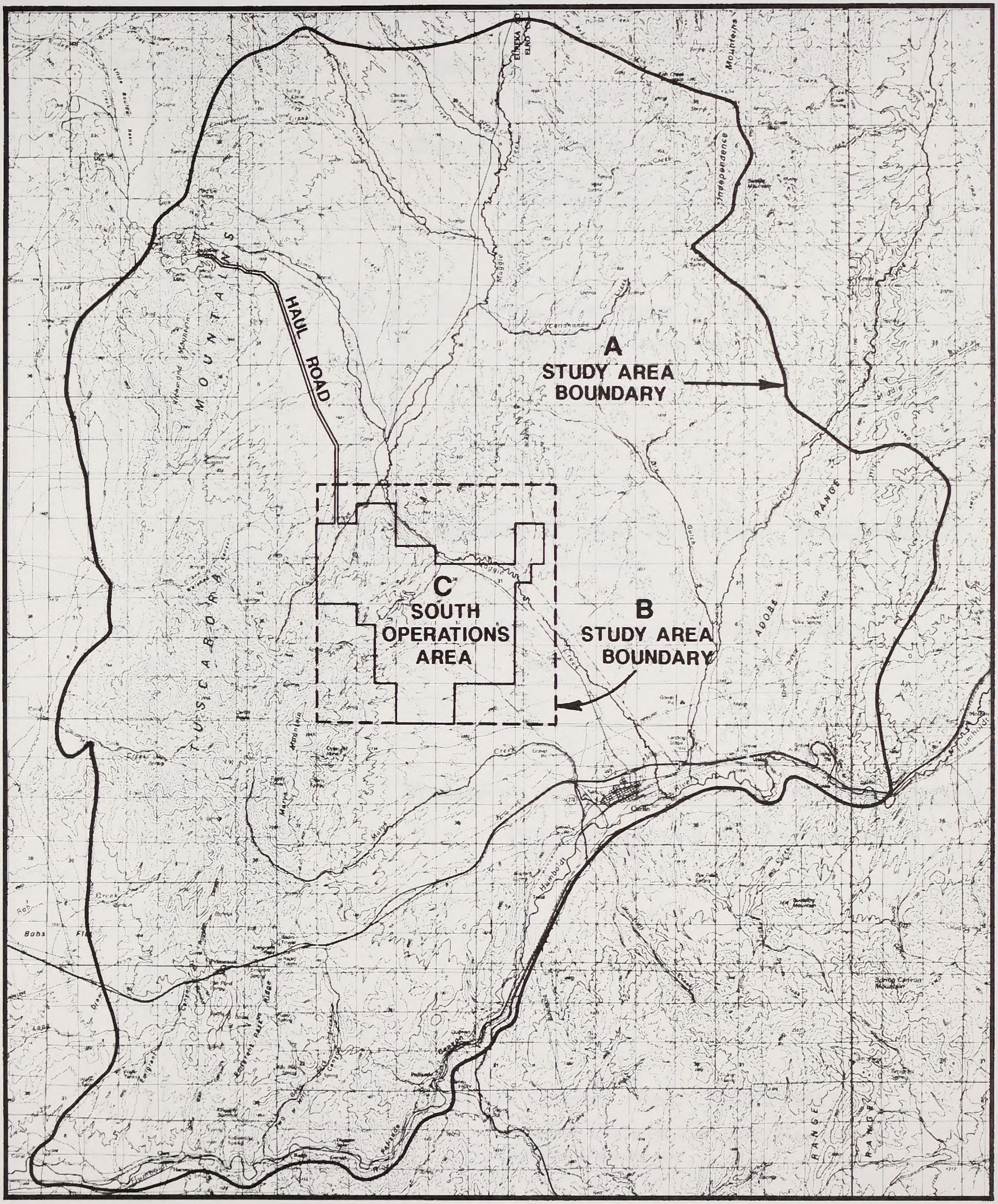
TABLE 3-1
Geologic History of the South Operations Area

Geologic Time[1]	Geologic Occurrence	Relationship to Mineralization
Paleozoic Era (225-570) Ordovician Period (430-500) Silurian Period (395-430) Devonian Period (345-395)	Local deposition of marine sedimentary rocks (dolomitic limestone and dolomite of the Hanson Creek Fm. grade upward to the dirty limestone & dolomite of the Roberts Mountain Fm. and the clean Devonian limestone) Deposition in the deeper westward ocean basin of the shale and chert of the Vinini Fm.	These marine sedimentary rocks host later gold mineralization and provide the organic carbon for the carbonaceous type of ore.
Paleozoic Era (225-570) Mississippian Period (325-345)	Thrust faulting (Chukar Gulch thrust fault) in which deeper water marine sedimentary rocks (shale & chert of the Vinini Fm.) are pushed eastward over local marine sedimentary rocks (Devonian Limestone and silty limestone of the Roberts Mountain Fm.)	Thrust faulting creates disrupted zones along the faults for future mineralization.
Paleozoic Era (225-570) Mesozoic Era (65-225) and Cenozoic Era (0-65)	High-angle and strike slip faulting along NW & NE trends (such as the Good Hope & Gold Quarry faults)	Faulting creates additional disrupted zones for future mineralization. Intersections of faults (Good Hope & Gold Quarry faults at Gold Quarry) will afford especially favorable conditions for migration of mineralizing fluids.
Mesozoic Era (65-225)	Regional emplacement of intrusive granitic rocks	These granitic intrusions are not evident at Gold Quarry, but they are believed to be the source of base metal mineralization in the Carlin Trend and to have produced additional disrupted zones for later gold mineralization at other deposits in the area.
Mesozoic Era (65-225) and Cenozoic Era (0-65)	Regional erosion	Land surface is lowered closer to the combination of host rocks and fault structures which sets the stage for subsequent gold mineralization.
Cenozoic Era (0-65) Tertiary Period (3-65)	Regional shallow intrusion and volcanism followed by fluvial and lacustrine deposition (Tertiary sediments of the Carlin Fm.)	Mineralizing fluids associated with the igneous activity deposit gold and associated sulfide in the fractured host rocks. The Tertiary sediments of the Carlin Fm. are deposited after mineralization; they contain some mineralized clasts but no primary gold deposition.
Cenozoic Era (0-65) Quaternary Period (0-3)	Recent localized erosion, deposition, and circulation of groundwater	Local erosion and deposition both exposes and masks parts of the mineralized host rocks. Groundwater circulation oxidizes the near-surface gold deposits.

[1] Geologic time presented with names of geologic time periods and approximate millions of years before the present in parentheses.

Hills-Cresent fault system, located 16 miles south of the site; and (3) the Cresent Fault, located 20 miles south of the site. Of these, the Northern Reese River-Argenta Rim-Boulder Valley fault system is considered to have the greatest potential for seismic activity at the South Operations Area (Slemmons 1983).

The potential effect of earthquake shaking on mine structures can be assessed during design of critical facilities. Two general approaches to assessing seismicity are: (1) estimation of the maximum credible earthquake (MCE) based on determination of active faults in the area, and (2) probabalistic estimation of the risk of earthquake occurrence based on regional seismic modeling. Typical seismic parameters used to characterize seismicity are: (1) magnitude of the controlling earthquake, (2) maximum horizontal acceleration induced in bedrock at the site by the controlling earthquake, and (3) probability of occurrence of the controlling earthquake. It should be noted that the MCE, being the largest possible earthquake, does not have a probability of occurrence. Table 3-2 presents the seismic characterization for the project site.

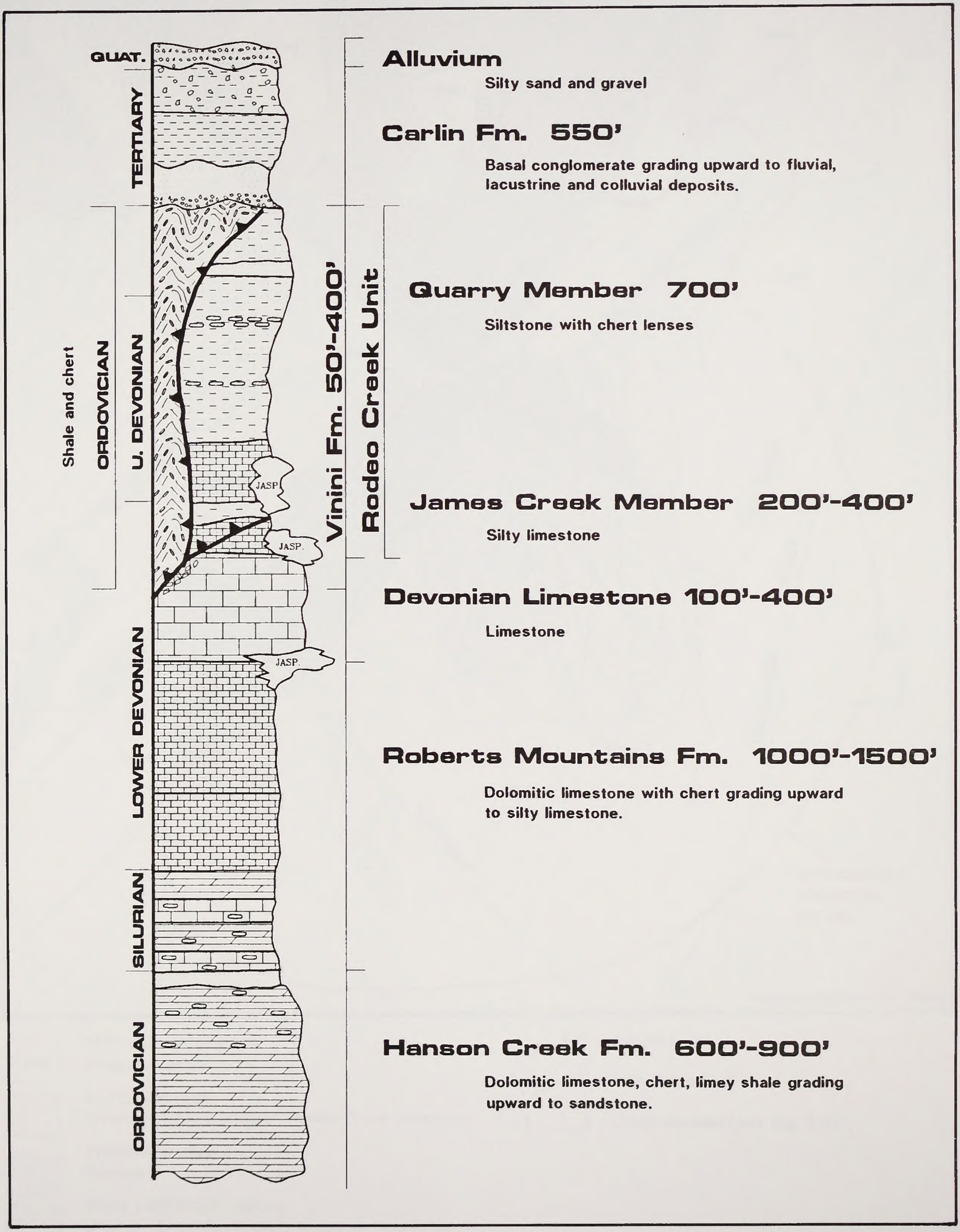


A Fisheries
Geology/Minerals
Livestock
Paleontology
Riparian/Wetlands
Threatened/Endangered
Water Resources
Wildlife

B Soils

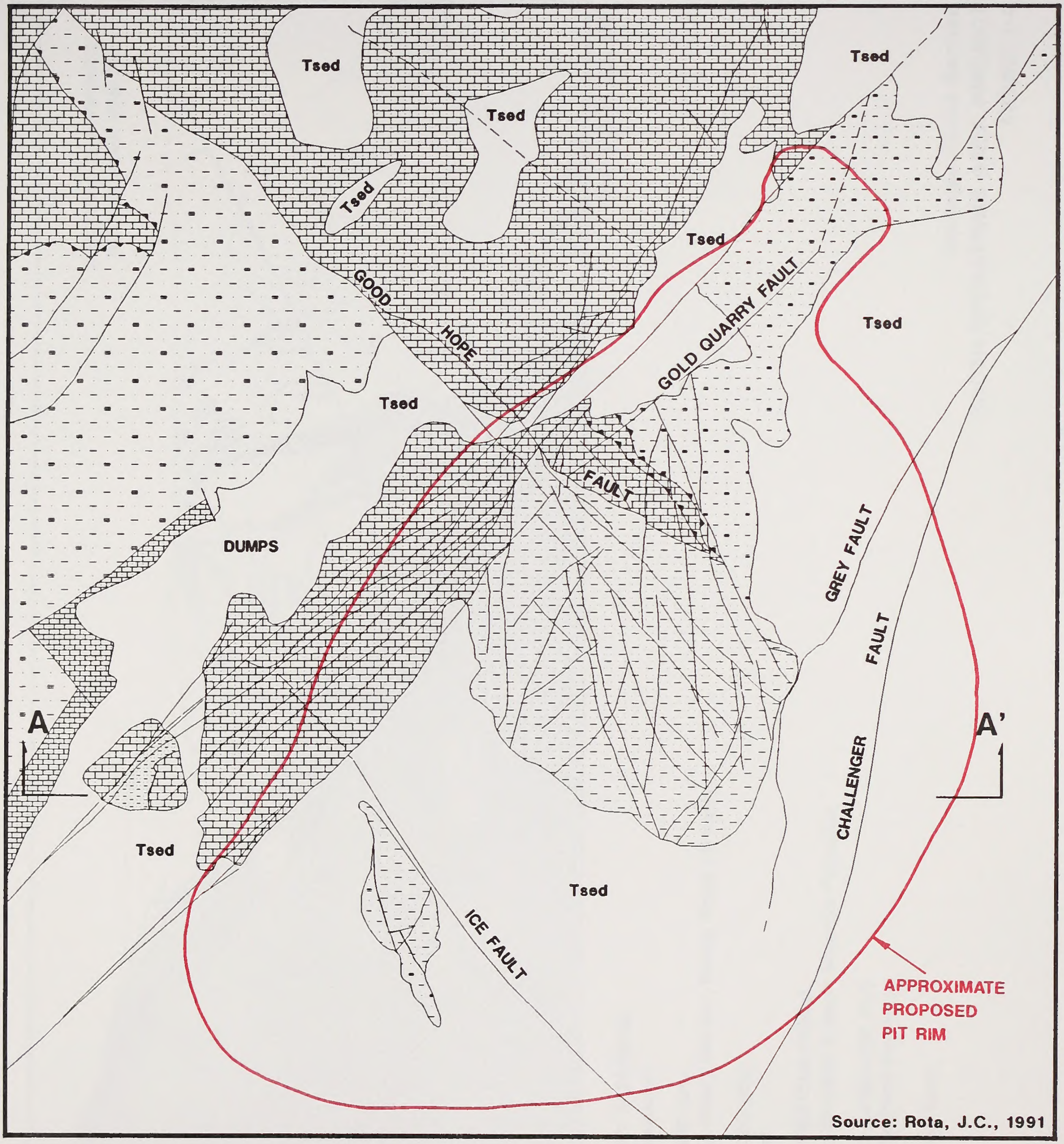
C Vegetation

Study Area Boundaries
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-1



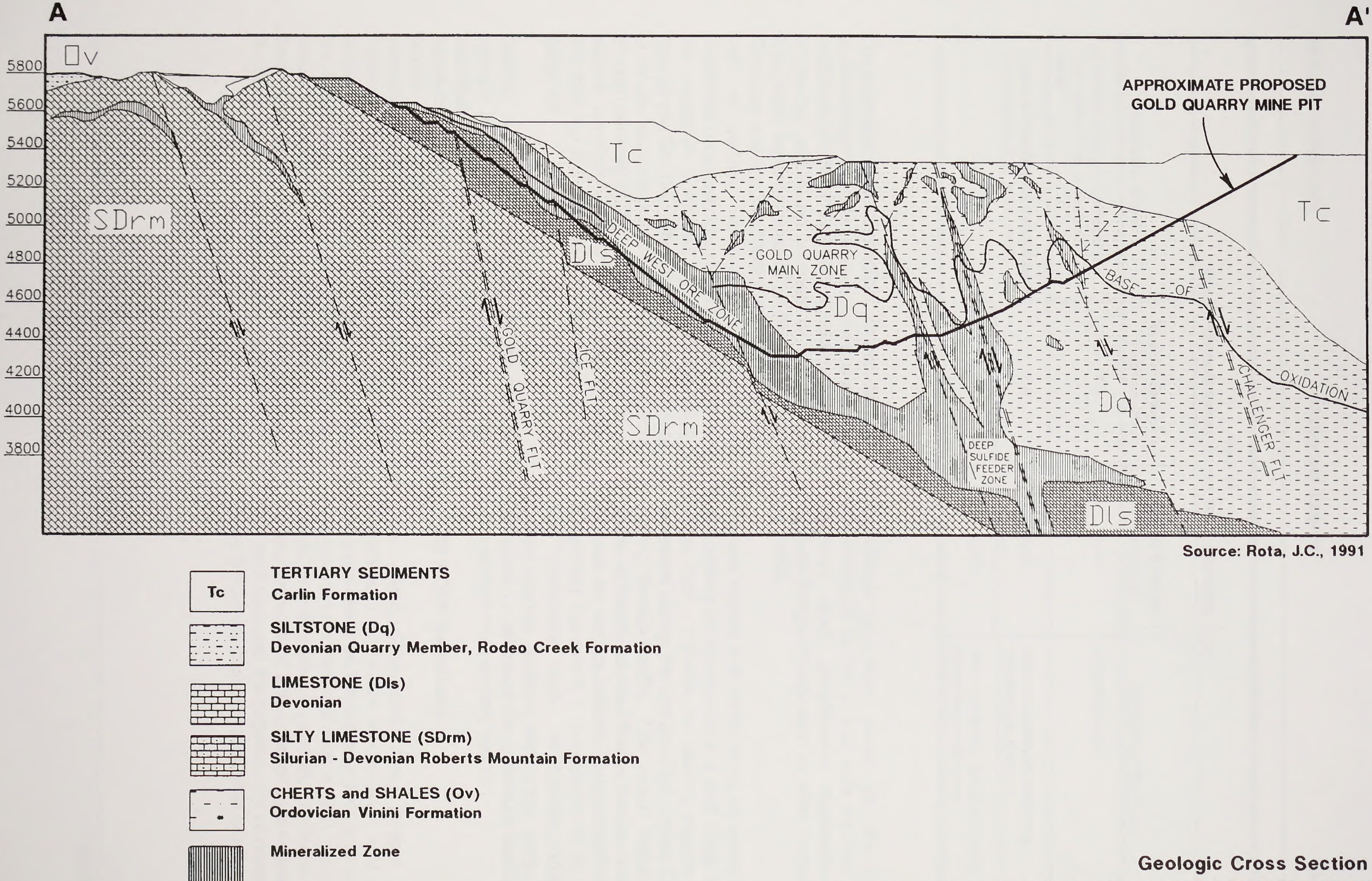
Source: Rota, J.C., 1991

General Stratigraphic Section



Tsed	TERTIARY SEDIMENTS Carlin Formation
	SILTSTONE (Dq) Devonian Quarry Member, Rodeo Creek Formation
	LIMESTONE (Dls) Devonian
	SILTY LIMESTONE (SDrm) Silurian - Devonian Roberts Mountain Formation
	CHERTS and SHALES (Ov) Ordovician Vinini Formation
	Thrust Fault
	High Angle Fault
	Cross Section (see Fig. 3-4)

Geologic Map
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-3



Geologic Cross Section
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-4

TABLE 3-2
Seismic Characterization for the South Operations Area

Assessment Method	Maximum Earthquake Magnitude (M)	Maximum Horizontal Acceleration (g)	Probability of Occurrence
Maximum Credible Earthquake from Active Fault (Slemmons 1983)	7.2	0.42	Not applicable
Regional Probabalistic Assessment (Algermissen et al. 1982, 1990)	7.3	0.15	90% probability of not being exceeded in 50 years
	7.3	0.30	90% probability risk of not being exceeded in 250 years

The long-term, post-reclamation seismic stability of site facilities has been reviewed using a seismic coefficient of 0.15g (15 percent of the acceleration of gravity) and found to meet or exceed an acceptable factor-of-safety of 1.0 (Newmont Gold Company and Shepherd Miller, Inc. 1992). In this kind of stability assessment, the seismic coefficient is typically chosen to be two-thirds of the maximum horizontal acceleration (Knight Piesold and Co. 1990); therefore, ground shaking at the site has a maximum horizontal acceleration of approximately 0.23g. This corresponds to a seismic condition midway between the 50-year and 250-year probabalistic exceedance periods in Table 3-2.

Seismic activity can also disrupt the ground beneath mine facilities. In general, the most potentially destructive kinds of disruption are liquefaction and surface rupture. Liquefaction occurs when soil loses much of its inherent strength during seismic shaking and becomes liquefied. Typically, liquefaction can occur only under certain conditions, including: (1) loose, unconsolidated, sandy earth material; (2) fully saturated earth material; and (3) earth material located relatively near to the ground surface. Because geotechnical investigations at the South Operations Area have shown the site to be characterized by firm to hard soils and rock and relatively deep groundwater, liquefaction is unlikely (Knight Piesold and Co. 1990; Sergent et al. 1984).

Surface rupture may occur along an active fault undergoing an earthquake or a fault close to an active fault. Potential for surface rupture was assessed during the design of the James Creek Tailing Storage Facility. This report states, "All faults at the site are classified as inactive, and the chance for surface ruptures from sympathetic or branching movement is considered to be very low" (Slemmons 1983). All facilities, including tailing storage facilities and leach pads, are designed to withstand the maximum horizontal acceleration from seismic events.

ACID ROCK DRAINAGE

The South Operations Area Project has experienced no known incidence of acid rock drainage (ARD) and throughout the Carlin Trend there is only one reported case of ARD. Mining of predominantly oxidized (nonsulfide) material with a large amount of acid-consuming limestone in the host rock and the regional arid environment have combined to avoid production of ARD.

Development of refractory (sulfide) ore deposits at the South Operations Area will increase the amount of potentially acid-producing material stored in stockpiles and disposed of in tailing embankments and waste dumps. This will provide a greater potential source of ARD than has existed in the past.

As discussed under Potentially Acid-Producing Rock in Chapter 2, approximately 8.4 million tons of non-oxide potentially acid-producing waste rock may be produced between 1993 and 1994, and approximately 44.3 million tons between 1995 and 2001. To date, no potentially acid-producing waste rock has been produced at the South Operations Area.

GEOLOGIC RESOURCES

Gold mining has been the primary geologic resources activity at the project site. Table 3-3 presents past and anticipated production amounts for the South Operations Area.

TABLE 3-3
Geologic Resource Development Schedule - South Operations Area

Mine/ Time Period	Oxide Ore (million tons)	Refractory Ore (million tons)	Waste (million tons)	Gold (million oz.)
GOLD QUARRY PIT				
Pre-1981	N/Av[1]	N/Av	N/Av	N/Av
1981-1992	178.3	2.2	268.2	5.4
1992-2002	159.5	18.4	254.4	6.1
Subtotal	**337.8**	**13.4**	**522.6**	**11.5**
MAC PIT				
Pre-1981	N/Ap	N/Ap	N/Ap	N/Ap
1981-1992	N/Ap	N/Ap	N/Ap	N/Ap
1992-2002	4.8	4.0	6.[illegible]	5.4
Subtotal	**4.8**	**4.0**	**6.5**	**0.1**
TUSC PIT				
Pre-1981	N/Ap	N/Ap	N/Ap	N/Ap
1981-1992	N/Ap	N/Ap	N/Ap	N/Ap
1992-2002	1[illegible].4	0.0	64.6	0.7
Subtotal	**13.4**	**0.0**	**65.0**	**0.1**
TOTAL	**356.0**	**20.6**	**594.1**	**12.3**

[1] N/Av = not available.
[2] N/Ap = not applicable.

Source: Newmont 1993c, 1993e.

PALEONTOLOGY

Paleontological resources in the study area consist of vertebrate, invertebrate, and paleobotanical fossils. Vertebrate fossils typically are associated with Tertiary sediments, but also may occur in younger Quaternary sediments. All known fossils in the study area have a relatively broad regional distribution, and are not restricted to the area or north-central Nevada.

Mammalian fossils found on BLM land during a survey of the nearby Carlin Gold Mine include remains of prehistoric horses, camels, and rodents (Firby and Schorn 1983). Invertebrate fossils include brachiopods, corals, graptolites, crinoids, and trilobites. Other mammalian fossils have been documented in Tertiary sediments northeast of the study area near Swales Mountain.

AIR RESOURCES

CLIMATE

The South Operations Area is located in the Carlin Basin airshed, a north-south oriented basin bounded on the west by the Tuscarora Range. The study area is located on generally rolling terrain at elevations of 5,170 to 5,680 feet above mean sea level. Nevada's climate is generally characterized as mid-latitude steppe.

The study area is subject to large daily temperature fluctuations, low relative humidity, and limited cloud cover. The Tuscarora Range directly affects the study area temperature and precipitation. Winds are predominantly from the west, but are influenced regionally by daily heating and cooling of the Tuscarora Range and locally by Marys Mountain, located 2 miles west of the project. After sunset cooler mountain air flows downslope, creating slow easterly wind movement across the study area. As temperatures increase after sunrise, warmer valley air rises upslope (westerly) until midday, when ground heating causes instability and variable wind directions.

WIND

Data for wind speed and direction, collected during 1990 at the South Operations Area, are summarized in Figure 3-5 and Table 3-4. In 1990, the predominant wind direction was west-northwest, with wind direction sectors west through northwest accounting for 50 percent of the annual hours. Northeast winds occurred least frequently. Northwest winds produced the strongest average wind speeds, with calm conditions, defined as less than 0.5 miles per hour, seldom occurring. Wind patterns show little variation in speed or direction by time of year.

AIR POLLUTION POTENTIAL

Air pollution potential is defined as the ability of air to disperse or cleanse itself of air pollutants. Factors that directly affect air pollution potential are wind speed, mixing height, and atmospheric stability. Atmospheric stability is a measure of the atmosphere's ability to disperse a pollutant. Unstable atmospheric conditions allow maximum dispersion, whereas stable atmospheric conditions represent minimum dispersion. Mixing height is the atmospheric height to which pollutant concentrations are readily mixed or dispersed.

Mixing heights vary daily and seasonally; they are highest during summer afternoons when solar heating is strongest, and lowest during periods of low wind speeds and temperature inversions. The latter conditions (commonly called stagnation episodes) do not occur frequently over extended periods in the Elko area. Temperature inversions occur frequently during nighttime, but they are readily removed by increased wind speeds during the days. Dispersion data collected during 1990 at the South Operations Area show that unstable conditions occurred 38 percent of the time, neutral conditions occurred 22 percent of the time, and stable conditions occurred 40 percent of the time.

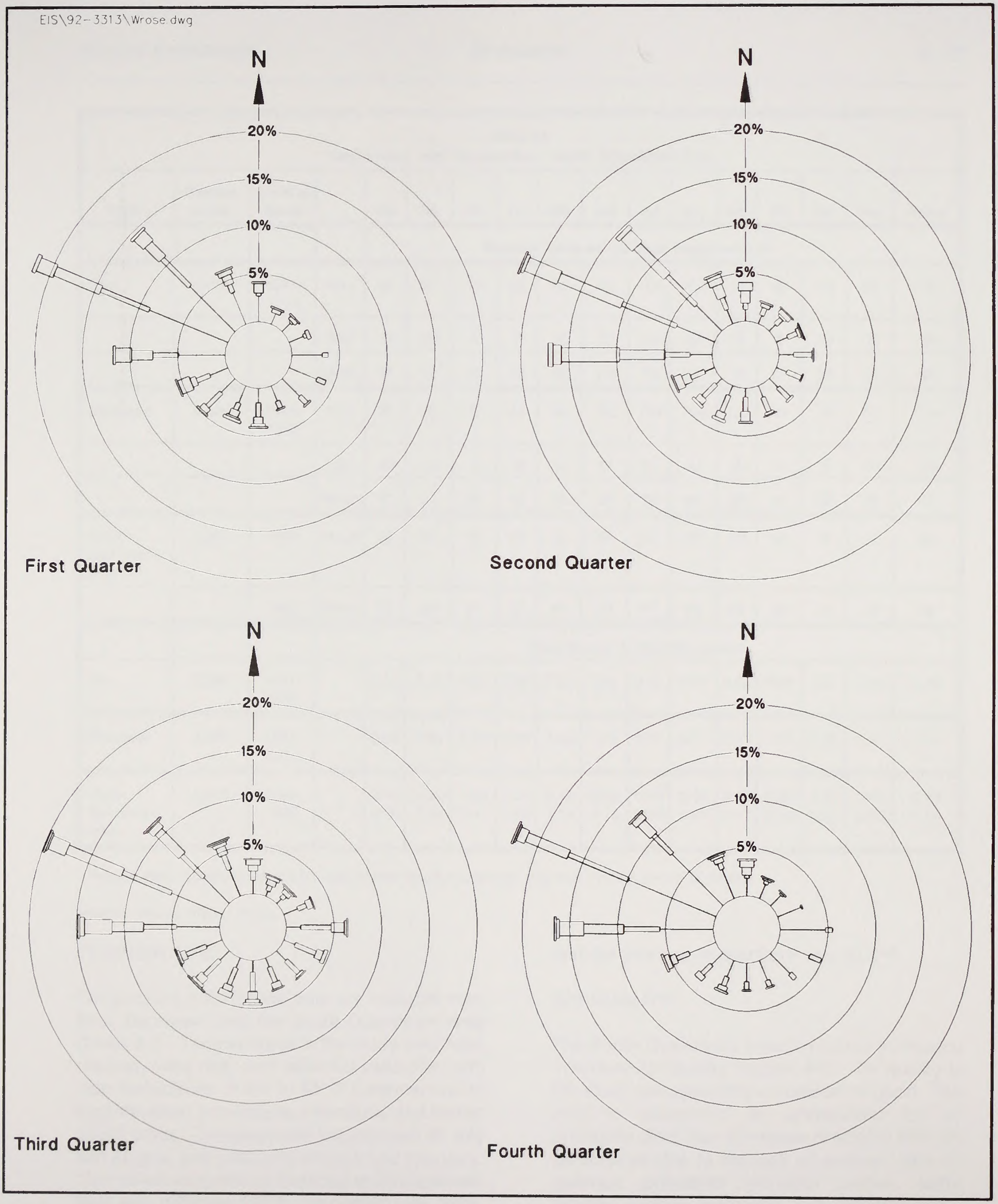
TABLE 3-4 Quarterly Distribution of Wind Speed by Direction for 1990 - South Operations Area								
Wind Direction	Frequency of Occurrence of Wind Speed							
	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter	
	%	Avg wind speed (mph)[1]	%	Avg wind speed (mph)	%	Avg wind speed (mph)	%	Avg wind speed (mph)
N	4.2	6.7	4.0	7.0	3.7	6.6	3.7	6.2
NNE	1.8	4.7	2.4	5.1	2.2	7.3	2.2	3.3
NE	1.9	4.9	2.6	7.0	4.9	5.9	4.9	2.5
ENE	2.3	4.9	2.6	5.5	3.2	4.8	2.8	2.2
E	3.8	2.9	3.5	3.9	6.4	5.5	5.4	2.5
ESE	4.1	3.4	2.9	4.6	4.8	5.7	4.8	2.8
SE	3.7	3.6	3.1	4.1	3.7	7.8	3.7	2.5
SSE	2.6	4.9	3.3	4.6	3.5	4.8	3.7	3.0
S	4.1	5.0	3.1	6.1	4.9	5.9	2.3	3.5
SSW	3.8	6.0	4.0	5.6	4.3	6.0	3.4	4.2
SW	4.9	5.4	4.0	6.4	4.9	5.9	3.7	4.4
WSW	5.5	4.9	4.0	7.3	5.0	5.2	6.8	5.5
W	11.7	6.7	17.1	10.7	14.9	7.8	16.6	7.1
WNW	21.9	6.0	21.7	7.7	19.7	6.6	22.4	5.1
NW	14.6	6.0	14.7	7.1	14.9	6.2	14.0	4.6
NNW	6.3	5.6	5.6	7.7	6.0	5.3	4.8	4.2
Total/Avg	**100**	**5.2**	**100**	**7.3**	**100**	**6.2**	**100**	**4.7**

[1] mph = miles per hour.

Source: Newmont 1991b.

PRECIPITATION

Mean annual precipitation at Elko for the period 1941 through 1970 was 9.73 inches. During 1989, precipitation totals were 7.88 inches at Elko and 6.99 inches at the South Operations Area. Although the two highest 24-hour precipitation totals recorded at Elko between 1941 and 1990 were 4.13 inches in August 1970 and 2.32 inches in September 1978, heaviest amounts of precipitation generally occur during December as snow and during May and June as rain. Summer precipitation occurs mostly as scattered showers and thunderstorms that contribute a minor amount to overall precipitation. Table 3-5 summarizes precipitation and temperature data.



Explanation: Diagram of frequency of occurrence (%) for each wind direction. Wind direction is the direction from which the wind is blowing. Measurements at Gold Quarry Mine site.

Wind Speed Class (MPH)
0-3
3-7
7-12
12-18
18-24
>24

1990 Wind Rose
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-5

TABLE 3-5
Temperature and Precipitation - South Operations Area

Station	Elevation in Feet	Period of Record		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
				Maximum, Minimum, and Mean Temperature (°F)[1]												
Elko	5,050	1941-1970	Max	58	67	77	83	92	101	102	102	99	86	74	59	102
			Min	-38	-28	-9	4	10	23	32	25	12	8	-11	-22	-38
			Mean	23	29	35	43	52	60	70	67	57	47	35	26	45
Beowawe	4,684	1941-1970	Max	65	70	79	84	94	102	104	104	101	91	75	64	104
			Min	-29	-10	-4	10	12	17	31	24	8	2	9	-23	-29
			Mean	27	34	38	46	55	62	70	68	58	49	37	29	48
South Operations Area	5,300	1989	Mean	28	27	40	50	52	65	74	70	70	50	35	17	48
		1990	Mean	21	29	41	50	54	63	77	69	60	47	35	29	48
			Mean Monthly Precipitation (Inches)													
Elko	5,050	1941-1970		1.16	0.77	0.82	0.82	1.02	1.01	0.40	0.61	0.33	0.66	1.01	1.12	9.73
Beowawe	4,684	1941-1970		0.68	0.59	0.55	0.85	1.00	1.07	0.27	0.35	0.34	0.57	0.80	0.87	7.94
South Operations Area	5,300	1989 1990		0.47 0.50	0.38 0.29	1.82 0.47	0.20 1.69	0.15 1.02	0.53 1.10	0.49 0.23	0.22 1.23	0.66 0.17	0.90 0.12	0.74 0.62	0.43 0.35	6.99 7.79

[1] Temperature maximum and minimum values are the extremes recorded during period of record.

Source: NOAA 1990a, 1990b.

TEMPERATURE

Temperature data for the area are available from Elko, Beowawe, and the South Operations Area (Table 3-5). Temperatures in the study area have relatively wide daily and seasonal variability, with daily fluctuations of 30° to 40° F common due to high elevation, proximity to mountains, and limited cloud cover. Temperatures are warmest in July and August, and coldest in January and February. The hottest temperature recorded at Elko between 1941 and 1970 was 102°F, the coldest was -38°F, and the average temperature was 45.4°F.

AIR QUALITY

The South Operations Area is located in Nevada Interstate Air Quality Region #47. Air quality in the study area generally is considered good. The area is designated as unclassified for air pollutants other than 10-micron or smaller (PM-10) particulates due to the lack of ambient data on gaseous pollutants (nitrogen oxides, sulfur dioxide, carbon monoxide, and photochemical oxidants). The project also is designated as a Class II area under the Prevention of Significant Deterioration (PSD) regulations. The PSD Class II designation allows for moderate growth or degradation of air quality within certain limits above baseline air quality. Designation as PSD Class I allows little or no growth or degradation of air quality. The nearest Class I area is located approximately 60 miles northeast of the study area (Jarbidge Wilderness).

Particulates have been monitored at several locations in the Study Area. Federal and Nevada ambient standards currently are for PM-10 suspended particulates. The Nevada Bureau of Air Quality has collected PM-10 data at Elko since September 1991. Newmont has monitored PM-10 particulates at the Gold Quarry site since July 1989 and Barrick Goldstrike (Betze) Mine has measured PM-10 concentrations since 1989. Table 3-6 summarizes PM-10 suspended particulate data for three monitoring sites. State and federal 24-hour and annual PM-10 standards (150 micrograms per cubic meter ($\mu g/m^3$) and 50 $\mu g/m^3$, respectively) have not been exceeded in the study area.

The maximum 24-hour PM-10 concentration measured was 142 $\mu g/m^3$, recorded at the Barrick Goldstrike Mine during a period of wind speeds exceeding 50 miles per hour. The second highest PM-10 concentration at Goldstrike was 61 $\mu g/m^3$. The maximum 24-hour PM-10 concentration measured at Gold Quarry was 45 $\mu g/m^3$, and the maximum annual PM-10 concentration measured was 37 $\mu g/m^3$ at the Nevada Bureau of Air Quality station in Elko.

Gasoline and diesel-powered vehicles and equipment result in emissions of various hydrocarbons. Table 3-7 reports the estimated emissions from these mobile sources at the South Operations Area.

TABLE 3-6
Summary of PM-10 Suspended Particulate Data
(Values in micrograms per cubic meter)

Site	Period of Record	Maximum 24-Hour	Annual Average
Elko	9/91 - 3/92	96	37
South Operations Area	7/89 - 12/91	45	17
Goldstrike	1989-1990	142	16

Source: NDCNR 1992a; Newmont 1992e; BLM 1991c.

TABLE 3-7
Mobile Emission Calculations for Gasoline and Diesel Usage at South Operations Area

	Light Duty Gasoline-Powered Trucks	Heavy Duty Diesel-Powered Vehicles
Usage (gallons/year)	396,000	10.8 million
Total Hydrocarbons	11.3 tons/yr.[1]	130.95 tons/yr.[2]
Carbon Monoxide (CO)	52.38 tons/yr.[1]	330.95 tons/yr.[2]
Nitrogen Oxides (NO_x)	5.89 tons/yr.[1]	261.9 tons/yr.[2]
Sulfur Dioxides (SO_2)	1.05 tons/yr.[3]	168 tons/yr.[3]

[1] Emission factors from AP-42, Volume II, Table 2.2.2. A, B, C (respectively), p. H116-H118.
[2] Emission factors from AP-42, Volume II, Table 2.2.2. A, B, C (respectively), p. H173-H175
[3] SO_2 factor from AP-42, Volume I, Table 3.3.1, p.3.3.2 (Gas and Diesel Powered Industrial Engines).

Source: Newmont 1993f.

WATER RESOURCES

SURFACE WATER QUANTITY

The South Operations study area lies within the Humboldt River Basin in northern Nevada. The region is characterized by an arid climate and north-trending fault-bounded mountain ranges with intervening basins or valleys. The Humboldt River Basin includes an area of nearly 17,000 square miles with an altitude range of approximately 3,900 to 11,800 feet above mean sea level. Headwaters of the Humboldt River are located in mountains in the northeast corner of the state. The river flows westward to the Humboldt and Carson Sink in west-central Nevada, where flow usually terminates due to seepage and evapotranspiration (Eakin and Lamke 1966). Rye Patch Reservoir is located on the Humboldt River approximately 130 miles downstream of the town of Carlin. This reservoir has a capacity of 194,300 acre-feet and is used for recreation, fishing, boating, and irrigation in the Lovelock area.

The South Operations Area is located within the Maggie Creek drainage, a north-extending tributary of the Humboldt River. Gold Quarry is the only mine located entirely within the Maggie Creek Basin; a portion of the Carlin Mine is located in this basin along the western drainage divide. Other major tributaries in the study area include Susie Creek, Marys Creek, and Boulder Creek. Susie and Marys creeks discharge to the Humboldt River near the town of Carlin; Boulder Creek drains southwest and discharges to the Humboldt River near the town of Battle Mountain. Tributaries to Maggie Creek in the study area include Soap, Simon, Lynn, Jack, Little Jack, East Cottonwood, Coyote, and Beaver creeks. These surface water drainages are shown in Figure 3-6.

Streamflow in northern Nevada varies considerably by season, with high flows typically occurring from March through June, and low flows from August through February. Some drainages or portions of drainages become dry during low-flow periods (ephemeral or intermittent conditions), flowing only in response to precipitation and/or snowmelt. Flow measurement stations in the study area are shown in Figure 3-7.

Springs function as a connection between groundwater and surface water hydrologic systems and provide baseflow discharge to the Humboldt River and its tributaries in the study area. Baseflow is defined as streamflow during the late fall and early winter period when cultural diversions and evapotranspiration are minimized and groundwater contributions to streamflow are not influenced by seasonal runoff. Baseflow measurements typically are made during the month of October. The combination of infiltration, evapotranspiration, and cultural diversions is highest for most streams in the study area in August and September.

Precipitation, which averages 10 inches annually, supplies groundwater recharge and surface water to the Humboldt River Basin. Annual snowpack averages 55 inches in the mountain areas. Outflow from the basin is primarily through evapotranspiration, spring flow, surface water runoff, and groundwater underflow. Evaporation loss from spring to fall is nearly 40 inches (Stone and Leeds 1991). Approximately 85 percent of total precipitation is lost through evapotranspiration, and the remaining 15 percent goes to surface runoff and groundwater recharge (Stone et al. 1991). In the Maggie Creek Basin, average recharge to groundwater from precipitation amounts to approximately 16,000 acre-feet per year (Nevada State Engineer's Office 1972).

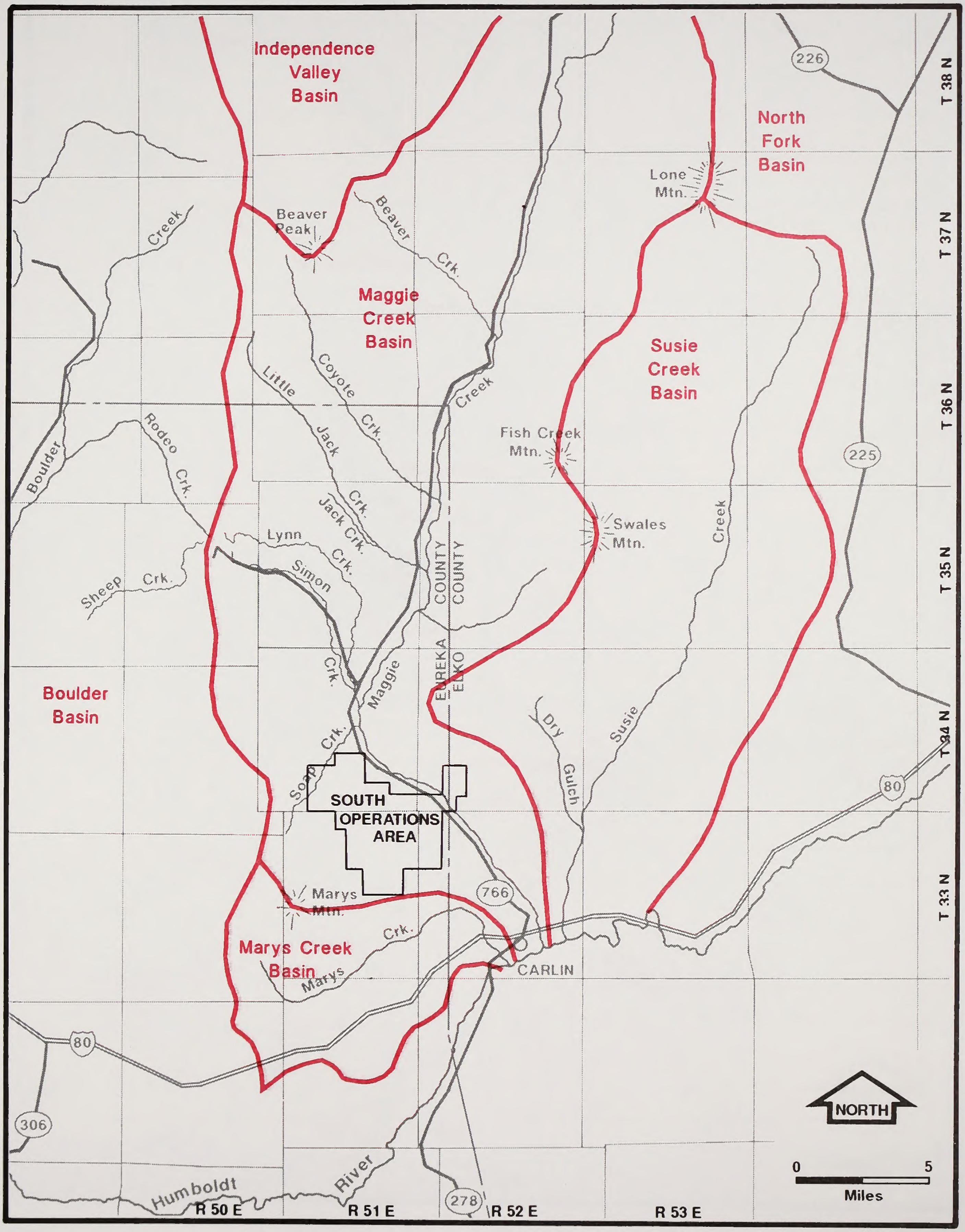
Humboldt River. The Humboldt River is the largest river in Nevada. The river's flow in the study area has been measured by the U.S. Geological Survey (USGS) at gaging stations near Carlin (Carlin Tunnels gage) and at Palisade (Figure 3-7). The Carlin gage is located approximately 5.5 miles upstream of the Maggie Creek confluence, and the Palisade gage is approximately 9 miles downstream of Maggie Creek. Average annual flow at the Carlin gage ranged from 64 to 1,730 cubic feet per second (cfs) during the period 1944-91; the long-term average flow for 48 years of record is 378 cfs (USGS 1992). Average annual flow at the Palisade gage for the period 1912-91 ranged from 35 to 1,845 cfs, with an average of 396 cfs for 84 years of record (USGS 1992). Within the last 10 years, high flows and flooding occurred in 1983-84, followed by a period of generally below-average flow conditions. Table 3-8 summarizes maximum, minimum, and average annual flows for the Carlin Tunnels and Palisade gages for the period 1984-91.

TABLE 3-8
Humboldt River Flows at Carlin Tunnels and Palisade for 1984-1991

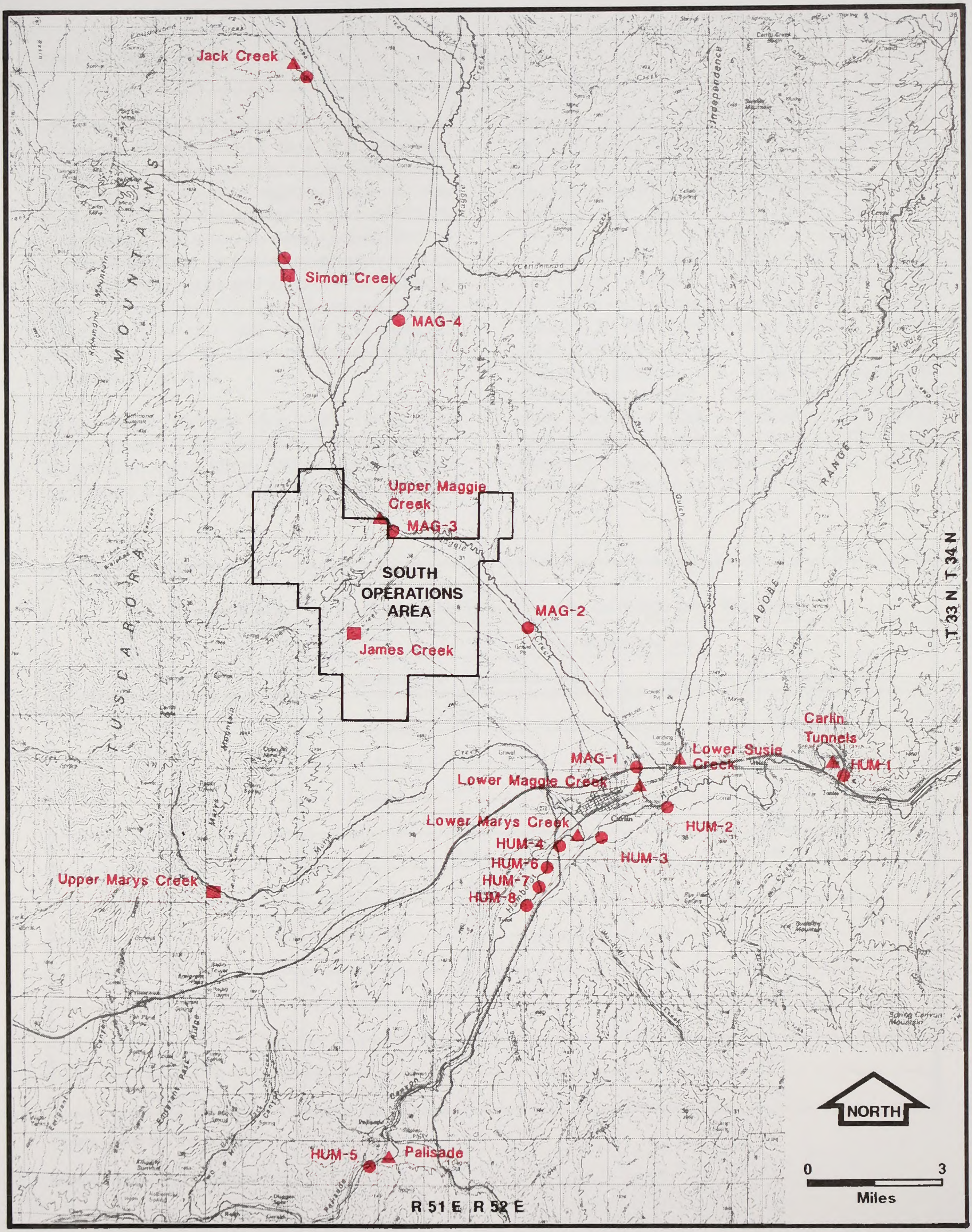
Water Year (Oct-Sept)	Maximum Flow		Minimum Flow		Average Annual Flow (cfs)
	cfs[1]	Month	cfs	Month	
Carlin Tunnels Gage					
1984	8250	May	132	September	1730
1985	1490	April	10	August	871
1986	5300	February	13	September	618
1987	748	May	1.2	September	150
1988	833	June	3.5	October	136
1989	1630	March	5.4	August	312
1990	1020	June	7.2	September	148
1991	1190	June	8.2	October	136
Palisade Gage					
1984	7870	May	177	September	1846
1985	1830	April	26	August	427
1986	5980	February	23	September	729
1987	768	May	13	September	172
1988	847	June	12	September	149
1989	2260	March	9.1	August	369
1990	1080	June	15	September	166
1991	1090	June	17	October	144

[1] cfs = cubic feet per second.

Source: USGS 1992.



Drainage Basins
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-6



▲ USGS Gaging Station

● Newmont Water Quality Sampling Station

■ Newmont Weir or Flume

Surface Water Monitoring
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-7

High flows in the Humboldt River typically occur during the months of April, May, and June; low flows are usually measured in August, September, and October. Average monthly flows for the Humboldt River at Palisade for the period 1903-76 are presented in Table 3-9. Average baseflow for the Humboldt River (October measurements) is 46 cfs at the Carlin gage and 65 cfs at the Palisade gage (Zimmerman 1992a). Baseflows in the Humboldt River can vary during and between years because of the recharge/discharge dynamics of the river.

During March through May 1992, USGS flow measurements at the Carlin and Palisade stations ranged from about 100 to 360 cfs. In June, flow declined to a range of 10 to 100 cfs. Flow was less than 10 cfs during most of July and August at Carlin and between 10 and 20 cfs during the same period at Palisade (Newmont 1992f). Average annual gain in flow between the Carlin and Palisade gages was 50 cfs for the period 1946-91; average baseflow gain in the same reach was 19 cfs (Zimmerman 1992a). After gaining in the reach between Carlin and Palisade, the Humboldt River loses an average of 126 cfs from Palisade to Rye Patch Reservoir due to natural phenomena (e.g., infiltration and evapotranspiration) and agricultural diversions (Zimmerman 1992a). Average and maximum daily discharge rates measured at four USGS gaging stations between Palisade and Rye Patch Reservoir range from 266 to 347 cfs and 5,800 to 9,900 cfs, respectively (USGS 1992).

TABLE 3-9
Average Monthly Flow for the Humboldt River at Palisade and Maggie Creek Near Mouth

Month	Average Monthly Flow (cfs)[1]	
	Humboldt River at Palisade (1903- 1976)	Maggie Creek near Mouth (1913-1924)
January	132	5.4
February	263	21
March	506	56
April	834	101
May	958	98
June	1142	20
July	332	3.5
August	54	2.1
September	32	1.4
October	47	4.3
November	75	4.4
December	95	3.5

[1] cfs = cubic feet per second.

Source: French et al. 1990.

Flooding in the Humboldt River Basin occurs under three typical conditions: (1) in winter as a result of rain on snow or frozen ground; (2) in spring as a result of rising temperatures that melt snow; and (3) in summer as a result of short-duration, high-intensity storms. In the Carlin area, winter and spring flooding have caused the greatest flood, erosion, and sediment damage (French et al. 1991).

On the Humboldt River at Palisade, a 100-year flood has an estimated peak flow of approximately 10,000 cfs (French et al. 1991). Peak flows recorded at the Palisade gage in 1983 and 1984 were 7,240 cfs and 7,870 cfs, respectively. Flood-frequency data for the Humboldt River show that flow equals or exceeds 10 cfs 92 percent of the time at the Carlin gage, and 99.7 percent of the time at Palisade (Stone et al. 1991). A discharge rate of 1,000 cfs is exceeded 11 percent and 16 percent of the time at the Carlin and Palisade gages, respectively. Federal Emergency Management Agency (FEMA) flood insurance maps delineating the 100-year floodplain have been prepared for the Humboldt River in the vicinity of Carlin (FEMA 1984, 1990).

Maggie Creek. Maggie Creek flows southward in a relatively wide, flat basin to its confluence with the Humboldt River near Carlin, draining an area of approximately 400 square miles. Immediately north of the South Operations Area, Maggie Creek is confined by Maggie Creek Canyon, or the "narrows". This bedrock feature divides the Maggie Creek Basin into upper and lower basins. Maggie Creek generally is a perennial stream above the canyon and intermittent through most of its lower basin. As Maggie Creek leaves the canyon and enters the broad, flat valley in the lower basin, streamflow declines due to infiltration losses to underlying deposits.

Flow gaging on Maggie Creek began in 1913 at a station located approximately one-half mile above its confluence with the Humboldt River. Continuous flow monitoring at this station was discontinued in 1924. Currently, the USGS operates two gaging stations installed in 1989 on Maggie Creek (Figure 3-7). The lower gage was replaced in April 1992 with one closer to the Humboldt River (Plume 1992). During the 1913-24 period of record, average daily discharge of lower Maggie Creek was 23.2 cfs (French et al. 1990). Average monthly flows during the same period are presented in Table 3-9. For the 1989-91 period of record, maximum daily discharge at the upper and lower gages was 160 cfs; average daily flow was approximately 5 to 10 cfs (USGS 1992). In general, average monthly flow in Maggie Creek is less than 10 cfs during 7 months of the year, and approximately 100 cfs during the months of April and May (Table 3-9).

In 1992, Maggie Creek at the upper gaging station reached peak flows of only 10 to 15 cfs from March through May, followed by a rapid decline to about 2 to 3 cfs in mid-May, and no flow by the end of July (Newmont 1992f). When the new gaging station was installed by the USGS near the mouth of Maggie Creek in April 1992, flow was approximately 0.2 cfs; the creek was dry or nearly dry from May through October (Plume 1992; Newmont 1992f). Maggie Creek flow below the canyon since about 1990 may have been reduced by groundwater drawdown that has developed around the Gold Quarry Mine area as a result of existing groundwater pumping (see Chapter 3, Groundwater Quantity).

Estimated 100-year peak flood flow for Maggie Creek near Carlin is 4,200 to 6,100 cfs (French et al. 1992). The greatest peak discharge on record for Maggie Creek is 2,440 cfs, measured in February 1962. Based on flood frequency curves, flow at the lower end of Maggie Creek is 1 cfs or more 72 percent of the time and 100 cfs or more only 8 percent of the time (Stone et al. 1991). A flow of 13 cfs or more can be expected 25 percent of the time.

The USGS has measured flow at several locations along Maggie Creek on the same day to evaluate water gain or loss. Flow measurements during the period 1988-92 suggest that Maggie Creek gains in flow above Maggie Creek Canyon, and loses water below the canyon. For example, in June 1991 flow increased from 3.2 cfs in upper Maggie Creek to approximately 7 cfs just above the canyon; flow decreased to about 5.4 cfs at the lower end of the canyon and continued to decrease to 0.14 cfs near its confluence with the Humboldt River (USGS 1992). During periods of low streamflow, there often is no flow in Maggie Creek at its confluence with the Humboldt River. Streamflow data on file with BLM show that in a 3-day period in late June and early July 1986, flow remained relatively constant (12 to 18 cfs) throughout a reach that extends approximately 5 miles above and below Maggie Creek Canyon.

In addition to the two gaging stations on the Humboldt River and two stations on Maggie Creek, the USGS maintains three other gaging sites in the project area: (1) Marys Creek near its confluence with the Humboldt River; (2) Susie Creek near the Humboldt River; and (3) Jack Creek. Newmont has installed three weirs or flumes to measure flow on Marys, James, and Simon Creeks. These surface water stations are shown in Figure 3-7.

Susie Creek. Susie Creek flows south to the Humboldt River, draining an area of approximately 212 square miles. A USGS gaging station was installed near the mouth of Susie Creek in April 1992. In most years, Susie Creek is ephemeral in the lower reaches and perennial in the upper basin area (Stone et al. 1991). Flow of Susie Creek at a point 16 miles above its confluence with the Humboldt River was measured by the USGS during the period 1956-58. Average annual flow at this location was about 6 cfs with average monthly flows ranging from 0.11 to 29.3 cfs (USGS 1963). Maximum annual flows for the 3 years of measurement were 184, 161, and 89 cfs (USGS 1963). Flow data on file with BLM show a high flow of 60 cfs recorded for April 30, 1985, at a location approximately 4 miles above Susie Creek's mouth. When the USGS gaging station was installed on Susie Creek near its mouth in April 1992, flow was approximately 0.2 cfs (Plume 1992). In October 1992, flow in upper Susie Creek was approximately 3 cfs and no flow was observed near the mouth of the creek (Plume 1992).

Marys Creek. Marys Creek flows under Interstate 80 and past Carlin "Cold" Springs before entering the Humboldt River east of Carlin. Marys Creek is ephemeral above Carlin Springs near its confluence with the Humboldt River. Discharge from the Carlin Springs allows the stream to flow perennially between the spring and the Humboldt River. The Marys Creek drainage covers approximately 75 square miles. A continuous-recording USGS stream gage that has been operating on Marys Creek below Carlin Springs since November 1989 shows maximum and minimum discharges of approximately 24 and 0.6 cfs, respectively (USGS 1992). Average annual flow is approximately 2.5 to 3.0 cfs. Flow at the gaging station typically shows a sharp decline in April or May corresponding to the start of irrigation on the Maggie Creek Ranch upgradient from the Carlin Springs (Newmont 1992f). The town of Carlin also obtains some municipal water from the springs, which affects flow measurements downstream at the gaging station.

The Marys Creek weir measures flow from snowmelt and springs in the upper reaches of the drainage. Flow measured at the weir during May through July 1992 ranged from 0.04 to 0.11 cfs (Newmont 1992f). Peak discharge in 1992 occurred in mid-June. Occasional flow measurements on file with BLM for the same area on upper Marys Creek during 1982-85 show a range of 0.25 to 4 cfs. French et al. (1991) calculated that a 100-year flood on Marys Creek would produce a peak flow of 2,600 cfs at the Interstate 80 bridge.

Jack, Simon, and James Creeks. Jack and Simon creeks are tributary to Maggie Creek north of the South Operations Area. James Creek is also tributary to Maggie Creek, but is located on the southern end of the South Operations Area. Jack Creek streamflow in 1992 peaked in early March at a rate of about 2.3 cfs, decreasing rapidly to about 1.0 cfs in mid-March, and to less than 0.3 cfs from June through October (Newmont 1992f). The USGS found Jack Creek dry on June 18 and October 24, 1991, at a location approximately 0.7 mile upstream of Maggie Creek (USGS 1992). Simon Creek has only one measured streamflow of 0.49 cfs, obtained on June 18, 1991 (USGS 1992). During the period May through October 1992, James Creek fluctuated within a flow range of 0.15 to 0.21 cfs (Newmont 1992f).

WATER QUALITY STANDARDS

Water quality standards for state waters have been established by the State of Nevada under the Nevada Water Pollution Control statutes (Nevada Administrative Code (NAC) 445.070 et seq.; Nevada Revised Statutes (NRS) 445.244). Beneficial use categories include drinking water (municipal or domestic supply), irrigation, livestock watering, industrial, recreation (contact and noncontact), propagation of wildlife, and aquatic life. Nevada's water quality criteria and standards for applicable chemical parameters and beneficial use categories are presented in Table 3-10. Groundwater quality may not be lowered below state or federal regulations prescribing standards for drinking water (NAC 445.24342). Limitations on degradation of water for mining operations are described in NAC 445.24342.

Water quality standards for the Humboldt River in the vicinity of the South Operations Area have been established at the Palisade control point (Table 3-11)(NAC 445.1372). Maggie Creek is included in the following stream classifications (NAC 445.121-1308): tributaries of Maggie Creek are designated Class A waters; Maggie Creek from where it is formed by tributaries to its confluence with Jack Creek is designated a Class B water; and Maggie Creek from its confluence with Jack Creek to the Humboldt River is considered Class C water (Table 3-12). Standards assigned to the rivers and streams consist of selected nonmetal parameters such as temperature, pH, chloride, nitrate, total dissolved solids, and suspended solids. Water quality standards for metals and other selected parameters in surface water are presented in Table 3-10.

Quality of any waters receiving waste discharges must be such that no impairment of beneficial usage occurs as a result of the discharge (NAC 445.118[2]). Discharge permits are required from the Nevada Department of Conservation and Natural Resources (NDCNR) Division of Environmental Protection for anyone who intends to discharge to state waters (NAC 445.140-174; NRS 445.221).

SURFACE WATER QUALITY

Surface water in the upper Humboldt River Basin is generally a calcium-bicarbonate type with hardness and pH ranges of 100 to 250 milligrams per liter (mg/L) and 6.5 to 9.5, respectively. Total dissolved solids and specific conductance generally are less than 500 mg/L and 500 micromhos per centimeter (μmhos/cm), respectively. Dissolved oxygen typically is in the range of 2.4 to 11 mg/L. Table 3-13 contains a summary of water quality data for selected parameters in the Humboldt River and Maggie Creek. Newmont (1992i) has been collecting surface water samples since April 1990 from four sites on Maggie Creek and eight sites on the Humboldt River (Figure 3-7). The USGS also collects water quality samples at selected streams and the Humboldt River in the study area. Relatively little variation in chemistry occurs during the low and high flow regimes, and when comparing samples collected from upstream and downstream stations.

Naturally occurring concentrations of metals in surface water at the project area generally are low or do not exceed detection limits. Several metals measured in the Humboldt River and/or Maggie Creek have exceeded drinking water quality standards, including chromium, iron, manganese, cadmium, selenium, and silver (Table 3-13). Concentrations of arsenic and cadmium in Maggie Creek and the Humboldt River have reached 0.021 mg/L.

TABLE 3-10
Water Quality Criteria and Standards for Nevada

Parameter[1] (mg/L)	Drinking Water Std. Primary	Drinking Water Std. Secondary	Municipal or Domestic Supply	Aquatic Life 1-Hr Average	Aquatic Life 96-Hr Average	Agriculture Irrigation	Agriculture Stock Water	Wildlife Propagation
Arsenic	0.05	--	0.05	0.36 As(III)	0.19 As(III)	0.1	0.2	--
Barium	1.0	--	1.0	--	--	--	--	--
Beryllium	--	--	0	--	--	0.1	--	--
Boron	--	--	--	0.55	0.55	0.75	0.5	--
Cadmium	0.01	--	0.01	[3]	[3]	0.01	0.05	--
Chromium	0.05	--	0.05	0.016 Cr(VI)	0.0011 Cr(VI)	0.1	1.0	--
Copper	--	1.0	--	[3]	[3]	0.2	0.5	--
Iron	--	0.3[0.6][2]	--	1.0	1.0	5.0	--	--
Lead	0.05	--	0.05	[3]	[3]	5.0	0.1	--
Manganese	--	0.05[0.1]	--	--	--	0.2	--	--
Mercury	0.002	--	0.002	0.0024	.000012	--	0.01	--
Nickel	--	--	0.0134	[3]	[3]	0.2	--	--
Selenium	0.01	--	0.01	0.020	0.005	0.02	0.05	--
Silver	0.05	--	0.05	[3]	[3]	--	--	--
Thallium	--	--	0.013	--	--	--	--	--
Zinc	--	5.0	--	[3]	[3]	2.0	25.0	--
Cyanide (WAD)	--	--	0.2	0.022	0.0052	--	--	--

Parameter[1] (mg/L)	Drinking Water Std. Primary	Drinking Water Std. Secondary	Municipal or Domestic Supply	Aquatic Life[4] Propagation	Aquatic Life[4] Put & Take	Agriculture Irrigation	Agriculture Stock Water	Wildlife Propagation
Alkalinity	--	--	--	less than 25% change		--	--	30-130
Chloride	--	250[500]	250[400]	--	--	--	1,500	1,500
Color (PCU)	--	--	--	--	--	--	--	--
Dissolved Oxygen	--	--	Aerobic	5.0	5.0	--	Aerobic	Aerobic
Fluoride	1.4-2.4	--	--	--	--	1.0	2.0	--
Nitrate as N	10	--	--	90(w)	90(w)	--	100	100
pH (SU)	--	6.5-8.5	5.0-9.0	6.5-9.0	6.5-9.0	4.5-9.0	5.0-9.0	7.0-9.2
Sulfate	--	250[500]	250[500]	--	--	--	--	--
Temp° C	--	--	--	Site specific determination		--	--	--
TDS	--	500[1,000]	500[1,000]	--	--	--	3,000	--
TSS	--	--	--	25-80	25-80	--	--	--
Turbidity (NTU)	--	--	--	50(w);10(c)	50(w);10(c)	--	--	--

1 mg/L = milligrams per liter; PCU = photoelectric color units; SU = standard units; NTU = nephelometric turbidity units; TDS = total dissolved solids; TSS = total suspended solids; C = degrees celsius.
2 Numbers in brackets [ ] are mandatory secondary standards for public water systems.
3 Parameter dependent on hardness; see NAC 445.1339 for equations to determine concentration.
4 (w) refers to warm water and (c) is for cold water. No letter designation indicates criteria are common to both warm and cold water.

Source: NAC 445.117; NAC 445.1339.

TABLE 3-11
Water Quality Standards for Humboldt River at Palisade Gage Control Point

Parameter[1] (mg/L)	Water Quality Standards for Beneficial Uses[2]	Most Restrictive Beneficial Use
Temp - °C	$\Delta T \leq 2°$ C [3]	Aquatic life (warm water fishery)
pH - SU	7.0 - 9.0 ΔpH $\pm$ 0.5	Water contact recreation; wildlife propagation
Dissolved Oxygen	$\geq$5.0	Aquatic life (warm water fishery)
Chlorides	$\leq$250	Municipal or domestic supply
Nitrates (NO_3)	$\leq$45	Municipal or domestic supply
TDS	$\leq$500	Municipal or domestic supply
TSS	$\leq$80	Aquatic life (warm water fishery)
Color - PCU	No adverse effects	Municipal or domestic supply
Turbidity - NTU	$\leq$50	Aquatic life (warm water fishery)

1 mg/L = milligrams per liter; °C = degrees celsius; SU = standard pH units; TDS = total dissolved solids; TSS = total suspended solids; PCU = photoelectric color units; NTU = nephelometric turbidity units. Limits apply from the control point at Palisade gage upstream to the Elko control point.

2 Δ = change; all values are single value measurements, except nitrates and TDS, which are annual averages.

3 Maximum allowable increase in temperature at the boundary of an approved mixing zone.

Source: NAC 445.1372.

TABLE 3-12
Class A, B & C Water Quality Standards for Nevada

Item	Class A Specifications	Class B Specifications	Class C Specifications
Floating solids or sludge deposits	None attributable to human activities	Only such amounts attributable to human activities which will not make the waters unsafe or unsuitable as a drinking water source, injurious to fish or wildlife or impair the waters for any other beneficial use established for this class.	Only those amounts attributable to the activities of man which will not make the receiving waters injurious to fish or wildlife or impair the waters for any beneficial use established for this class.
Odor-producing substances	None attributable to human activities	Only such amounts which will not impair the palatability of drinking water or fish or have a deleterious effect upon fish, wildlife or any beneficial uses established for waters of this class.	Not specified.
Sewage, industrial wastes or other wastes	None allowed	None which are not effectively treated to the satisfaction of the department.	None which are not effectively treated to the satisfaction of the department.
Toxic materials, oil, deleterious substances, colored or other wastes	None allowed	Only such amounts as will not render the receiving waters injurious to fish or wildlife or impair the receiving waters for any beneficial use established for this class.	Only such amounts as will not render the receiving waters injurious to fish or wildlife or impair the receiving waters for any beneficial use established for this class.
Settleable solids	Only amounts attributable to human activities which will not make the waters unsafe or unsuitable as a drinking water source or which will not be detrimental to aquatic life or for any other beneficial use established for this class.	Only such amounts attributable to human activities which will not make the waters unsafe or unsuitable as a drinking water source, injurious to fish or wildlife or impair the waters for any other beneficial use established for this class.	Only those amounts attributable to the activities of man which will not make the receiving waters injurious to fish or wildlife or impair the waters for any beneficial use established for this class.
pH	Range between 6.5 and 8.5	Range between 6.5 and 8.5	Range between 6.5 and 8.5
Dissolved Oxygen	Must not be less than 6.0 mg/L[1]	For trout waters, not less than 6.0 mg/L; for non trout waters, not less than 5.0 mg/L.	For trout waters, not less than 6.0 mg/L; for nontrout waters, not less than 5.0 mg/L.
Temperature	Must not exceed 20° C. Allowable temperature increase above natural receiving water temperature: None	Must not exceed 20° C for trout waters or 24° C for nontrout waters. Allowable temperature increase above natural receiving water temperatures: None	Must not exceed 20° C for trout waters or 34° C for nontrout waters. Allowable temperature increase above natural receiving water temperatures: 3° C
Fecal Coliform	The fecal coliform concentrations, based on a minimum of 5 samples during any 30-day period, must not exceed a geometric mean of 200 per 100 mL, nor may more than 10 percent of total samples during any 30-day period exceed 400 per 100 mL.	The fecal coliform concentrations, based on a minimum of 5 samples during any 30-day period, must not exceed a geometric mean of 200 per 100 mL, nor may more than 10 percent of total samples during any 30-day period exceed 400 per 100 mL.	See NAC 445.124
Total phosphate	Must not exceed 0.15 mg/L in any stream at the point where it enters any reservoir or lake, nor 0.30 mg/L in streams and other flowing waters.	Must not exceed 0.3 mg/L.	Must not exceed 1.0 mg/L
Total Dissolved Solids	Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less).	Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less).	Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less).

[1] mg/L = milligrams per liter.

Source: NAC 445.121-1308.

TABLE 3-13
Summary of Water Quality for Maggie Creek and Humboldt River

Surface Water Station[1]	Total Concentration Ranges[2]															
	Temp C°	pH SU	DO mg/L	TDS mg/L	TSS mg/L	Turb. NTU	Ag mg/L	As mg/L	Ba mg/L	Cd mg/L	Cr mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Pb mg/L	Se mg/L
MAG-1	9-24	8.4-8.9	4.4-9.2	300-410	-5-15	-0.5-6.5	-.005	-.005-.014	.05-.10	-.005-.006	-.002-.003	.10-.54	-.0001-.0003	.016-.11	-.002 -.06	-.005
MAG-2	0-20	7.2-8.5	3.8-9.5	270-400	-5-32	-0.5-4.0	-.005	-.005-.019	.05-.10	-.005	-.002-.005	.10-.38	-.0001-.0002	.011-.054	-.001-.012	-.005
MAG-3	0.2-18	8.2-9.3	3.2-10.4	310-490	-5-28	0.8-5.0	-.005	-.005-.014	.05-.10	-.005-.01	-.002-.007	.05-1.6	-.0001-.0003	.006-.43	-.001-.002	-.005
MAG-4	0.3-18	7.7-8.8	3.1-11.0	250-800	-5-24	-0.5-6.0	-.005	-.005-.012	.01-.10	-.005-.006	-.002-.006	-.01-.71	-.0001-.0003	.006-.08	-.001-.015	-.005
HUM-1	0.8-22	7.1-8.7	4.4-10.8	190-352	1-140	2.5-55	-.005-.096	-.005-.014	.005-.13	-.005-.006	-.002-.007	.09-3.3	-.0001-.0006	.015-.19	-.002-.01	-.005
HUM-2	1-22	7.1-8.5	4.2-11.1	246-370	5-336	1-115	-.005-.012	-.005-.012	.074-.17	-.005-.021	-.002-.10	-.01-3.5	-.0001-.0004	-.005-.29	-.002-.01	-.005
HUM-3	0.8-24	7.2-8.5	4.7-11.6	250-414	-1-344	2-125	-.005-.014	-.005-.019	.057-.24	-.005-.013	-.002-.007	.05-6.4	-.0001-.0009	.013-.40	-.002-.035	-.005-.012
HUM-4	2-20	6.5-8.6	4.2-10.1	230-450	-5-169	2-45	-.005	.005-.013	.066-.14	-.005-.006	-.002-.10	.07-2.4	-.0001-.0004	.017-.15	-.002-.008	-.005
HUM-5	2-20	7.3-8.5	4.1-11.1	242-364	-5-188	2.5-45	-.005-.018	-.005-015	.074-.14	-.002-.005	-.002-.38	.1-2.5	-.0001-.0003	.017-.14	-.002-.05	-.005
HUM-6	15-25	7.2-8.2	2.4-4.7	280-452	-5-169	-.5-42	-.005	-.005-.021	.11-.34	-.005-.007	-.002-.10	-.05-2.6	-.0001-.0003	.013-.17	-.002-.02	-.005
HUM-7	5.4-30	7.0-8.7	4.0-10.6	210-356	3-195	2.5-43	-.005	-.005-.019	.074-.17	-.005-.005	-.002-.005	.1-2.7	-.0001-.0002	.025-.18	-.002-.05	-.005
HUM-8	9-24	7.0-8.6	4.2-10.1	236-350	6-128	1.2-41	-.005	-.005-.015	.073-.15	-.005-.007	-.002-.006	.1-3.2	-.0001-.0003	.027-.15	-.002-.012	-.005
Drnkg[3] Water Stds	--	6.5-8.5(s)	--	500(s)	--	--	0.05	0.05	1.0	0.01	0.05	0.3(s)	.002	0.05(s)	0.05	0.01
Aquatic[4] Life Stds	--	6.5-9.0	5.0	--	25-80	10	10.6	.19-.36	5.0	1.8-7.4	.0011-.016	1.0	.000012-.0024	--	6.5-166	.005-.02

1 MAG-1 through MAG-4 are located on Maggie Creek; HUM-1 through HUM-8 are located on the Humboldt River; HUM-6 is located where the Carlin Hot Spring discharges into the Humboldt River; see Figure 3-7 for station locations. All samples collected by Newmont. All four stations on Maggie Creek are within the Class C designation; all stations on the Humboldt River, except HUM-5, are within the Palisade control point designation.

2 Concentration ranges of samples collected generally quarterly during 1990-92; "-" means less than the reported detection limit; DO=dissolved oxygen (field measured); TDS = total dissolved solids; TSS = total suspended solids; turb. = turbidity; Ag = silver; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Fe = iron; Hg = mercury; Mn = manganese; Pb = lead; Se = selenium; C° = degrees celsius; SU = standard pH units (lab measured); mg/L = milligrams per liter; NTU = nephelometric turbidity units.

3 All concentrations reported are primary drinking water standards unless followed by (s) indicating secondary standards (see NAC 445.117).

4 Ag, Cd, and Pb concentrations are calculated based on a hardness of 175 mg/L representative of Maggie Creek and the Humboldt River (see NAC 445.1339).

Source: Newmont 1992i; NAC 445.117; NAC 445.1339.

Quality of water in Maggie Creek generally is better than in the Humboldt River.

Representative water samples collected from Jack, James, Marys, and Susie creeks are presented in Table 3-14. Samples collected from Jack Creek and Marys Creek in September 1992 show no detectable concentrations of most metals.

Temperature of surface water in the project area varies considerably throughout the year, and seems to be more dependent on ambient air temperature than discharge rate (Table 3-15). During summer, water temperatures in Maggie Creek and the Humboldt River typically are in the range of 15 to 25°C. In winter, surface water temperatures generally are less than 10°C. Maximum recorded water temperatures in Maggie Creek and the Humboldt River during the period 1990-92 are 24°C and 30°C, respectively (Table 3-15). Water temperature in Maggie Creek increases downstream; for example, in April 1992, Maggie Creek temperature was 10°C north of the South Operations Area and 18°C near its confluence with the Humboldt River (Table 3-14). Temperature variations along the Humboldt River are less pronounced in the project area; however, temperature increases typically are observed in the river for a short distance downstream of the Carlin Hot Spring (stations HUM-6, HUM-7, and HUM-8; Figure 3-7).

Water quality samples were collected at 12 stations on the Humboldt River during November 1991 and April 1992 and analyzed for pH, specific conductance, alkalinity, and sulfate (JBR 1992a). These four parameters showed only slight variation between stations in any one season. With the exception of pH, all parameters showed moderate decreases from fall to spring periods. River flow was approximately twice as great in spring (165 cfs average) as compared with fall (82 cfs average). For the two sample events, pH ranged between 8.2 and 9.0, alkalinity averaged approximately 200 mg/L, and average sulfate

TABLE 3-14
Summary of Water Quality for Jack Creek, James Creek, Marys Creek and Susie Creek

Stream	Total Concentrations[1]														
	Sample Date	Temp C°	pH SU	TDS mg/L	TSS mg/L	Turb. NTU	Ag mg/L	As mg/L	Ba mg/L	Cd mg/L	Cr mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Pb mg/L	Se mg/L
Jack Creek	9-14-92	10.7	7.3	280	-5	0.4	-.005	-.005	.06	-.005	-.005	.09	-.0001	.023	-.002	-.005
James Creek	10-20-92	15.3	8.3	270	48	2.5	-.005	-.005	.09	-.005	-.005	.43	-.0001	.016	.003	-.005
Marys Creek	9-14-92	17.3	7.2	400	-5	0.3	-.005	-.005	.07	.005	.005	.02	-.0001	.023	-.002	-.005
Susie Creek	12-17-92	.08	8.1	330	6	0.8	-.005	.007	.08	-.005	-.005	.08	-.0001	.008	-.002	-.005

[1] TDS = total dissolved solids; TSS = total suspended solids; turb. = turbidity; Ag = silver; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Fe = iron; Hg = mercury; Mn = manganese; Pb = lead; Se = selenium; C° = degrees celsius measured in field; SU = standard pH units (lab measured); mg/L = milligrams per liter; NTU = nephelometric turbidity units; "-" means less than the reported detection limit.

Source: Newmont 1992f; Newmont 1993g.

TABLE 3-15
Water Temperatures in Maggie Creek and Humboldt River

Surface Water Station[1]	Water Temperature[2] (°C)											
	4/90	5/90	4/91	5/91	6/91	7/91	9/91	12/91	3/92	4/92	9/92	
MAG-1	1[illegible]	10	2	13-16	24	--	--	--	10	18	--	
MAG-2	10	10	7	10-14	24	--	--	2	8	18	--	
MAG-3	8	7	9	10-13	18	18	--	0.2	7	11	--	
MAG-4	6	6	2	10	17	--	17	0.3	9	10	14	
HUM-1	1[illegible]	1[illegible]	6-8	10	14-22	21	17	0.3	9	1[illegible]	12	
HUM-2	17	15	9	14-17	20-22	--	14	1	10	16	16	
HUM-3	17	1[illegible]	2	15-18	20-24	--	15	0.3	10	1[illegible]	12	
HUM-4	19	20	--	--	1[illegible]	--	15	2	1[illegible]	10	14	
HUM-5	17	16	--	14-15	18-21	23	17	2	1[illegible]	10	20	
HUM-8	--	--	16	18	17-21	--	14	20	23	25	16	
HUM-1	--	--	2	10	18-21	22	26	5.4	9	16	30	
HUM-8	--	--	14	1[illegible]	18-21	--	27	--	--	16	20	
Humboldt River At Carlin Tunnels Gage[3]	10/81	11/81	12/81	1/82	2/82	3/82	4/82	5/82	6/82	7/82	5/82	9/82
	6-15	2-8	1-6	0.5-2	1-5	4-9	6-15	11-19	15-22	17-24	21-23	9-21

1 MAG-1 through MAG-4 are located on Maggie Creek; HUM-1 through HUM-8 are located on the Humboldt River; HUM-6 is located where the Carlin Hot Spring discharges into the Humboldt River; see Figure 3-7 for station locations. The four stations on Maggie Creek are within the Class C designation; all stations on the Humboldt River, except HUM-5, are within the Palisade control point designation (see Tables 3-10 and 3-11).

2 Instantaneous temperature measurement on 1 or 2 days within the month in degrees celsius.

3 Mean daily temperature range for the month in degrees celsius.

Source: Newmont 1992f; USGS 1992.

concentration was about 45 mg/L (JBR 1992a). Specific conductance had the most significant change, averaging 443 μmhos/cm in spring and 544 μmhos/cm in fall. Water temperature ranged from 2 to 5°C in November and from 13 to 17°C in April.

STREAM AND RIVER MORPHOLOGY

The Humboldt River generally meanders through a broad valley with a low gradient of approximately 0.1 and 0.2 percent (JBR 1992a). Bedrock outcrops near the channel in some locations but has little overall influence on the river channel. In many locations near the study area, river alignment is restricted by riprapped banks that protect the interstate highway and railroad. Cobbles and coarse gravel dominate the channel bottom, although all ranges of particle size occur (JBR 1992a). The Humboldt River in the vicinity of the study area has fair to moderate bank stability with 25 to 60 percent of river bank covered by vegetation or gravel and cobble materials (JBR 1992a).

According to the U.S. Army Corps of Engineers (COE), channel capacity of the Humboldt River is in the range of 1,000 to 1,500 cfs in the vicinity of Carlin and Palisade (COE 1950; 1976). Recent studies by French et al. (1991; 1992), however, suggest the hydraulic capacity of the present Humboldt River channel in the vicinity of Carlin ranges from 1,900 to 6,500 cfs. This increase may be a result of channel scouring during the 1983-84 floods. These studies also concluded that there are sections of the channel where local conditions result in below-average channel capacity. Channel capacity is the maximum flow that can be accommodated within the banks.

With the exception of Maggie Creek Canyon, Maggie Creek meanders in a wide valley in response to fine-grained, erosion-resistant material (Tertiary sediments and alluvium derived from Paleozoic siltstone). The majority of Maggie Creek downstream of the South Operations Area is an entrenched, sinuous, gravel-bed channel with a high width/depth ratio on slopes less than 0.7 percent (Rosgen 1992). Some portions of the channel are underlain by easily eroded, fine-grained sediments. Bank erodibility generally is high to very high (Rosgen 1992). The Maggie Creek channel is bounded on both banks by an alluvial terrace. Man-induced changes to channel configuration by irrigation diversions are evident. Bankfull discharge in Maggie Creek is approximately 80 cfs, with a bankfull width and mean depth of approximately 30 feet and 0.8 foot, respectively (Rosgen 1992).

The Marys Creek channel is well defined although its hydraulic capacity is limited and its location in the valley likely changes in response to flood flows (French et al. 1991). The majority of particles in the streambed are less than 1 inch in diameter. No specific information is available on channel conditions of Susie Creek; however, this channel appears to be similar to Maggie Creek.

SPRING AND SEEP SURVEYS

Numerous springs and seeps have been inventoried by Newmont within a 10-mile radius of the South Operations Area (Hovda 1990; Skidmore 1991, 1992; Gilbert et al. 1992). Information gathered during the field surveys includes geologic occurrence and control, development, vegetation type, water pH, specific conductance, dissolved oxygen content, water temperature, and flow rate. Figure 3-8 shows the 52 springs inventoried by Newmont in the study area since fall 1990. These 52 springs are not inclusive of all springs and seeps in the study area but were selected to be representative of the various spring types and locations. JBR (1992b) conducted a comprehensive spring and seep inventory in May and June 1992 that identified approximately 200 springs and seeps in the study area (Figure 3-8). The BLM also inventoried all springs and seeps it could find on public land during the summer of 1982. Available data on springs and seeps in the study area are summarized in Appendix A.

Springs in the Carlin Trend area have been categorized into several main types based on geologic control (Stone et al. 1991; Balleau Groundwater Consulting 1992). Discharge of water can occur at the contact of permeable and impermeable materials such as at faults, dikes, cliffs, or other barriers. Some springs and seeps represent exposure of the water table in a depression or topographic low. Water also can be stored and released from localized areas of unconsolidated material such as colluvium. Water can be at artesian pressure (confined or semiconfined condition) or at atmospheric pressure (unconfined condition). Springs can be associated with extensive groundwater flow systems or they can be "perched" or "bounded" where the source is a relatively small, localized groundwater system separated from regional groundwater. Most springs and seeps in the project area are located at and above the base of mountains and far above the elevation of regional groundwater in adjacent valleys. According to Balleau Groundwater Consulting (1992), springs above an elevation of about 6,000 feet are typically isolated from the regional groundwater flow system.

The majority of inventoried springs and seeps have flow rates of less than 5 gallons per minute (gpm). Based on 1991 measurements by Newmont, only 15 springs exceeded flow rates of 5 gpm; four of these springs had flows greater than 50 gpm. Precipitation in 1991, however, was below average. Seasonal variations in flow occur with most springs, indicating shallow perched systems where flow is easily influenced by seasonal precipitation. In addition, numerous springs have experienced a general declining trend in flow since fall 1990. For example, spring no. 34 (Cherry Spring; Figure 3-8) had a flow of 25 gpm in fall of 1990, 1 to 5 gpm in spring of 1991, <1 gpm in fall of 1991, and 0.4 gpm in spring of 1992. Data from BLM files for 1982 field studies also show that the majority of springs observed in the South Operations study area were flowing at rates of less than 5 gpm.

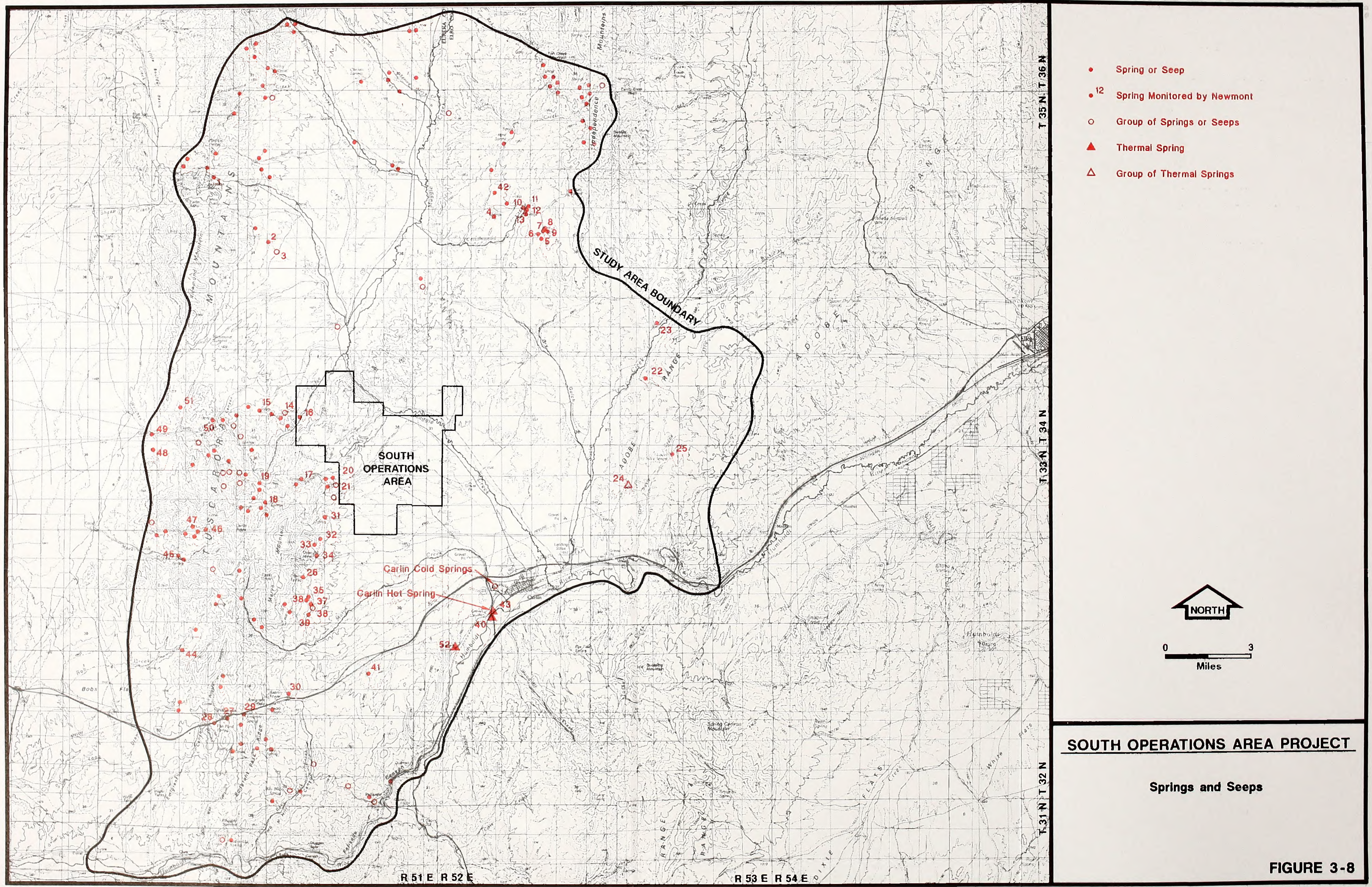
Springs may be classified as either thermal or nonthermal based on temperature and chemical characteristics (Gilbert et al. 1992). Thermal springs generally have higher trace metal and major ion concentrations than nonthermal springs. Temperatures for springs of a nonthermal origin range from approximately 8 to 26°C, whereas those of thermal springs typically range from 55 to 68°C. In the study area, four spring sites are considered thermal (Figure 3-8).

Dissolved oxygen ranges from 5.0 to 8.0 mg/L for nonthermal springs and is less than 3.0 mg/L for thermal springs. Specific conductance is generally greater than 1,000 µmhos/cm for thermal springs and less than 500 µmhos/cm for nonthermal springs. Nine of the inventoried springs have been analyzed for a larger set of chemical parameters; selected results of these analyses are presented in Table 3-16. Metals generally are at low concentrations or nondetectable. In general, quality of springs and seeps over four surveys conducted during the period 1990-92 has shown little overall change or discernible pattern. The pH values of all springs range from 5.5 to 9.7 (Appendix A).

TABLE 3-16
Summary of Water Quality for Selected Springs in the South Operations Area

Spring Site[1]	Total Concentrations[2]														
	Temp C°	pH SU	TDS mg/L	TSS mg/L	Turb. NTU	Ag mg/L	As mg/L	Ba mg/L	Cd mg/L	Cr mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Pb mg/L	Se mg/L
SPR-1	11	7.6	3620	25	5	.011	.031	-.1	.015	-.1	1.48	.0009	.11	.17	-.005
SPR-18	12	7.5	182	11	18	-.005	.009	-.1	-.005	-.1	2.96	-.0005	.08	-.05	-.005
SPR-21	11	8.1	330	2	-0.5	-.005	-.005	-.1	-.005	-.1	.11	-.0005	-.05	.08	-.005
SPR-23	15	7.8	204	1	-0.5	-.005	-.005	-.1	-.005	-.1	-.05	-.0005	-.05	-.05	-.005
SPR-24	63	7.9	698	8	1	-.005	.007	.59	-.005	-.1	.75	-.0005	-.05	.08	-.005
SPR-28	16	8.1	718	17	4	-.005	.007	.22	-.005	-.1	.57	-.0005	.08	.11	-.005
SPR-34	16	7.8	424	9	2	-.005	-.005	-.1	-.005	-.1	.69	-.0005	.48	.08	-.005
SPR-42	15	7.4	232	3	-0.5	-.005	-.005	-.1	-.005	-.1	-.05	-.0005	-.05	-.05	-.005
SPR-43	67	7.8	434	1	1	-.005	.013	.23	.005	-.05	-.05	-.0005	-.05	-.05	-.01

1 See Figure 3-8 for locations of springs.
2 Samples collected in April or May 1991; "-" means less than the reported detection limit: TDS = total dissolved solids; TSS = total suspended solids; turb. = turbidity; Ag = silver; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Fe = iron; Hg = mercury; Mn = manganese; Pb = lead; Se = selenium; C° = degrees celsius; SU = standard pH units (lab measured); mg/L = milligrams per liter; NTU = nephelometric turbidity units.
Source: Skidmore 1991.



SOUTH OPERATIONS AREA PROJECT

Springs and Seeps

FIGURE 3-8

In the vicinity of the town of Carlin, two major spring complexes discharge from bedrock material and flow into the Humboldt River. The one known as Carlin Hot Spring discharges adjacent to the Humboldt River at an estimated rate of between 1 and 2 cfs and a temperature as high as 79°C (Skidmore et al. 1991). This spring is submerged under the Humboldt River except during low-flow conditions. The second major spring near the town of Carlin, known as the Carlin "Cold" Spring complex, discharges in the Marys Creek drainage near its confluence with the Humboldt River. This group of springs flows at an average rate of 2.8 cfs. An average rate of about 1.0 cfs is diverted from this spring for municipal use at Carlin (NDCNR 1992b). These two spring sites are shown in Figure 3-8.

GROUNDWATER QUANTITY

Recharge, flow, and discharge of groundwater are influenced primarily by geologic conditions. In the South Operations Area, sedimentary deposits have primary porosity and permeability surrounding individual grains; subsequent earth movements produced secondary permeability via faults and fractures. Alteration associated with mineralization has further influenced these conditions. Subsurface geologic structures may act as hydraulic conduits for increased groundwater flow or as barriers to groundwater movement. Geologic structures in the study area that influence groundwater movement include the Roberts Mountain thrust fault and a number of basin-bounding, high-angle normal faults and fault zones with displacements of several thousand feet (Stone et al. 1991).

Groundwater recharge in the project area occurs primarily through fractured bedrock in the mountains and through unconsolidated alluvium in the valleys. An annual recharge rate of 0.6 inches has been estimated for the project area (Plume and Stone 1992). Some stream reaches also lose flow and thus recharge the shallow groundwater system. Groundwater leaves the basin as evapotranspiration, springs and seeps, and discharge into the Humboldt River and some reaches of Maggie, Marys, and Susie creeks. Approximately 9 to 19 cfs of groundwater flows into the Humboldt River between Carlin Tunnels and Palisade (HCI 1992a; Zimmerman 1992b).

Five hydrostratigraphic units are recognized in the South Operations Area (Table 3-17). The shallowest unit is younger basin-fill alluvium (Quaternary age). Below the alluvium are the following hydrostratigraphic units in descending order: older basin-fill sediments known as the Carlin Formation (Tertiary age); volcanic rocks (Tertiary age); siltstone (Paleozoic age); and carbonate rocks (Paleozoic age). Underlying these five units is Eureka Quartzite (Paleozoic age), a formation with low permeability that restricts groundwater movement. In the South Operations Area, the siltstones are structurally separated from the carbonates by thrust faults and/or normal faults.

TABLE 3-17
Major Hydrostratigraphic Units in South Operations Area

Hydrostratigraphic Unit	Geologic Age	Stratigraphic Unit	Unit Description
Younger basin-fill deposits	Quaternary	Alluvium	Sorted to poorly sorted deposits of stream flood plains
Older basin-fill deposits	Tertiary	Carlin and Humboldt Formations	Volcaniclastic sedimentary rocks and deposits of fluvial and lacustrine origin
Volcanic rocks	Tertiary	Volcanic rocks	Rhyolite and basalt flows
Siltstones and shales	Devonian to Ordovician	Rodeo Creek Unit and Vinini Formation	Clastic sedimentary rocks
Carbonate rocks	Devonian to Ordovician	Roberts Mountain and Hanson Creek Formations	Carbonate and minor clastic sedimentary rocks

Source: Plume and Stone 1992.

Groundwater flow in the five hydrostratigraphic units can be generalized as three primary flow systems: (1) perched system in all units associated primarily with mountainous areas; (2) upper unconfined or water table system primarily in basin-fill sediments, siltstones, and volcanics; and (3) lower semiconfined carbonate rock system. Perched groundwater occurs where groundwater moves separately in shallow sediments and bedrock fractures, usually discharging as springs at elevations higher than the regional groundwater systems. Groundwater in the upper unconfined system generally flows within each separate drainage basin toward the basin axes and ultimately to discharge areas along the Humboldt River (Figure 3-9). In the Maggie Creek Basin, the water table system generally flows to the southeast at a gradient of 1.25 percent. Based on limited groundwater level data in the lower semiconfined carbonate unit, flow generally is to the southwest at a gradient of about 0.1 percent. Within the carbonate unit are local geothermal systems expressed by elevated water temperatures at various wells and hot springs.

Groundwater levels have been measured periodically by Newmont and the USGS in numerous wells in the vicinity of the Gold Quarry Mine (Figure 3-10). Depth to groundwater varies widely in the study area depending on the location and hydrostratigraphic unit intercepted. Some wells flow naturally at ground surface and are referred to as flowing artesian wells. Seasonal variations in the water table have been observed in regional wells from a range of less than 1 foot to more than 12 feet, averaging about 9 feet (Zimmerman 1992c). Some of these wells show a declining trend over the last 5 to 7 years due to general drought conditions.

Water level declines of up to 40 feet in the siltstone and carbonate aquifers have been observed since 1989 near the Gold Quarry Mine as a result of groundwater pumping (Newmont 1992f). Current water table elevation contours in the South Operations Area are shown in Figure 3-9. Wells outside of the immediate Gold Quarry Mine area show little or no apparent drawdown effects from pumping at the mine.

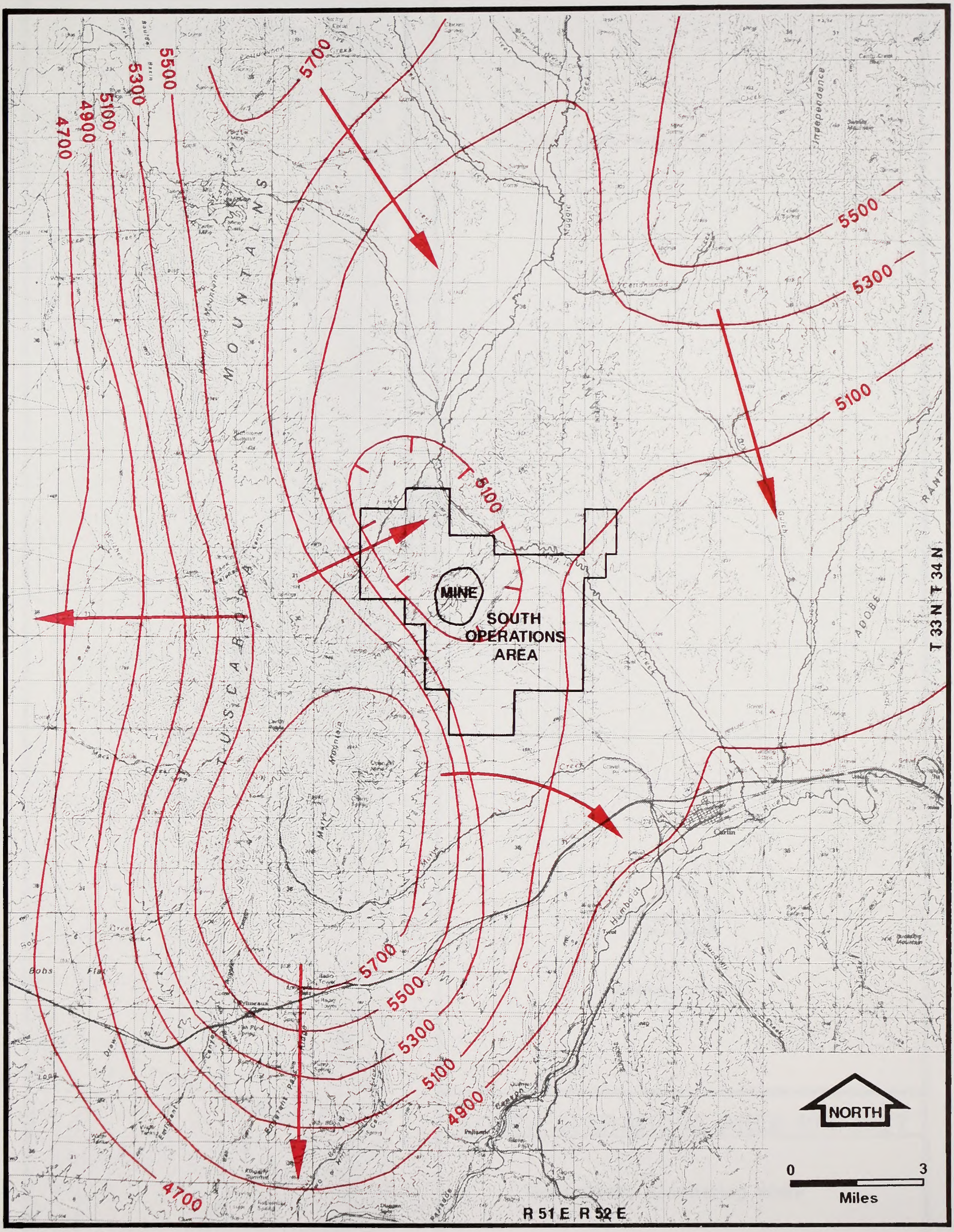
The hydrogeologic character of hydrostratigraphic units and major structures in the pit area were examined from several aquifer tests. Table 3-18 summarizes results of aquifer tests conducted at the South Operations Area. Well locations are shown in Figure 3-10.

Alluvium. The unconfined alluvial unit is limited in extent and occurs beneath and adjacent to streams and rivers. This unit is composed of unconsolidated mixtures of clay, silt, sand, and gravel at thicknesses of 10 to over 300 feet. Permeability of these unconsolidated materials is variable. Exchange of water between streams and the subsurface occurs primarily within the alluvial material.

Tertiary Sediments. Basin-fill sediments of Tertiary age are often referred to as the Carlin Formation. Lithology of this unit is variable and includes siltstone, sandstone, welded tuff, mudstone, shale, conglomerate, and limestone. Thickness of these sediments ranges from a few hundred feet to more than 5,000 feet. Depth to water ranges from 25 to over 300 feet below ground surface. Permeability of these materials generally is low to moderate.

Tertiary Volcanics. The Tertiary volcanic rocks consist of rhyolite and basalt flows. Thicknesses of over 300 feet have been identified in the project area. Secondary fractures have made the volcanic unit very permeable. Three wells in the Maggie Creek Basin reportedly are completed in the volcanics. Depth to water in these wells ranges from 36 to 66 feet. The Carlin Spring probably issues from a contact between the highly permeable volcanics and a less permeable sedimentary unit (Stone et al. 1991).

Siltstone. Siltstone material of Paleozoic age lies below the Tertiary deposits and has been faulted out of sequence by the Roberts Mountain thrust. This unit is assigned to the Vinini Formation and consists primarily of fine-grained clastic material at thicknesses of up to several thousand feet. Groundwater generally is unconfined in this unit;



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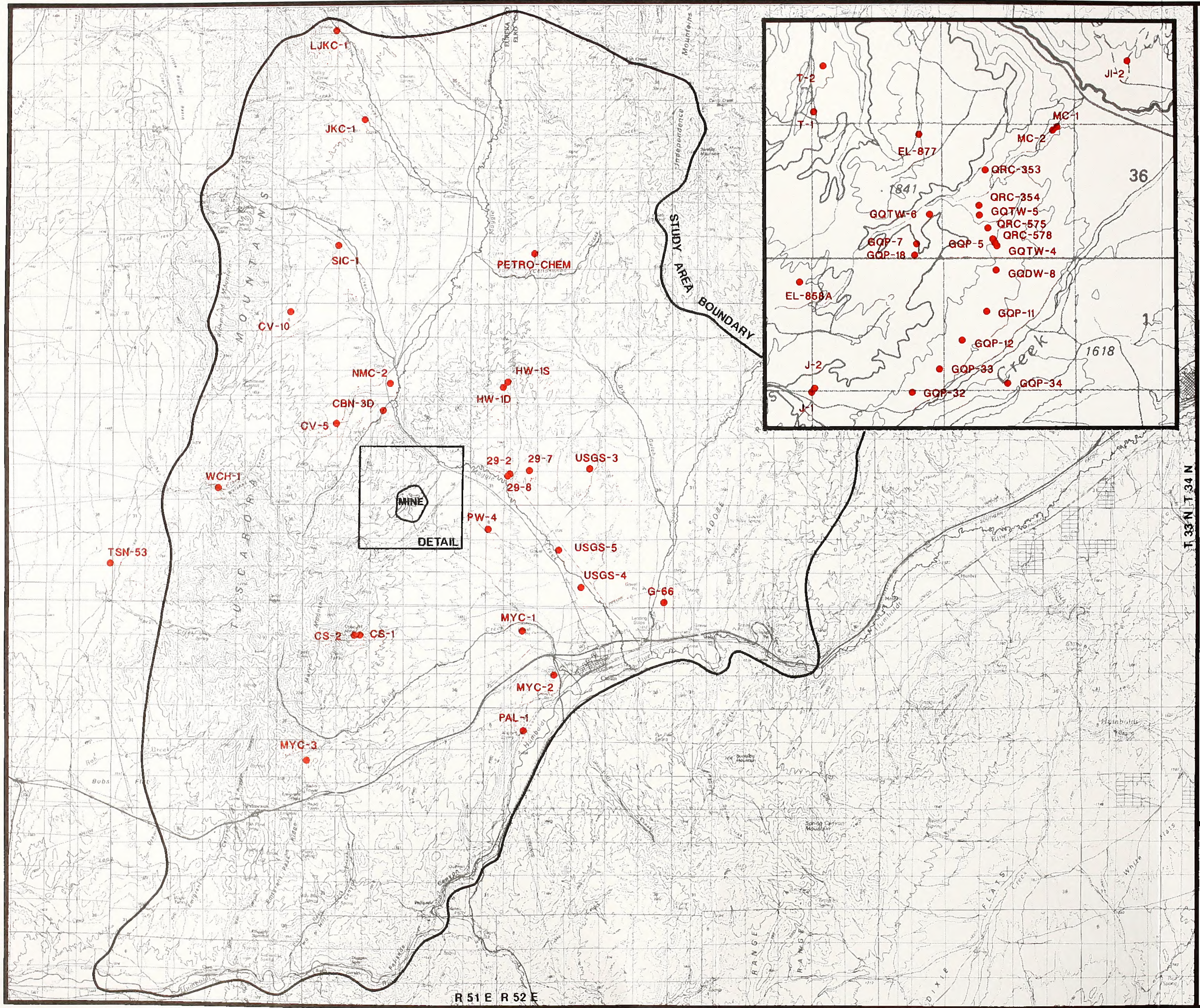
Water Level Elevation Contour, Sept. 30, 1992 (Contour Interval : 200 Feet)

Direction of Groundwater Flow

Water Table Contour Map
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-9



● Groundwater Monitoring Locations

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SOUTH OPERATIONS AREA PROJECT

Groundwater Monitoring Wells

FIGURE 3-10

TABLE 3-18
Summary of Aquifer Tests Conducted at the South Operations Area

Well No.[1]	Hydrostratigraphic Unit	Well Depth (feet)	Pumping Rate (gpm)[2]	Pumping Period (hours)	Transmissivity (ft^2/day)[3]	Comments[4]
GQTW-1	Roberts Mtn Limestone	997	750	97	7,700	Gold Quarry fault zone; $S = 6 \times 10^{-3}$; K = 20 ft/day
GQTW-2	Vinini Siltstone	577	273	102	600	Unaltered siltstone; $S = 9 \times 10^{-4}$; K = 2 ft/day
GQTW-3	Paleozoic Siltstone	945	2,800	240	60,000	$S = 5 \times 10^{-3}$
GQTW-4	Paleozoic Siltstone	755	5,300	240	60,000	$S = 3 \times 10^{-3}$
GQTW-5	Paleozoic Siltstone	820	275	240	6,700	Good Hope fault zone; $S = 1 \times 10^{-3}$
GQTW-6	Roberts Mtn Limestone	1620	1400	160	70,000	$S = 5 \times 10^{-3}$; K = 23 ft/day
CBN-1	Roberts Mtn Limestone	500	480	5	>53,000	Air lift test; minimal drawdown
MC-2	Roberts Mtn Limestone	1,201	4,000	41	145,000	Fractured Gold Quarry fault zone
PW-9	Roberts Mtn Limestone	710	2,200	24	25,000	Located near well MC-2
29-WW	Carlin Formation	405	220	51	1,100	$S = 1 \times 10^{-2}$; K = 1 ft/day

1 See Figure 3-10 for well locations.

2 gpm = gallons per minute. During some aquifer tests, various pumping rates were used; the average pumping rate is presented in the table.

3 ft^2/day = square feet per day. In some cases, several values for transmissivity (T) were determined using various observation wells and calculation methods; an approximate average value for T is presented in the table.

4 S = storativity or storage coefficient; K = hydraulic conductivity (horizontal). In some cases, several values for storativity were determined; an approximate average value for S is presented in the table.

Source: Golder Associates, Inc. 1990; Pettit et al. 1991; Pettit 1992; Pettit et al. 1992.

however, some wells have encountered artesian or confined conditions (Stone et al. 1991). Depth to water ranges from less than 100 feet to 300 feet or more. Where the siltstone is silicified and brittle, fractures have developed that provide considerable secondary permeability. The siltstone unit is exposed in most of the mountainous areas, and therefore receives the greatest portion of precipitation recharge.

Carbonates. Approximately 3,000 feet of carbonate rock (limestone) is situated between the overlying siltstone aquifer and the underlying Eureka Quartzite confining unit that forms the effective bottom of the local groundwater flow system. Groundwater in the carbonate is dominantly semiconfined or confined. Depth to groundwater in carbonate rocks ranges from flowing artesian conditions to over 500 feet. Groundwater flow in this unit generally is to the southwest, whereas groundwater moves primarily to the southeast in the four overlying hydrostratigraphic units. High permeability is common in the carbonate rock due to fractures and faults. The carbonate and overlying siltstone units are the primary units that would be intercepted and dewatered by the Gold Quarry Mine pit.

GROUNDWATER QUALITY

General groundwater quality for selected parameters in the study area is summarized in Table 3-19. Groundwater quality is influenced by geology, flow paths, residence time, and, in some cases, human factors. In general, water quality from all five major hydrostratigraphic units is similar; however, concentrations of ions are higher in the deeper units because of longer residence times. Groundwater from all hydrostratigraphic units is of the calcium-carbonate or sodium-carbonate type. Typical concentration ranges for selected chemical parameters are as follows: specific conductance = 100 to 600 μmhos/cm; total dissolved solids =200 to 400 mg/L; pH = 6.5 to 8.5; dissolved oxygen = 2.5 to 6.0 mg/L; hardness = 100 to 300 mg/L; and temperature = 11 to 19°C (deeper units = 23 to 33°C).

Quality of groundwater to be pumped from the South Operations Area has been characterized by wells completed in the deeper siltstone and carbonate units (e.g., wells GQTW-4 and GQTW-5; Table 3-19). Groundwater parameters in the deep siltstone and carbonate that have exceeded drinking water standards include arsenic, iron, and selenium (Table 3-19). Hardness of deeper groundwater is approximately 200 mg/L and total dissolved solids ranges from about 330 to 400 mg/L. Average deep water temperature and pH are approximately 25°C and 7.5, respectively. Geothermal gradients observed in some South Operations Area wells range from 0.6 to 4°C per 100 feet (Stone et al. 1991).

TABLE 3-19
Summary of Groundwater Quality in the South Operations Study Area

Aquifer		Concentration Ranges[2]																	
	Wells Sampled[1]	Temp C°	pH SU	Hard mg/L	DO mg/L	TDS mg/L	Turb. NTU	Ag mg/L	As mg/L	Ba mg/L	Cd mg/L	Cr mg/L	Fe mg/L	Hg mg/L	Mn mg/L	Ni mg/L	Pb mg/L	Se mg/L	Zn mg/L
Alluvium	JKC-1	14.3	8.0	260-280	--	310-340	4-4.5	-0.005	-.005-.009	.05-.31	-.005	-.005	-.01-0.88	-.0001	-.005-.009	-.01	-.001 -.002	-.005	-.02
Tertiary Volcanics	MYC-2	15.1	8.1	92-95	--	210-220	-0.2	-0.005	.01-.011	.06	-.005	-.005	-.01	-.0001	-.005-.006	-.01	-.001 .002	-.005	-.02
Carlin Formation	MYC-1, 29-7,29-8	15.2-18.6	8.1	150-200	--	240-370	-0.2	-0.005	-.005-.009	.08-.24	-.005	-.005	-.01	-.0001	-.005-.021	-.01	-.001 .002	-.005	-.02-.07
Deep Siltstone & Limestone	GQTW-4, GQTW-5	23-33.4	7.3-8.1	197-230	4.8	330-396	1-7.6	-0.005	.023-.182	.07-.09	-.005	-.005	.02-.98	-.0001 -.0004	.006-.042	-.01-.02	-.002	-.005-.029	.02-.11
Drinking Water Standards[3]		--	6.5-8.5(s)	--	--	500(s)	--	0.05	0.05	1.0	0.01	0.05	0.3(s)	.002	0.05(s)	--	0.05	0.01	5.0(s)

1 See Figure 3-10 for locations of monitoring wells.

2 Concentrations for metals are dissolved; concentrations for other parameters are total; samples were collected in June and September 1992; "-" means less than the reported detection limit; Hard = hardness; DO = dissolved oxygen (field measured); TDS = total dissolved solids; turb. = turbidity; Ag = silver; As = arsenic; Ba = barium; Cd = cadmium; Cr = chromium; Fe = iron; Hg = mercury; Mn = manganese; N = nickel; Pb = lead; Se = selenium; Zn = zinc; C° = degrees celsius; SU = standard pH units (lab measured); mg/L = milligrams per liter; NTU = nephelometric turbidity units.

3 All concentrations reported are primary drinking water standards unless followed by (s) indicating secondary standards (see NAC 445.117).

Source: Newmont 1992f; NAC 445.117; NAC 445.1339.

Metals have been analyzed as both total and dissolved concentrations. For groundwater, dissolved concentrations typically are most representative of groundwater quality because suspended material in the water sample from turbulent pumping can result in higher total concentrations. Highest concentrations of metals typically are found in deeper wells located in and near the Gold Quarry Mine pit. Metals in the alluvium, Carlin Formation, and Tertiary volcanics are low or below detection limits. Arsenic is the most common metal that exceeds detection limits in groundwater. Highest concentrations of arsenic are found in the deeper mine pit production wells (up to 0.218 mg/L total and 0.182 mg/L dissolved arsenic). Selenium has been detected in some mine pit wells at concentrations of up to 0.059 mg/L.

HYDROLOGIC MONITORING PROGRAM

Newmont collects hydrologic information in the vicinity of the South Operations Area on a periodic basis as part of its ongoing monitoring program. Results of groundwater and surface water monitoring are submitted on a quarterly basis to the NDCNR and BLM. The Maggie Creek Basin Monitoring Plan (Newmont 1991a) was prepared to provide a means of evaluating potential impacts of mine activities and dewatering. Hydrologic monitoring is intended to establish baseline data and report evolving conditions for both groundwater levels and quality and surface water flow and quality. Data collected by Newmont are supplemented by USGS information collected at surface water gaging stations and groundwater monitoring wells. Spring and seep surveys were initiated by Newmont in the fall of 1990 and have been conducted on a semiannual basis.

Forty-seven groundwater wells are currently monitored by Newmont for water levels and/or water quality (Table 3-19 and Figure 3-10). Water levels are measured quarterly and water quality samples are collected on a monthly basis. Spring and seep surveys to monitor flow and quality conditions (temperature, pH, specific conductance, and dissolved oxygen) will continue in the study area. Nine selected springs are sampled and analyzed for a complete set of chemical parameters (Table 3-16).

Surface water monitoring involves 18 stations on six streams and the Humboldt River. Discharge is measured using seven continuous recorders on Jack Creek, Maggie Creek, Marys Creek, Susie Creek, and the Humboldt River. Maggie Creek and the Humboldt River each have two gaging stations in the study area. Three weirs or flumes have been installed on Simon Creek, James Creek, and upper Marys Creek (Figure 3-7). Water quality samples are collected at 14 sites on Jack Creek (1), Simon Creek (1), Maggie Creek (4), and the Humboldt River (8) (Figure 3-7). The USGS collects some of the hydrologic information outlined above as well as additional surface water and groundwater data in the project area. This information is presented annually in the USGS Water Resources Data reports for Nevada. Hydrologic monitoring by Newmont will continue for a period of time to be established by an agreement between BLM and Newmont.

TABLE 3-20
South Operations Area Monitor Wells[1,2]

Well ID	Screen Interval (Feet)	Total Depth (Feet)
PIT AREA MONITOR WELLS		
SILTSTONE		
GQTW-4	55-735	820
GQDW-8	233-954	1,040
GQP-11	700-720	770
GQP-5[3]	360-380	600
J-1	440-460	500
J-2S	430-450	735
MC-1	100-300	387
QRC-575[3]	155-195	700
QRC-578[3]	357-377	440
LIMESTONE		
EL-858A	1,079-1,099	1,100
EL-877	1,030-1,070	1,120
GQP-12	100-300	820
GQP-18D	1,580-1,600	1,600
GQP-18S	1,060-1,080	1,600
GQP-32	440-460	660
GQP-33	820-840	840
GQP-34	1,309-1,329	1,330
GQP-7	640-660	800
GQTW-5[3]	250-1,300	1,322
J-2D	700-720	735
JI-2	585-605	655
MC-2	1,041-1,201	1,208
QRC-353[3]	640-660	660
QRC-354	340-360	800
T-1	778-798	800
T-2	778-798	800
REGIONAL MONITOR WELLS		
SILTSTONE		
CS-1	280-300	320
HW-15	1,120-1,140	1,755
LJKC-1	440-500	500

TABLE 3-20
South Operations Area Monitor Wells[1,2]

Well ID	Screen Interval (Feet)	Total Depth (Feet)
MYC-3	1,013-1,033	1,035
PAL-1	278-298	305
TSN-53	525-545	820
WCH-1	570-590	600
LIMESTONE		
CBN-3D	575-580	580
CS-2	380-420	325
CV-5	2,730-2,750	2,750
CV-10	1,415-1,435	1,435
HW-1D	1,735-1,755	1,755
CARLIN FORMATION		
29-2	130-140	142
29-7	165-184	820
29-8	69-89	90
G-31[3]	100-164	170
G-66	65-145	145
MYC-1	655-675	675
PAL-1	178-958	1,000
PETRO-CHEM	75-175	820
PW-4	140-520	540
SIC-1	170-180	230
TERTIARY VOLCANICS		
MYC-2	74-84	85
USGS-3	278-298	305
USGS-4	77-97	105
USGS-5	152-172	175
ALLUVIUM		
JKC-1	308-318	320

1 See Figure 3-10 for locations of wells.

2 All wells are measured quarterly for water levels. The following wells are sampled monthly for quality analyses: GQTW-4, GQDW-8, MC-2, LJKC-1, CS-2, 29-7, 29-8, MYC-1, NMC-2, PW-4, SIC-1, MYC-2, and JKC-1.

3 Wells that have been recently removed due to active mining or not useable for monitoring purposes.

SOILS

The study area is located on landforms typical of the Basin and Range Province, with isolated, north-south trending, tilted, fault-block mountain ranges rising abruptly above large alluvium-filled desert basins. The mountain ranges, modified by recurring erosion and depositional cycles, consist of exposed sedimentary, metamorphic, and volcanic rock. Soils have formed on landforms dominated by gentle to steeply sloping mountains and uplands, fans, piedmont fans, alluvial flats and terraces, alluvial plains, and remnant land surfaces.

Soil classifications of the study area (Westech 1992) indicate high diversity in soil development as well as limitations to plant growth. The deepest and most highly developed soils occur on alluvial valley bottoms and convex upland slopes. The youngest and often shallowest soils are formed in recently deposited materials or in parent material recently exposed by erosion (University of Nevada 1981; U.S. Department of Agriculture (USDA) 1980).

Soil-limiting factors affecting vegetation include salts (high electrical conductivity and/or sodium adsorption ratio), coarse fragments, texture, depth to bedrock, cemented or clay pan depth, flooding frequency, and depth to water table. These soil parameters are highly variable, affecting both soil salvage volumes and qualities for reclamation purposes (JBR 1992c; BLM 1991a; USDA 1980).

Soil mapping units are presented in Table 3-21 under the six parent material types and general physiographic position. Soil physical and chemical characteristics, limitations to plant growth, and classification and comments for each mapping unit are contained in a separate technical report (Westech 1992). Soil salvage depths for reclamation purposes were determined from physical and chemical characteristics of soils that would be disturbed by mining activities (USDA 1980) or were reported in soil baseline reports (JBR 1992c; BLM 1991).

Soil evaluations indicated that only 3 of the 56 soil mapping units delineated within the study area are unsuitable for topsoil salvage, while an additional 10 units may contain significant acreages of unsuitable topsoils. The remaining soil mapping units exhibit suitable salvage depths ranging from 5 to 41 inches. The following list shows the distribution of soil mapping units by topsoil salvage quality (the 3 units with soils unsuitable for salvage are included in the 14 poor quality map units below). Additional information regarding soils characteristics and salvage depths can be found in the Soils Section of Chapter 4 and in a separate technical report (Westech 1992).

SOIL MAPPING UNITS	TOPSOIL SALVAGE QUALITY
14	Poor
11	Poor to Fair
7	Poor to Good
4	Fair
4	Fair to Good
16	Good
TOTAL 56	

VEGETATION

Vegetation in the vicinity of the Carlin Trend (Figure 3-1) is dominated by sagebrush steppe, with riparian vegetation bordering drainages, springs, and seeps. Big sagebrush dominates on deep, salt-free soils, along with bluebunch wheatgrass and Sandberg bluegrass. Open Utah juniper stands cap the ridgetops at elevations between 5,000 and 8,000 feet where precipitation exceeds 12 inches per year (Cronquist et al. 1972). In general, the study area reflects ongoing disturbance by grazing and fire. Areas have been cleared of sagebrush either chemically, mechanically, or by wildfire, and have been seeded to crested wheatgrass or naturally revegetated to cheatgrass. Riparian vegetation is much reduced, with only a fringe of willows or other shrubs remaining along the streambanks. Willows are infrequent along Maggie Creek and smaller drainages, and overgrazing has caused streambanks to erode in many areas.

TABLE 3-21
Soil Mapping Units[1] by Parent Material

LOESS
Thin loess over colluvium and alluvium from limestone and shale
C-J3
Loess high in volcanic ash over mixed alluvium
CF-S3 CH-S3 CH-EA3 CK-S3 CS-EA3 CS-J3 CT-EA3
Loess high in volcanic ash over volcanic residuam
B-J5 BZm-S8 BZm-EA8 PC-S8 SW-S8 SW-EA8 T-J4
Loess moderate in volcanic ash over alluvium and residuam derived from tuff
H-J6 OU-S4 OU12-EA4 OU18-EA4
Loess high in pyroclastic materials
TT-S9
LOESS AND ALLUVIUM
Loess high in volcanic ash and alluvium derived from mixed volcanic rock
CK-S3 DM-S4 DN-EA7 012-J3 024-J3 OG-J3 OR-EA4 OSB-S2 OTA-S2 OU-S4 OU12-EA4 OU18-EA4 OV-EA4 OV-S4 SR-S4 WIA-S2
ALLUVIUM
Alluvium derived from mixed rock sources
Au-S1 BE-J7 CF-S3 CR-EA3 Fm-S1 Od-S2 Od-J2 SW-S8 SW-EA8 Wd-S1 WE-S2
Mixed alluvium derived from sandstone, siltstone conglomerate, and pyroclastic material embedded with tuff
CH-S3 CH-EA3 SH20-J7 SHO-20-J7 WE-S2
RESIDUUM
Residuum derived from tuff, tuffaceous sandstone and mixed rock sources, volcanic ash and loess
OU-S4 OV-S4 OV-EA4 P12-J3 P15-J3 P16-J3 PC-S8 PK-EA8 PT-EA4 SC-EA8 SC-J8 SD-S8 SU-S8 SU-EA8 SW-S8 TA-S9
RESIDUUM AND COLLUVIUM
Residuum and colluvium derived from chert, shale, and quartzite
SD-S8 TT-S9
COLLUVIUM
BZm-S8 BZm-EA8 M-J5 MRO-J10

[1] The first letter(s) and/or number(s) is the mapping unit symbol, followed by a "J" if the unit is from the JBR (1992c) report, an "EA" if from the BLM EA report (BLM 1991), and an "S" if from the SCS soil survey (USDA 1980). The number at the end of the unit corresponds to the following general landscape positions:

1. Floodplains
2. Low stream terraces & fans
3. Low terraces & fans
4. Fans & upland terraces
5. Low foothills
6. Strongly dissected foothills
7. Dissected terraces
8. Uplands
9. Mountains
10. Canyon walls and rock outcrops

Note that some mapping units are listed under more than one parent material.

Range condition of lower elevation sites is poor to fair due to concentrated livestock use, while condition of higher elevation sites is fair to excellent (JBR 1992c). Livestock are not herded out of riparian areas onto higher elevation forage, but salt placement and upland water sources encourage dispersal to some extent. A study conducted by JBR (1992c) in the vegetation study area (Figure 3-1) during summer 1992 and information provided by the BLM (Whitlock 1993) provided the basis for the following information on range sites.

The Loamy 10 to 12 inch precipitation zone (p.z.) range site occurs on low stream terraces, dissected terraces, sideslopes, uplands, and ridgecrests (JBR 1992c). Slopes typically are 4 to 30 percent. Vegetation is dominated by an assemblage of sagebrush species, including basin big sagebrush, Wyoming big sagebrush, and mountain big sagebrush. Additional dominant species include Douglas rabbitbrush, Sandberg bluegrass, bottlebrush squirreltail, basin wildrye, and bluebunch wheatgrass. Vegetation species for the study area are included in Appendix B. Total vegetative canopy cover for this site is 44.0 percent, with shrubs contributing 22 percent, grasses 16 percent, and forbs and mosses 6 percent (Appendix B). This range site constitutes 21 percent of the vegetation study area (2,439 acres).

The Loamy 8 to 10 inch p.z. range site occurs on alluvial fans, low terraces, low foothills, sideslopes, and uplands on slopes ranging from 4 to 75 percent, but most commonly on slopes of 4 to 30 percent (JBR 1992c). Dominant plant species include Wyoming big sagebrush, Sandberg bluegrass, bottlebrush squirreltail, Thurber needlegrass, and bluebunch wheatgrass. Total vegetative canopy cover for this type is 36 percent, with shrubs contributing 18 percent, grasses 12 percent, and forbs and mosses 6 percent (Appendix B). This range site constitutes 58 percent of the study area (6,806 acres).

The Chalky Knoll range site occurs on sideslopes of hills and rock-pediment remnants on all aspects. Slopes are typically 8 to 30 percent (JBR 1992c). Species composition differs substantially from other vegetation types, with antelope bitterbrush, Saskatoon serviceberry, Wyoming big sagebrush, Douglas rabbitbrush, and spineless horsebrush dominating. The most common grass species are basin wildrye and Sandberg bluegrass. Grass species found in this range site but not recorded frequently in the study area include thickspike wheatgrass, Indian ricegrass, and needle-and-thread. Total vegetative canopy cover is 26 percent, with shrubs contributing 16 percent, grasses 6 percent and forbs and mosses 4 percent (Appendix B). This range site constitutes 4 percent of the study area (525 acres).

The Dry Floodplain range site is located on outer margins of axial-stream floodplains, fans, skirts, and along intermittent drainageways. Slopes range from 2 to 4 percent, but are typically less than 2 percent. Vegetation is dominated by basin big sagebrush, Douglas rabbitbrush, Sandberg bluegrass, and western wheatgrass. Total vegetative canopy cover is 37 percent, with grasses contributing 29 percent, shrubs 6 percent, and forbs and mosses 2 percent (Appendix B). This range site constitutes 1 percent of the study area (95 acres).

The South Slope 8 to 12 inch p.z. range site occurs on south-facing sideslopes of hills, erosional fan remnants, and rock pediment remnants. Slopes range from 30 to 50 percent. Vegetation is dominated by bluebunch wheatgrass, cheatgrass, Sandberg bluegrass, Douglas rabbitbrush, and bottlebrush squirreltail. Total vegetative canopy cover is 24 percent, with shrubs at 13 percent, grasses 10 percent, and forbs and moss 1 percent (Appendix B). This range site constitutes 3 percent of the study area (398 acres).

The Churning Clay 8 to 12 inch p.z. range site occurs on lower slopes of uplands, with slopes of 4 to 15 percent. Dominant plant species are big sagebrush, bluebunch wheatgrass, rubber rabbitbrush, bottlebrush squirreltail, Sandberg bluegrass, arrowleaf balsamroot, and lupine. Vegetative composition is 71 percent grasses, 15 percent shrubs, and 10 percent forbs (USDA 1980). This range site constitutes 3 percent of the study area (299 acres).

The Shallow Loam 8 to 12 inch p.z. range site occurs on hilly uplands, with slopes of 15 to 50 percent. Dominant plant species include cheatgrass, Wyoming big sagebrush, rubber rabbitbrush, lupine, Sandberg bluegrass, and basin wildrye. Vegetative composition by air dry weight is 83 percent grass, 2 percent forbs, and 15 percent shrubs. Site information for the location within the study area indicates the site was burned (Whitlock 1993). This range site constitutes 1 percent of the study area (66 acres).

The Claypan 10 to 12 inch p.z. range site occurs on high alluvial terraces with slopes of 2 to 8 percent. Dominant plant species include low sagebrush, Sandberg bluegrass, bottlebrush squirreltail, goldenweed, and cheatgrass, with traces of Douglas rabbitbrush, spiny hopsage, and rubber rabbitbrush. Vegetative composition by air dry weight is 68 percent shrubs, 30 percent grass, and 2 percent forbs (Whitlock 1993). This range site constitutes 4 percent of the study area (480 acres).

Riparian vegetation makes up the remaining 5 percent of the study area (528 acres). Riparian vegetation is described in Chapter 3, Riparian Areas and Wetlands.

Plants in the study area designated as "noxious weeds" by the State of Nevada include: Scotch thistle, whitetop, Canada thistle, leafy spurge, Douglas waterhemlock, diffuse knapweed, and Russian knapweed (Davison 1992). Plants designated as "injurious weeds" are: buffalobur, halogeton, povertyweed, tamarisk, and small burdock.

Scotch thistle is the most troublesome weed in the study area. Growing 6 feet tall and spiny, it can make an area ungrazable, as livestock will not move through dense infestations. This weed is a prolific seed producer with seed remaining viable for 7 years. The Maggie Creek drainage immediately below Newmont's main facilities is infested with Scotch thistle, as are many sites throughout the study area (Davison 1992).

Distribution of weeds on BLM land is not well documented. The Nevada Department of Agriculture is compiling existing BLM, U.S. Forest Service, and state data on maps to delineate the extent of weed populations in the area (Davison 1992; Whitlock 1992).

RIPARIAN AREAS AND WETLANDS

Riparian areas and wetlands are associated with perennial and intermittent streams (JBR 1993), the Humboldt River (JBR 1992a; Rawlings and Neel 1989), and springs and seeps (JBR 1992b). Riparian areas associated with the Humboldt River and tributaries within the study area are shown in Figure 3-11. Wetlands associated with springs and seeps were inventoried using the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987).

Riparian areas are managed as an important resource on public lands (Almand and Krohn 1978; BLM 1991c) and are defined as:

> A form of wetland transition between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence (Leonard et al. 1992)

Waters of the United States (including wetlands) are regulated for dredge and fill activities under the Federal Clean Water Act (33 U.S.C. 1251 et seq.). Waters of the United States are defined as:

> All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide, all interstate waters including interstate wetlands, all other waters, such as interstate 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 which would or could affect interstate or foreign commerce; all impoundments of waters otherwise defined as waters of the United States...tributaries of waters [defined above]; the territorial sea; and wetlands adjacent to waters [defined above].... (40 Code of Federal Regulations 230.3 and 33 Code of Federal Regulations 328.3).

Wetlands are a subset of waters of the United States supporting vegetation and meeting other criteria and are defined as:

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas (40 Code of Federal Regulations 230.3 and 33 Code of Federal Regulations 328.3).

RIPARIAN AREAS

Major tributaries to the Humboldt River frequently support a riparian zone ranging in width from a few feet immediately adjacent to the stream channel to relatively wide zones on broad floodplains. Where hydrophytic vegetation, hydric soils, and wetland hydrology are present, these drainages support a riparian wetland. Riparian zones are valuable in providing sediment retention, floodflow alteration, nutrient removal and transformation, increased production (relative to uplands) for livestock and wildlife forage, habitat diversity for aquatic and terrestrial wildlife, and streambank stability.

Thirteen riparian vegetation types are present along tributaries to the Humboldt River within the study area (JBR 1993). Table 3-22 lists riparian vegetation types, sites where each vegetation type commonly occurs, and plant species found in each vegetation type. Table 3-23 lists acreage by riparian vegetation type for tributary drainages within this study area.

Approximately 2,136 acres of riparian areas are present within the study area, of which 1,356 acres (64 percent of total riparian area) qualify as riparian wetland or nonwetland waters of the United States (Table 3-23). Nonwetland waters of the United States include streambeds, low stream terraces, and gravel bars that do not meet wetland criteria (as defined in Environmental Laboratory 1987) but are subject to regulation of Section 404 of the Clean Water Act.

The most extensive riparian zones are associated with Maggie Creek (1,336 acres), lower Susie Creek (263 acres) Jack and Little Jack creeks (214 acres), and Coyote and Spring creeks (133 acres). All other streams have less than 40 acres each of associated riparian vegetation (Table 3-23). The most common riparian types associated with tributary drainages include upland meadow, streamside sedge meadow, grassy wet meadow, grassy meadow, B1 bench and B2 bench (Table 3-23).

Riparian zones on the Humboldt River floodplain were inventoried to describe vegetation types and establish transects that could be used to monitor changes related to mine water discharge to the river (JBR 1992a). Fifteen riparian types were identified on the floodplain within the study area. Table 3-24 lists plant species composition and site conditions for Humboldt River riparian types within the South Operations study area.

Riparian vegetation along the Humboldt River can be divided into two major categories: (1) riparian upland and (2) riparian lowland. Riparian upland types generally occupy the highest floodplain terraces or benches and are sufficiently above groundwater or away from the river channel so that they are more similar to upland vegetation than riparian vegetation. Riparian upland types include upland shrub, upland grass, and greasewood/rabbitbrush. These relatively dry types dominate the floodplain vegetation of the Humboldt River (Rawlings and Neel 1989).

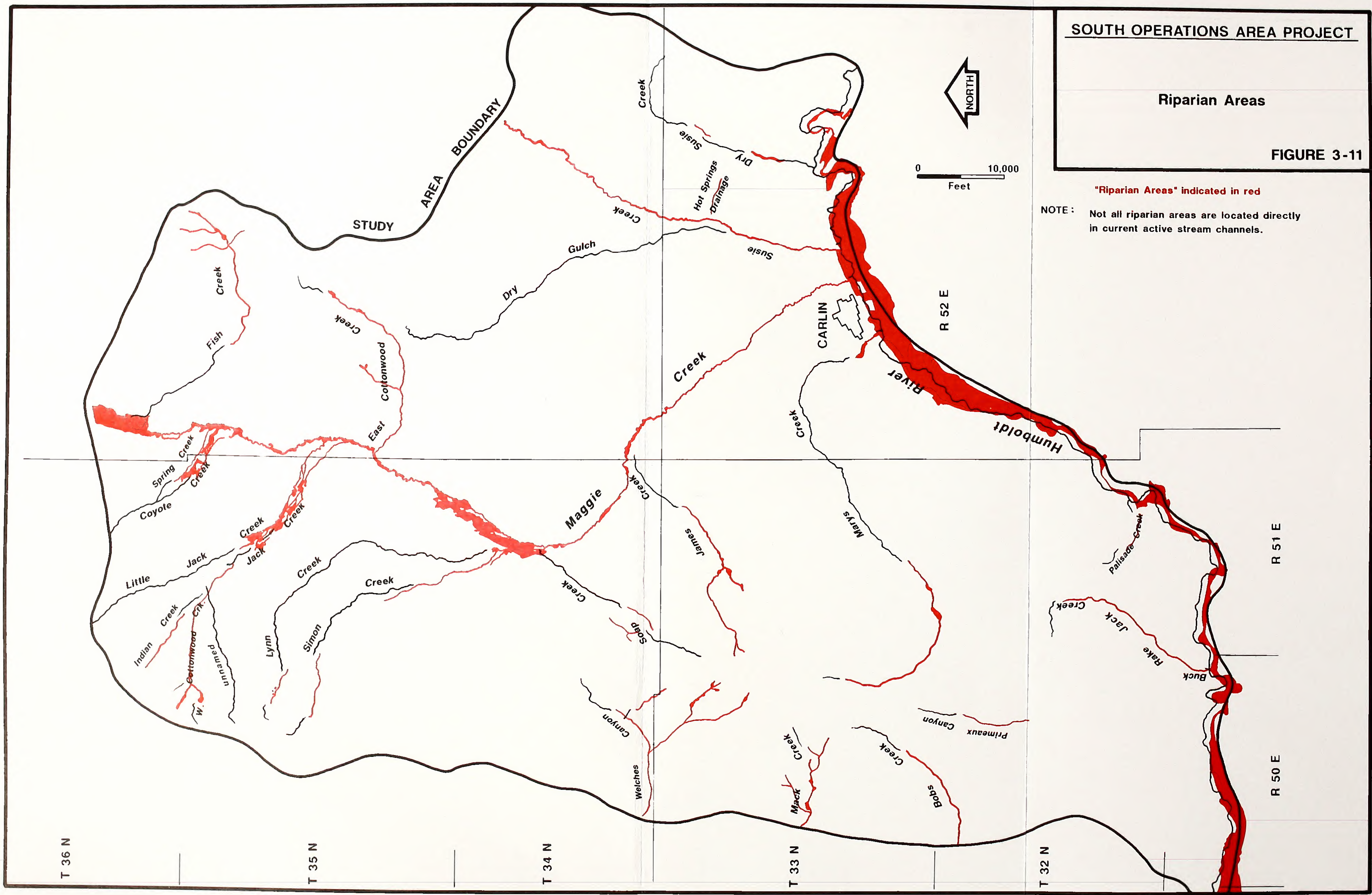

SOUTH OPERATIONS AREA PROJECT
Riparian Areas
FIGURE 3-11
0 10,000
Feet
"Riparian Areas" indicated in red
NOTE: Not all riparian areas are located directly in current active stream channels.
NORTH
STUDY AREA BOUNDARY
CARLIN
Humboldt River
Maggie Creek
Susie Creek
Dry Susie
Hot Springs Drainage
Dry Gulch
Fish Creek
Cottonwood Creek
East Cottonwood
Spring Creek
Coyote Creek
Jack Creek
Little Jack Creek
Indian Creek
W. Cottonwood Crk.
unnamed
Lynn
Simon Creek
Soap Creek
James
Marys Creek
Canyon
Welches
Mack Creek
Bobs Creek
Primeaux Canyon
Palisade Creek
Jack Creek
Rake
Buck
R 52 E
R 51 E
R 50 E
T 36 N
T 35 N
T 34 N
T 33 N
T 32 N

TABLE 3-22
Riparian Vegetation Types and Dominant Species Along Tributaries to the Humboldt River Near the South Operations Area

Vegetation Type	Site	Dominant Species
Streamside	In or immediately adjacent to streams at or below ordinary high water mark (OHWM)	Fewflowered spikerush (*Eleocharis pauciflora*), American bulrush (*Scirpus americanus*), annual muhly (Muhlenbergia minutissima), *American* speedwell (*Veronica americana*), Kentucky bluegrass (*Poa pratensis*), Baltic rush (*Juncus balticus*)
B1 Bench	Above streamside type on stream deposits below OHWM	Annual muhly (Muhlenbergia minutissima), rabbitfootgrass (*Polypogon monspeliensis*), American bulrush (*Scirpus americanus*), coyote willow (*Salix exigua*), silverweed cinquefoil (*Potentilla anserina*), exalted centaury (*Centaurium exaltatum*), Canada horseweed (*Conyza canadensis*)
B2 Bench	Secondary terrace above B1 Bench type and OHWM	Cheatgrass (*Bromus tectorum*), big sagebrush (*Artemisia tridentata*), rubber rabbitbrush (*Chrysothamnus neuscosus*), pinnate tansymustard (*Descurainia pinnata*), creeping wildrye (*Elymus triticoides*)
Gravel Bar	Within channel or adjacent to stream below OHWM	Povertyweed (*Iva axillaris*), rabbitfootgrass (*Polypogon monspeliensis*), Canada cocklebur (*Xanthium strumarium*), inland saltgrass (*Distichlis spicata*), fivehook bassia (*Bassia hyssopifolia*), whitetop (*Cardaria draba*)
Yellow Willow Thicket	Banks adjacent to streams or in areas of high water table	Yellow willow (*Salix lutea*), Kentucky bluegrass (*Poa pratensis*), Douglas sedge (*Carex douglasii*), western mountain aster (*Aster occidentalis*), coyote willow (*Salix exigua*), catchweed bedstraw (*Galium aparine*), Canada thistle (*Cirsium arvense*)
Coyote Willow Thicket	Banks adjacent to streams or in areas of high water table	Coyote willow (*Salix exigua*), Kentucky bluegrass (*Poa pratensis*), western mountain aster (*Aster occidentalis*), yellow willow (*Salix lutea*), fewflowered spikerush (*Eleocharis pauciflora*), creeping wildrye (*Elymus triticoides*), common yarrow (*Achillea millefolium*), annual muhly (Muhlenbergia minutissima), fowl bluegrass (*Poa palustris*)
Cattail/Pond	Within perennial streams or with artesian seeps and springs in broad wet meadows	Cattail (***Typha latifolia***), hardstem bulrush (*Scirpus acutus*), American bulrush (*Scirpus americanus*), algae
Sedge Meadow	Broad floodplains adjacent to perennial streams or below seeps and springs	Nebraska sedge (*Carex nebraskensis*), Baltic rush (*Juncus balticus*), woolly sedge (*Carex lanuginosa*), fowl bluegrass (*Poa palustris*), western mountain aster (*Aster occidentalis*), annual muhly (Muhlenbergia minutissima)
Baltic Rush Meadow	Broad floodplains of perennial streams	Baltic rush (*Juncus balticus*), fowl bluegrass (*Poa palustris*), slim sedge (*Carex praegracilis*), redtop bentgrass (*Agrostis stolonifera*), common yarrow (*Achillea millefolium*)
Grassy Wet Meadow/Grassy Meadow	Broad floodplains of perennial streams	Slim sedge (*Carex praegracilis*), fowl bluegrass (*Poa palustris*), Kentucky bluegrass (*Poa pratensis*), Baltic rush (*Juncus balticus*), silverweed cinquefoil (*Potentilla anserina*), potentilla (*Potentilla gracilis*), western mountain aster (*Aster occidentalis*)
Upland Meadow	Above grassy wet meadow on drier sites with upland soils	Basin wildrye (*Elymus cinereus*), inland saltgrass (*Distichlis spicata*), cheatgrass (*Bromus tectorum*), rubber rabbitbrush (*Chrysothamnus nauseosus*), big sagebrush (*Artemisia tridentata*), black greasewood (*Sarcobatus vermiculatus*)
Remnant Riparian	Terraces adjacent to streams where downcutting (entrenchment) has lowered stream elevation	Cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), bottlebrush squirreltail (*Sitanion hystrix*), nettle (*Urtica dioica*), western mountain aster (*Aster occidentalis*), big sagebrush (*Artemisia tridentata*), coyote willow (*Salix exigua*),Bailey buckwheat (*Eriogonum baileyi*), Woods rose (*Rosa woodsii*), rubber rabbitbrush (*Chrysothamnus nauseosus*)
Aspen	Terraces of intermittent streams - stream usually entrenched	Quaking aspen (*Populus tremula tremulaides*), cheatgrass (*Bromus tectorum*), Kentucky bluegrass (*Poa pratensis*), dandelion (*Taraxacum officinale*), golden currant (*Ribes aureum*), big sagebrush (*Artemisia tridentata*)

Source: Adapted from JBR 1993.

TABLE 3-23
Acres of Riparian Vegetation by Vegetation Type Associated With Tributaries to the Humboldt River[1]

STREAM	RIPARIAN VEGETATION TYPE[2]													Riparian Wetland and Nonwetland Waters of the U.S.[3]	Non-wetland Riparian	Total Riparian
	Stream-side	B1 Bench	B2 Bench	Gravel Bar	Yellow Willow Thicket	Coyote Willow Thicket	Cattail/Pond	Sedge Meadow	Baltic Rush Meadow	Grassy Wet Meadow/ Grassy Meadow	Upland Meadow	Remnant Riparian	Aspen			
Maggie Creek	173.8	124.9	142.8	1.7	74.3	89.0	1.7	212.8	20.8	228.9	264.9	-	-	822.4	513.2	1,335.6
James Creek	6.1	1.1	-	-	1.9	-	-	-	-	-	-	0.7	18.2	9.1	18.9	28.0
Soap Creek	2.8	-	<0.1	-	-	-	0.4	-	-	-	-	1.2	-	3.2	1.2	4.4
Marys Creek	12.0	1.5	3.9	-	0.6	2.4	0.1	-	-	-	-	2.5	4.5	16.6	10.9	27.5
Lower Susie Creek	71.0	121.0	68.9	2.0	-	-	-	-	-	-	-	-	-	194.0	68.9	262.9
Mack Creek	7.1	-	-	-	1.2	-	-	-	-	-	-	5.3	-	8.3	5.3	13.6
Primeaux Canyon	0.6	0.1	-	-	-	-	-	-	-	-	-	0.1	-	0.7	0.1	0.8
Palisade Creek	0.3	-	-	-	-	-	-	-	-	-	-	0.3	-	0.3	0.3	0.6
Welches Canyon	7.3	-	-	-	1.3	-	-	-	-	-	-	4.1	6.6	8.6	10.7	19.3
Lynn/Simon Creeks	2.0	-	-	-	-	-	-	4.1	22.6	2.4	6.0	2.0	0.1	31.1	8.1	39.2
West Cottonwood Creek	3.7	3.3	2.3	0.4	-	-	-	-	-	-	-	1.4	11.4	7.4	15.1	22.5
East Cottonwood Creek	0.7	-	-	-	-	0.6	0.1	1.3	-	3.7	-	0.1	0.1	6.4	0.2	6.6
Fish Creek	2.9	5.4	-	-	0.8	-	-	-	-	-	-	-	0.8	9.1	0.8	9.9
Indian Creek	1.1	0.4	-	0.3	-	-	-	-	-	-	-	0.4	-	1.8	0.4	2.2
Jack/Little Jack Creeks	27.1	0.5	-	-	14.5	8.0	-	35.4	46.3	-	82.2	-	-	130.0	84.0	214.0
Coyote/Spring Creeks	9.8	-	-	-	9.2	4.7	-	28.3	-	39.7	41.1	-	-	91.7	41.1	132.8
Hot Springs drainage	3.3	1.5	-	-	-	-	-	-	-	-	-	-	-	4.8	0	4.8
Bobs Creek	1.8	-	-	-	-	-	-	-	-	-	-	-	-	1.8	-	1.8
Buck Rake Jack Creek	4.5	-	-	-	-	-	-	-	-	-	-	-	-	4.5	-	4.5
Dry Susie Creek	0.3	-	-	-	-	-	-	-	4.4	-	-	-	-	4.7	-	4.7
TOTAL	**338.2**	**259.7**	**217.9**	**4.4**	**103.8**	**104.7**	**2.3**	**281.9**	**94.2**	**274.7**	**394.2**	**18.1**	**41.7**	**1,356.4**	**779.3**	**2,135.7**

[1] See Figure 3-11 for location of riparian areas.
[2] See Table 3-22 for vegetation type descriptions.
[3] Nonwetland Waters of the U.S. include streambeds and low benches along streams which fail to meet either of three wetland criteria (wetland hydrology, hydric soils, or hydrophytic vegetation), but are subject to Section 404 of the Clean Water Act since they meet criteria for Waters of the United States.
Source: Adapted from JBR 1993.

TABLE 3-24
Riparian Vegetation Types Along the Humboldt River Within the South Operations Study Area

VEGETATION TYPE	SITE	DOMINANT SPECIES
Bulrush	In low-lying oxbows, meanders, and sloughs with high groundwater late into the growing season	Bulrushes (*Scirpus* species), hardstem bulrush *(Scirpus acutus)*, rushes (*Juncus* species), sedges (*Carex* species), Nebraska Sedge (*Carex nebraskensis)*
Cattail	In low-lying oxbows, meanders, and sloughs with standing water or high groundwater throughout the growing season	Common cattail (*Typha latifolia*), bulrushes (*Scirpus* species), hardstem bulrush (*Scirpus acutus)* rushes (*Juncus* species)
Young Willow	Recently exposed stream-laid deposits, moist to wet soils lining channel banks, newer oxbows and meanders	Coyote willow (*Salix exigua*), cheatgrass (*Bromus tectorum*), ragweed (*Ambrosia* species), rabbitfootgrass (*Polypogon monspeliensis*)
Mature Willow	Older stream-laid deposits, moist to wet soils lining channels, older oxbows and meanders, and irrigation ditches	Coyote willow (*Salix exigua*), Woods rose (*Rosa woodsii*), reed canarygrass (*Phalaris arundinacea*), common reed (*Phragmites australis)* white sweetclover (*Melilotus alba*)
Rose	Moist depressions and banks	Woods rose (*Rosa woodsii*), golden currant (*Ribes aureum*), Kentucky bluegrass (*Poa pratensis*)
Poplar (cottonwood)	Moist, subirrigated low areas and planted around ranches	Narrowleaf cottonwood (*Populus angustifolia*), black cottonwood (*Populus balsamifera trichocarpa*) Poplar (*Populus* species)
Wet Meadow	Floodplain terraces or benches with seasonally saturated soils	Bluegrass (*Poa* species), Nebraska sedge (*Carex nebraskensis*), Baltic rush (*Juncus balticus*), golden sedge (*Carex aurea*), timothy (*Phleum species*)
Grass	Drier floodplain terraces or benches	Bluegrass (*Poa* species), bottlebrush squirreltail (*Sitanion hystrix*), Basin wildrye (*Elymus cinereus*), alkali sacaton (*Sporobolus airoides*)
Saltgrass	Older, relatively dry meanders and upland terraces	Inland saltgrass (*Distichlis spicata*), black greasewood (*Sarcobatus vermiculatus*), reed canarygrass (*Phalaris arundinacea*), seepweed (*Suaeda* species)
Greasewood/ Rabbitbrush	Dry upland terraces, generally highest floodplain elevations	Black greasewood (*Sarcobatus vermiculatus*), rubber rabbitbrush (*Chrysothamnus nauseosus*), cheatgrass (*Bromus tectorum*), pepperweed (*Lepidium* species)
Upland Shrub	Upland terraces and alluvial or colluvial fans	Rubber rabbitbrush (*Chrysothamnus nauseosus*), black greasewood (*Sarcobatus vermiculatus*), big sagebrush (*Artemisia tridentata*), cheatgrass (*Bromus tectorum*), inland saltgrass (*Distichlis spicata*), white sweetclover (*Melilotus alba*)
Annual Weed	Recently exposed stream-laid deposits or overgrazed terraces	Cheatgrass (*Bromus tectorum*), rabbitfootgrass (*Polypogon monspeliensis*), dock (*Rumex species*), white sweetclover (*Melilotus alba*), pepperweed (*Lepidium* species), Canada cocklebur (*Xanthium strumarium*)
River Channel	Active channel	Flowing-water, stream-deposit vegetation at lower flows (annual weed or young willow)
Stream Deposits	Seasonally exposed stream-laid deposits within or adjacent to active channel	Generally unvegetated or sparsely vegetated, see annual weed and young willow descriptions
Open Water	Ponds formed in deeper oxbows, meanders, borrow pits, or other depressions	Cattail (*Typha latifolia*), bulrushes (*Scirpus* species), rushes (*Juncus* species), and sedges (*Carex* species) on pond margin, submerged or floating aquatics in open water

Source: Adapted from JBR 1992a; Rawlings and Neel 1989; Manning and Padgett 1992; Bradley 1993.

Riparian lowland includes types adjacent to the river (on islands, point bars or terraces), oxbows, and cut-off meanders where river action or groundwater has a direct influence on vegetation. Riparian lowland types would be most likely to be affected by proposed operations and acreages by type are listed in Table 3-25. The most abundant of these types from Maggie Creek to 26.5 river miles downstream is the stream deposit type, which occupies 352.5 acres (47 percent of lowland riparian vegetation). The stream deposit type includes unvegetated or sparsely vegetated gravels, sands or silts, or recently formed types dominated by weedy annuals or young willow.

Dominant types on older stream deposits, terraces or cut-off meanders include mature willow, bulrush/cattail, and saltgrass. These older lowland riparian types are generally found where groundwater is close to the surface, although in some cases their occurrence may be related to seasonal storage of surface water. The cattail and bulrush types occupy the wettest sites, where standing water or saturated soils prevail through most of the growing season. Willow and wet meadow types frequently have saturated soils or high water tables during the early to middle part of the growing season. Some mature willow stands, however, may be found where groundwater is 5 feet or more below the surface. These stands may have become established when groundwater was shallower, but now have sufficient root systems to survive where depth to groundwater has increased. The saltgrass type occurs in drier cut-off meanders with groundwater at depths of 4 to 5 feet (JBR 1992a).

TABLE 3-25
Acres of Lowland Riparian Vegetation by Vegetation Type Along the Humboldt River from the Mouth of Maggie Creek to 26.5 Miles Downstream[1]

Riparian Vegetation Type[2]	Area (Acres)	Percent of Total
Young Willow	21.1	9
Mature Willow	220.4	29
Bulrush/Cattail	77.1	10
Saltgrass	64.3	9
Poplar	0.3	< 1
Stream Deposits[3]	352.5	47
Rose	11.1	1
Open Water[4]	5.1	< 1
TOTAL	**751.9 Acres**	**100%**

1 Adapted from JBR (1992a) based on 1992 aerial photographs; does not include developed fields or upper floodplain types (greasewood/rabbitbrush, grass or upland shrubs).
2 See Table 3-24 for vegetation type descriptions.
3 Includes unvegetated and sparsely vegetated alluvial materials, and islands and point bars dominated by annual weeds or willow.
4 Small areas of open water are also included in bulrush/cattail type.

SPRING/SEEP WETLANDS

Approximately 200 individual or groups of springs and seeps have been inventoried within the study area (JBR 1992b). Some smaller springs and seeps less than 200 square feet (0.005 acre) were not inventoried unless they were part of a larger spring complex. Most springs and seeps have associated wetlands ranging in size from a few square feet to almost 100 acres. Some spring and seep sites do not have associated wetlands, as one or more wetland criterion (hydrophytic vegetation, hydric soils, or wetland hydrology) is absent. The total wetland area associated with inventoried springs and seeps is approximately 193 acres, of which the majority is associated with a few large sites (Table 3-26). Most springs and seeps (91 percent) have less than 1 acre of associated wetland; these small areas total 22.7 acres and account for 12 percent of wetlands occurring at springs and seeps. Seventeen of the largest sites total 170.2 acres and account for 88 percent of the total wetland acreage associated with springs and seeps. Springs and seeps are shown in Figure 3-8.

Vegetation associated with springs and seeps is usually dominated by herbaceous species (grasses, sedges, rushes, and forbs), including Nebraska sedge (*Carex nebraskensis*), fowl bluegrass (*Poa palustris*), alkali buttercup (*Ranunculus cymbalaria*), Baltic rush (*Juncus balticus*), watercress (*Nasturtium officinale*), redtop bentgrass (*Agrostis stolonifera*), fewflowered spikerush (*Eleocharis pauciflora*), and golden sedge (*Carex aurea*). Species composition and dominance varies substantially, reflecting site conditions (primarily moisture regime, slope, aspect, soils, and water temperature - e.g., cold or warm springs) and land use (primarily grazing intensity). At a few springs and seeps, woody plants are conspicuous and include Booth willow (*Salix boothii*), Woods rose (*Rosa woodsii*), coyote willow (*Salix exigua*), and quaking aspen (*Populus tremuloides*).

TABLE 3-26
Size Class and Wetland Acreage of Inventoried Springs and Seeps in the South Operations Study Area

Spring/Seep Size Class	Number of Sites	Percent of Sites	Wetland Acreage	Percent of Total Acreage
<0.01 acre	[illegible]	12	<0.1	0
≥0.01<0.10 acre	80	42	3.4	2
≥0.10<1.00 acre	70	37	19.2	10
≥1.00 acre	17	9	170.2	88
TOTAL	**190 Sites**	**100 %**	**192.9 Acres**	**100 %**

Source: Adapted From JBR 1992b.

Although springs and seeps and associated wetlands cover a small area relative to upland vegetation, they have the following important functions and values:

- Livestock and wildlife watering sources: Many springs and seeps have been developed to provide water for domestic livestock. Developments include tanks, troughs, and ponds. These watering sources also benefit wildlife.

- Increased vegetation productivity: Because wetlands associated with springs and seeps are often substantially more productive than adjacent uplands, remain greener longer into the growing season, and lack sagebrush cover, they provide valuable forage for domestic livestock and wildlife.

- Ecological diversity: Spring and seep wetlands create habitat diversity for wet-site plants, insects, birds, amphibians, reptiles, and wildlife. These sites may serve as refuges for some plant and animal species.

- Groundwater discharge: Springs and seeps are locations of natural groundwater discharge at ground surface. They can provide an important contribution to surface flow in streams and rivers, especially during low-flow periods.

These important ecological values of spring and seep wetlands have been substantially degraded by livestock grazing, which is moderate to very heavy except at sites that have been fenced (JBR 1992b).

Total riparian and wetlands acreage within the study area, exclusive of upland riparian vegetation along the Humboldt River, is about 3,080 acres. Non-wetland riparian vegetation associated with springs and seeps was inventoried in conjunction with the riparian inventory (JBR 1993) and discussed previously under Riparian Areas. The total of 3,080 acres of riparian areas and wetlands may slightly overestimate acreage since some spring/seep wetlands occur in drainage bottoms and may be included in both the spring/seep acreage and the riparian inventory acreage.

TERRESTRIAL WILDLIFE

This description of terrestrial wildlife resources in the South Operations study area was developed through discussions with natural resource agency personnel, site visits, review of regional environmental analysis documents, general literature sources, and JBR's 1991-92 wildlife baseline study (JBR 1992d).

MULE DEER

The South Operations Area is located within the Nevada Department of Wildlife's (NDOW) Management Area Six. Mule deer is the most abundant big game species in this management area, with an estimated 19,900 mule deer present during the fall of 1992 (Hess 1992). This total represents approximately 11 percent of Nevada's statewide mule deer population.

The South Operations Area is located in mule deer transitional range that is used during migration from higher elevation summer ranges in the north to lower elevation winter ranges at the southern end of the Tuscarora Mountains (Figure 3-12). In addition, a few mule deer are present year-round in the study area.

Timing and duration of the fall migration are primarily a function of climatic conditions. Snow accumulation in summer range initiates southward migration. In mild winters, or during winters with late accumulations of snow, mule deer linger in transitional range to take advantage of the cover and browse afforded by shrub communities and riparian zones. Under these conditions, mule deer may not reach the winter range until late December. They arrive at the winter range in good physical condition due to the high quality of browse in the transitional range. Their late arrival reduces use of browse on the winter range.

When snow accumulates early in the season, mule deer move through the transitional range more rapidly. They spend more time on the winter ranges, which have been degraded by fire in recent years.

Prior to 1987, mule deer reportedly moved southward along both flanks of the Tuscarora Mountains to their winter ranges. Since 1987, most deer on the west side of the mountains shift to the east flank at Simon Creek and continue south to Welches Canyon; some move west to the Sheep Creek or Izzenhood winter ranges before reaching Simon Creek (Gray 1992). The shift in migration route may have been influenced by the loss of shrubs for cover and browse on the west side of the Tuscarora Mountains due to a series of fires that degraded habitat along the route (Back 1992). Development of mines along the Carlin Trend also may have been a factor (Evans 1992).

At Welches Canyon (northwest of the South Operations Area), some deer cross back to the west side of the mountains and continue south to the Dunphy Hills winter range. Deer on the east side of the mountains move south to Marys Mountain and the Emigrant Pass-Palisade Canyon area. These migration routes and winter ranges are shown in Figure 3-12. A substantial number of deer cross Interstate 80 near the Palisade exit. There are no "deer passes" under the highway, but NDOW and a local sportsman's group (Northeastern Nevada Mule Deer Federation) contributed money and labor to modify 2 miles of woven-wire fence along Interstate 80 to facilitate deer movement and reduce fatalities (Hess 1992; Gray 1992).

Mule deer also move south from the Independence Mountains summer range. While the majority go southeast to the Adobe winter range, some may move southwest at Cottonwood Creek through the hills along Maggie Creek to the Schroeder Mountain and Marys Mountain areas. The extent of use of this transitional range has not been evaluated. This transitional range crosses part of the South Operations Area (Figure 3-12).

The Dunphy Hills winter range now supports 2,000 to 3,000 mule deer (up to 4,000 in some years). Much of the area has burned, and mule deer are critically crowded into smaller areas of marginal habitat. BLM and NDOW, in cooperation with Newmont and other mining companies are working to rehabilitate crucial deer winter range in the Dunphy Hills and the Izzenhood Range (Hess 1992; Gray 1992).

Spring migration is also affected by climatic conditions. In spring, the dominant diet of mule deer changes from browse to grasses and forbs. Deer eat early season grasses, such as cheatgrass and Sandberg bluegrass, and forbs that appear first on south and west-facing slopes. Burned areas with little forage value during the fall migration can provide valuable spring forage. Consequently, mule deer are not restricted to fall migration routes, and the return through the transitional range in the spring is much more diffuse.

Many factors contribute to mule deer mortality. In addition to legal harvest of mule deer during the hunting season, other sources of mortality include predation by mountain lions, poaching, accidents with vehicles, and disease. Deer may also become entangled in fences that are too high, have improper wire spacing, or are placed on steep slopes that increase the difficulty of jumping the fence. The NDOW considers losses to these factors relatively minor compared to potential losses on degraded winter ranges during a severe winter (Gray 1992).

PRONGHORN

A herd of 250 to 300 pronghorn winter in a 25-square-mile area between Susie Creek and Maggie Creek north of Carlin (Figure 3-12). In the 1992-93 winter, however, snow accumulations forced pronghorn into the Humboldt River flood-plain and adjacent south-facing slopes, in a band about 2 miles wide and 10 to 12 miles long (Figure 3-12). Fences, Interstate 80, and the river created barriers that may have inhibited movement further south.

These antelope migrate north on the east side of Maggie Creek to summer on a 1,200-square-mile area west of the Independence Mountains (Gray 1992). Antelope have been observed during summer on winter range (Wold 1992). The population has been expanding in response to low mortality during recent mild winters, but is potentially susceptible to massive losses during a hard winter because of limited, poor-condition winter range (Hess 1992).

Pronghorn are typically associated with open rangelands (shrub cover is usually less than 30 percent) with low shrubs (often less than 24 inches tall to allow unrestricted visibility) and a good forb component (Yoakum 1980). Their primary diet is shrubs, including big sagebrush and bitterbrush. Forbs account for less than 10 percent of the diet in winter, but 20 to 30 percent during other seasons. Grasses are primarily used (about 11 percent) in the fall (Yoakum 1980). Mosaics of shrublands and grasslands or open stands of low-growing sagebrush are preferred habitats. Areas devoid of shrubs due to frequent fires, or large stands of tall-growing sagebrush that restrict visibility, provide little value to pronghorn.

BIGHORN SHEEP

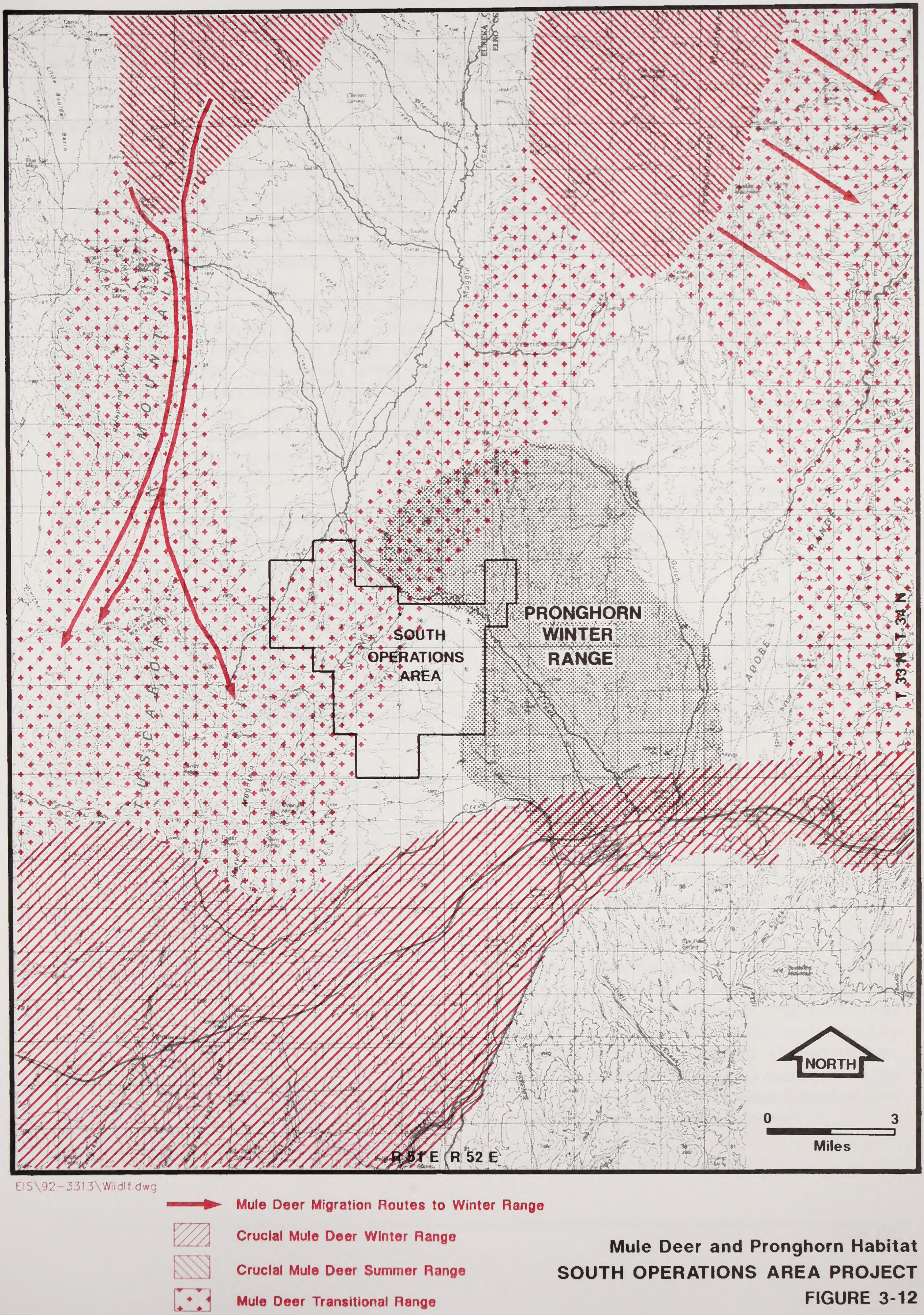
Two herds of reintroduced bighorn sheep are found in northwestern Elko County. Neither herd is near the South Operations Area.

OTHER MAMMALS

The BLM's list of mammals recorded in the Elko District totals 76 species, including 5 shrews, 12 bats, 5 rabbits and hares, 33 rodents, 15 carni-vores and 6 ungulates. Of these, 2 to 3 shrews, 9 to 10 bats, 4 rabbits and hares, 22 to 27 rodents, 11 to 13 carnivores and 2 ungulates (about 50 to 60 total species) could be expected in the study area.

Of the 50 to 60 species that could occur in the study area, a few, such as the house mouse, are generally restricted to human-related habitats such as houses or barns. Four species (river otter, mink, beaver, and muskrat) are essentially aquatic, although they may occasionally be observed away from water. Eight to nine species, including the vagrant shrew, montane vole, Nuttall's cottontail, and raccoon, are usually found in riparian or wetland habitats.

Most mammals (35 to 45 species) are considered to be upland species, even though they may be also occur in forest, riparian, or wetland habitats. For example, the Merriam's shrew, pygmy rabbit, several ground squirrels, and the sagebrush vole may be entirely restricted to sagebrush or grassland habitats, while the coyote, porcupine, mountain lion, and mule deer may be found in a wide variety of habitats. Some bats may roost in buildings, trees, mine adits, caves, or cracks and crevices in rocks in upland habitats even though they forage for insects in habitats near water. Four bats (long-eared myotis, little brown bat, Townsend's big-eared bat, and big brown bat) were documented in the study area in 1992, and pallid bats may also occur.



Mule Deer and Pronghorn Habitat
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-12

UPLAND GAME BIRDS

Three species of upland game birds (sage grouse, chukar, and Hungarian partridge) are year-long residents in the vicinity of the Proposed Action. The sage grouse is a native species normally associated with sagebrush habitats in rolling hills and benches along drainages. In spring they congregate at breeding sites called leks, where the males conduct displays to attract females. Six leks have been identified and named in the study area: Upper Fish Creek Bench, Lower Fish Creek Bench, Richmond Mountains, South Marys Mountain, South Jack Creek, and Palisade Complex. The largest of these (Palisade Complex) had 35 to 40 sage grouse in attendance in spring 1992 (JBR 1992d).

Mesic habitats associated with springs, seeps, or water developments are especially important to sage grouse in summer and autumn. The succulent forbs and abundant insects found in these habitats provide the diet required for growth of young sage grouse and feather molt of the adults. Upland habitats in the study area do not provide the quality and quantity of food for these crucial events; therefore, from mid-summer to mid-autumn sage grouse are dependent on mesic habitats.

In winter, sage grouse are able to utilize a wide variety of sagebrush-dominated habitats, depending on weather, snow depths, forage quality, and grouse activity. In general, winter range can be broadly defined as large areas having a mosaic of sagebrush species, heights, ages, and forage quality. Low-elevation sagebrush stands on benches or south or west-facing slopes may be relatively more important, particularly during severe winters.

The chukar is an introduced species often found on rugged slopes and canyons and associated drainages. Water availability (springs, seeps, water developments) directly influences chukar occurrence within these habitats, since chukar regularly visit water sources to drink. Broods and adults feed extensively on succulent vegetation, seeds, and insects in mesic habitats during summer (Christensen 1970).

The Hungarian partridge, another introduced species, is often associated with complexes of grassland, shrubland, grain fields, and water sources. Hungarian partridge are widespread but not abundant in the study area. They are not as water-dependent as chukar, or as riparian-dependent as sage grouse, although they may consume insects, green vegetation, and perhaps water in mesic habitats.

The mourning dove is a native migratory game bird found seasonally in the study area. Doves generally nest in tall shrubs and trees; because they consume water, they tend to congregate near water sources. Large numbers have been observed in dense willows along upper Maggie Creek and in the Little Jack and Indian Creek drainages.

RAPTORS

Raptors include eagles, vultures, hawks, falcons, and owls. The BLM's bird species list for the Elko District includes 1 vulture, 2 eagles, 11 hawks, 4 falcons, and 9 owls. Of these 27 species, 17 have been recorded in the study area (JBR 1992d).

Raptors occupy a great diversity of habitats. Some, such as the sharp-shinned hawk, may be restricted to one habitat (wooded sites) for nesting and foraging. Others, such as the ferruginous hawk, may nest in one habitat (pinyon-juniper) while foraging in others. Others, such as the golden eagle, may nest and forage in a broad range of habitats. All habitats (with the possible exception of some disturbed sites) within the study area are used for foraging by one or more raptor species. Because of their vegetative diversity, abundance of perches, and diversity and density of prey, riparian habitats may be used by the greatest diversity of raptors. Upland habitats, which predominate in the study area, provide the major foraging habitat for buteos (broad-winged hawks), eagles, and prairie falcons.

Nests of 10 species (golden eagle, red-tailed hawk, ferruginous hawk, Swainson's hawk, prairie falcon, American kestrel, northern goshawk, northern harrier, great horned owl, and long-eared owl) have been documented in the study area.

Five other species (turkey vulture, sharp-shinned hawk, Cooper's hawk, short-eared owl, and burrowing owl) have been observed in the study area during the nesting season, even though nests were not found (JBR 1992d). The most common nesting species were golden eagle, red-tailed hawk, prairie falcon, and great horned owl. Some species, such as American kestrel and northern harrier, may nest more commonly than has been documented.

Primary nest habitats include cliffs (golden eagle, red-tailed hawk, ferruginous hawk, prairie falcon, American kestrel, great horned owl), aspen or cottonwoods (red-tailed hawk, Swainson's hawk, American kestrel, northern goshawk, great horned owl), juniper (ferruginous hawk), and riparian/willow (Swainson's hawk, northern harrier, great horned owl, long-eared owl). Other habitats used for nesting include utility poles, abandoned buildings, clay banks, and marsh vegetation. Of 76 nests found in the study area, 6 (3 prairie falcons, 2 golden eagles, and 1 ferruginous hawk) are within 1 mile of the South Operations Area.

The east flank of the Tuscarora Mountains in the vicinity of the Proposed Action is not considered a major migratory corridor for raptors, but does receive some use. During winter, two additional species of raptors (rough-legged hawk and bald eagle) are found in the study area. Rough-legged hawks feed primarily on rodents, jackrabbits, and carrion. Their abundance in the study area is probably controlled by the severity of winter to the north, and by availability of prey in the study area. Bald eagles have been observed along the Humboldt River (Bradley 1992). If the river is ice-free, they may prey on fish or waterfowl; however, their primary foods are jackrabbits and carrion (usually dead mule deer and pronghorn).

WATERFOWL AND SHOREBIRDS

Although BLM's bird species list for the Elko District contains about 75 waterfowl and shorebird species, the number of species occurring in the study area is smaller due to the relatively limited amount of water. Waterfowl and shorebirds recorded in the study area during the baseline study include the Canada goose, mallard, green-winged teal, gadwall, spotted sandpiper, killdeer, great blue heron, white-faced ibis, snowy egret, black-crowned night heron, and sandhill crane.

Habitat for waterfowl and shorebirds in the study area includes perennial streams, small ponds and reservoirs, and the Humboldt River. Depending on the season and the species, riparian and wetland habitats may provide nesting sites, feeding areas, and rest/security areas. Some species may also forage or nest in adjacent habitats, such as irrigated hayfields or springs and seeps. Other species normally considered to be associated with water, such as gulls, will often forage far from water.

OTHER NONGAME BIRDS

The BLM list for the Elko District contains 246 species of birds. A total of 125 species, including upland game birds, raptors, waterfowl (51 species total, all discussed above), and songbirds were recorded in the study area during the baseline study (JBR 1992d). Of the 121 remaining species, many are not expected to occur in the vicinity of the South Operations Area due to habitat limitations.

Of the 74 species of nongame birds grouped as songbirds, 18 species, such as the belted kingfisher, orange-crowned warbler, yellow warbler, common yellowthroat, yellow breasted chat, yellow-headed blackbird, red-winged blackbird, and house finch, were generally restricted to riparian or wetland habitats. Twenty-five species, such as the horned lark, pinyon jay, rock wren, mountain bluebird, blue-gray gnatcatcher, sage thrasher, green-tailed towhee, and sage sparrow, were found primarily in upland habitats. The remaining 31 species, such as the white-throated swift, Say's phoebe, barn swallow, black-billed magpie, house wren, European starling, and lark sparrow, could utilize a variety of habitats. Some might nest in upland habitats and forage in riparian habitats; others might nest in riparian habitats and forage in upland habitats. Others might nest and forage in both.

REPTILES AND AMPHIBIANS

Diversity of amphibians and reptiles in BLM's Elko District appears to be limited by the cool, dry climate. A total of 28 species have been identified in this area. Of these, 5 amphibians (frogs and toads), 7 lizards, and 4 to 5 snakes could be expected in the study area. Most amphibians are dependent on water sources at some time during their life cycles, usually for breeding; some may be restricted entirely to permanent water sources. Reptiles generally do not require water sources but some species forage extensively in mesic or wetland habitats. Most reptiles and amphibians in the study area would be considered common, but the distribution of western toad and spotted frog is uncertain and being investigated (Barss 1992).

AQUATIC HABITAT AND FISHERIES

The Humboldt River and its tributaries in the study area were productive Lahontan cutthroat trout fisheries when white explorers and settlers arrived in Nevada in the 1840s (NDOW 1972). Since the early 1900s, aquatic habitat in the Humboldt River drainage has been adversely affected by channelization, dams, willow eradication, bank stabilization, land leveling, wetland draining, urban development, gravel mining, and season-long livestock grazing (Rawlings and Neel 1989). As a result of deteriorated watershed conditions and poor water quality, Lahontan cutthroat trout have been extirpated from the Humboldt River and are restricted in the Maggie Creek drainage to Maggie, Little Jack, Coyote, Beaver, Toro Canyon, and Little Beaver creeks.

Currently, the Humboldt River supports warm-water fish species. Bullheads and catfish were planted and became established in the Humboldt River early in the century. Other species, such as smallmouth bass, largemouth bass, bluegill, white crappie, channel catfish, and white catfish have been sporadically stocked since the mid-1950s. Carp also have colonized all portions of the Humboldt River in the study area. Native fish species in the Humboldt River include Lahontan redside, redside shiner, mountain sucker, speckled dace, and Tui chub.

The most productive and diverse aquatic habitats in the study area occur within Maggie Creek and its tributaries; Susie Creek; Buck Rake Jack Creek on the south side of the Tuscarora Range; Mack and Welches creeks, on the west side of the Tuscarora Range; and the Humboldt River from Carlin Canyon downstream of the confluence with Emigrant Gulch. Intermittent drainages provide marginal aquatic habitat during periods of high runoff, usually in spring. Springs and seeps are important for aquatic invertebrates and amphibians, but do not support fish populations.

Maggie Creek, Susie Creek, the Humboldt River, and the lower reaches of most tributaries are relatively low-gradient streams, often with entrenched, wide-bottomed channels; vertical, unstable banks; and generally degraded habitat conditions. Lower reaches of Maggie, Susie, Little Jack, Lynn, and Marys creeks often dry up during summer months due to low flows or water diversion. Seasonal cessation of flows greatly reduces species diversity and production of aquatic invertebrates and fish, and reduces riparian habitat (JBR 1992e). Stable stream channels with relatively high aquatic habitat values are present in the headwaters of Simon Creek and Little Jack Creek, and in the wet meadows of lower Little Jack Creek and Coyote Creek.

Eight streams within the study area, all tributaries of the Humboldt River, have fish populations (Table 3-27). Speckled dace are the most abundant fish, followed by redside shiners and mountain suckers. A small remnant population of brook trout has been reported for Spring Creek, a tributary of Coyote Creek. Little Jack Creek and upper Maggie Creek support Lahontan cutthroat trout (JBR 1992e).

Aquatic invertebrates (important fish food and indicators of overall biological stability and

TABLE 3-27
Fish Population Estimates Per Mile Based on Sampling in the South Operations Area[1]

Stream	Speckled Dace	Redside Shiner	Mountain Sucker	Brook Trout	Lahontan Cutthroat Trout
Buck Rake Jack Creek	10	--	--	--	--
Cottonwood Creek (west)	1,070	--	--	--	--
Coyote Creek	--	--	--	10	--[1]
Indian Creek	380	--	--	--	--
Jack Creek	60	--	--	--	--
Little Jack Creek	20	--	--	--	150
Maggie Creek	12,890	270	20	--	10
Susie Creek	13,410	190	280	--	--

[1] Data extrapolated from surveys on 0.1 mile sections of the streams.
[2] Surveys did not record Lahontan cutthroat trout in Coyote Creek because the surveys were conducted downstream of the primary population center.

Source: JBR 1992e.

productivity) are found in all streams in the study area. Streams producing the greatest biomass of aquatic insects and other invertebrates are, in decreasing order of productivity: Little Jack Creek, Fish Creek, James Creek, and Susie Creek. Streams producing the lowest biomass of aquatic invertebrates are: Jack Creek, Maggie Creek, and Coyote Creek. Other streams are intermediate in biomass production.

Streams producing the highest diversity of aquatic invertebrates, in decreasing order of diversity, are: West Cottonwood, Marys, Indian, Mack, James, Susie, and Little Jack creeks. Other streams in the study area have relatively low species diversity values.

Maggie Creek, the largest drainage in the study area (other than the Humboldt River), has an average flow of approximately 5 to 10 cfs; Susie Creek is the next largest drainage, with an average flow of less than 6 cfs. All other streams generally have average flows of less than 1 cfs. Although Maggie Creek has relatively low productivity and species diversity values, it provides habitat for the largest and most diverse fish populations (Table 3-27). Susie Creek has fish populations similar in size and diversity to Maggie Creek except that Lahontan cutthroat trout are not present. The U.S. Fish and Wildlife Service has designated Susie Creek a potential stream for introduction of Lahontan cutthroat trout (U.S. Fish and Wildlife Service 1992). In recent years BLM has initiated stream improvement practices to enhance aquatic and riparian habitat.

Although springs and seeps in the study area do not support fish, many contain a diversity of aquatic invertebrates. The kinds and number of invertebrates are influenced by parameters such as waterflow, water quality, substrate conditions, aquatic vegetation, streambank vegetation, and surrounding land use. Of particular concern in the study area are mollusks (snails and clams), since some species are considered "candidate" species under the Endangered Species Act. Mollusks were inventoried at 65 springs and seeps in the study area in September 1992 (McGuire 1992). California floater, a fresh-water mussel, may inhabit the Humboldt River in the study area (see Chapter 3, Threatened, Endangered, and Candidate Species).

Although no "candidate" species were found at these sites, 11 different organisms, including two species of springsnails, were collected. One of these springsnails, *Flumincola nevadensis*, is known to occur only in a warm spring approximately 3 miles southwest of Carlin (Section 5, T32N,R52E) and 8 miles south of the Gold Quarry Mine. The other species, which has not yet been described, was found at two locations in the study area (Willy Billy Spring - Section 32, T32N, R51E and Rattlesnake Spring - Section 2, T31N, R50E). It is not known if these two springsnail species exist at other locations in the Great Basin (McGuire 1992).

THREATENED, ENDANGERED, AND CANDIDATE SPECIES

Three species listed under the Endangered Species Act of 1973 and 16 Category 2 species (candidates for listing as threatened or endangered) occur in or near the study area. Species observed during field surveys or for which there is suitable habitat present in the study area are listed in Table 3-28. Listed or candidate species potentially present in the study area have been identified by the U.S. Fish and Wildlife Service (Harlow 1992).

THREATENED AND ENDANGERED SPECIES

Birds

Bald Eagle (Endangered)

Bald eagles are periodic seasonal migrants and winter residents in Nevada. A few bald eagles occasionally may be present in the study area as transient visitors or may winter near bodies of water which remain free or partially free of ice. Bald eagles usually winter near unfrozen bodies of water because fish and waterfowl are common prey and riparian areas often have cottonwood trees used as perches. Wintering bald eagles were observed in 1992 along the Humboldt River at five locations between Elko and Battle Mountain (NDOW 1992). No bald eagle nests or communal roosts are known in or near the study area.

Peregrine Falcon (Endangered)

Like bald eagles, peregrine falcons pass through Nevada as seasonal migrants. None has been reported in the study area. No nest sites are known in the vicinity of the study area.

Fish

Lahontan Cutthroat Trout (Threatened)

Historically, Lahontan cutthroat trout occupied streams throughout the Humboldt River drainage including the Humboldt River. Habitat degradation, water development projects, and introduction of non-native trout that hybridize and compete with Lahontan cutthroats have eliminated this species over much of its former range. Stream surveys within the Humboldt River drainage have identified 60 Lahontan cutthroat streams with 227 miles of occupied habitat (Coffin 1982). Since 1982, Lahontan cutthroat trout have been found to inhabit 447 miles of stream in Nevada with stream-dwelling populations estimated at 110,000 fish (U.S. Fish and Wildlife Service 1992).

Lahontan cutthroat trout occur in 6 of 11 streams in the upper Maggie Creek Basin -- Maggie, Little Jack, Beaver, Toro Canyon, Coyote, and Little Beaver creeks (Figure 3-13). The upper Maggie Creek basin is estimated to have about 12.6 miles of habitat occupied by Lahontan cutthroats, with numbers estimated at 7,000 fish (U.S. Fish and Wildlife Service 1992). Fishery data compiled by BLM for the period 1977-1992 identify about 22 miles of habitat where Lahontan cutthroats have been documented by field surveys. In addition, about 8 miles of middle Maggie Creek (the portion of stream from the canyon to the confluence with Jack Creek) have suitable Lahontan habitat that appears to be periodically occupied by this fish. Coyote Creek is the most productive Lahontan cutthroat stream in the Maggie Creek drainage.

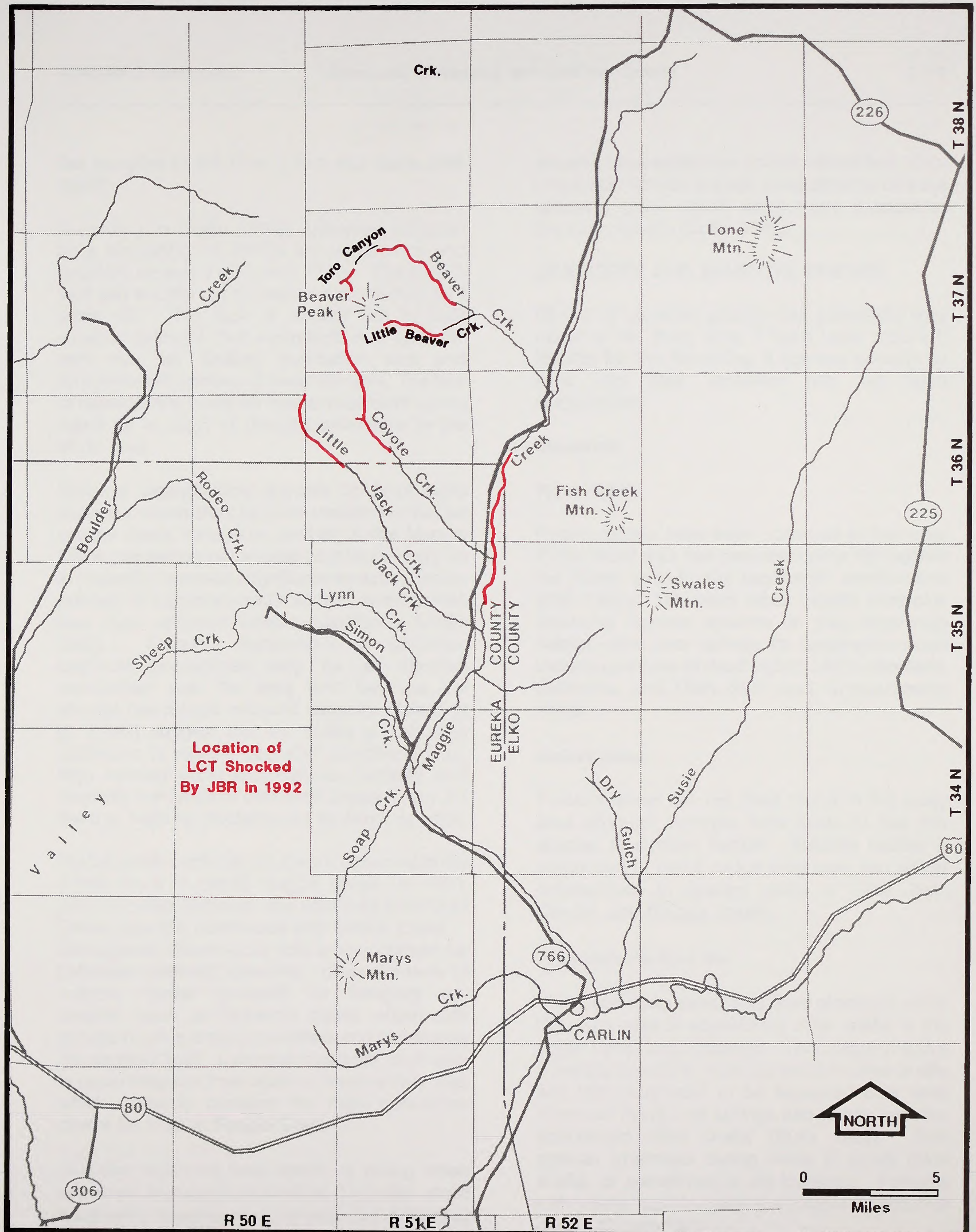
Fishery studies in 1992 (JBR 1992f) recorded a small population of Lahontan cutthroat in Maggie Creek upstream from the confluence with Coyote Creek (Figure 3-13). These fish ranged from 14 to 18 inches in length. Lahontan cutthroats were locally abundant in Little Jack Creek with most

TABLE 3-28
Endangered, Threatened, and Candidate Species Potentially Occurring in the South Operations Area

Common Name	Scientific Name	Status[1]	Occurrence in Project Area
	Mammals		
Pygmy rabbit	*Brachylagus idahoensis*	Category 2	Present
Spotted bat	*Euderma maculatum*	Category 2	Unreported
Townsend's big-eared bat	*Plecotus townsendii*	Category 2	Present
Preble's shrew	*Sorex preblei*	Category 2	Unreported
	Birds		
Northern goshawk	*Accipiter gentilis*	Category 2	Present, nesting
Ferruginous hawk	*Buteo regalis*	Category 2	Present, nesting
Peregrine falcon	*Falco peregrinus anatum*	Endangered	Unreported
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Present, winter
Loggerhead shrike	*Lanius ludovicianus*	Category 2	Present
White-faced ibis	*Plegadis chihi*	Category 2	Present
	Fish		
Lahontan Creek tui chub	*Gila bicolor obesa*	Category 2	Present
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*	Threatened	Present
	Amphibians		
Spotted frog	*Rana pretiosa*	Category 2	Present
	Invertebrates		
California floater	*Anodonta californiensis*	Category 2	Previously reported
Mattoni's blue butterfly	*Euphilotes rita mattoni*	Category 2	Unreported
Nevada viceroy	*Limenitis archippus lahontani*	Category 2	Present
	Plants		
Meadow pussytoes	*Antennaria arcuata*	Category 2	Unreported
Broad fleabane	*Erigeron latus*	Category 2	Unreported
Lewis buckwheat	*Eriogonum lewisii*	Category 2	Unreported

1 Species in Category 2 may warrant threatened or endangered status, but sufficient biological information is lacking to support this designation. Additional studies are needed to determine if the California floater, Mattoni's blue butterfly, and meadow pussytoes occur in the project area.

Source: U.S. Fish and Wildlife Service 1992.



Source: Bureau of Land Management, Elko District

Documented Lahontan Cutthroat Trout (LCT) Habitat (1977-1992)

Occupied Lahontan Cutthroat Trout Habitat
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-13

fish sampled in the 6 to 7 inch size class (JBR 1992f).

According to Coffin (1982), Lahontan cutthroat trout exceeding 14 inches are uncommon and probably exceed 4 to 5 years of age. The 6- to 7-inch fish in Little Jack Creek are probably 3 to 4 years old. The lack of smaller fish in both streams indicates that reproduction is sporadic and may be limiting population size and recruitment in portions of these streams. The lack of reproduction could be due to insufficient spring runoff as a result of drought conditions in the study area.

Because reproduction appears to have been limited or nonexistent in these streams for the last several years, long-term survival of the Maggie Creek population of Lahontan cutthroats may be in jeopardy; however, significant variation occurs annually in Lahontan cutthroat trout streams with less than optimum habitat conditions (Coffin 1982). Frequent fluctuations in Lahontan cutthroat populations may be an effective mechanism over the long term because the species has a rapid rebound capacity. Nelson et al. (1992) suggest that the ability of Lahontan cutthroats to tolerate degraded conditions (e.g., high summer water temperatures, turbidity, and relatively low levels of dissolved oxygen) may aid them in resisting displacement by exotic species.

No Lahontan cutthroat trout were observed in the 8-mile reach of middle Maggie Creek. In 1980, one Lahontan cutthroat was observed in Maggie Creek near the confluence with Simon Creek. Although the riffle-to-pool ratio is not optimum for Lahontan cutthroat spawning, other elements of suitable habitat (primarily for foraging) are present, such as undercut banks, streamside shrubs in some areas, and debris and variation in the channel itself. Lahontan cutthroat trout exist in upper Maggie Creek north of the inventory area which probably contains the main population center for trout in Maggie Creek.

Lahontan cutthroat trout spawn in spring when snowmelt increases streamflow. Typically, small headwater streams are preferred for spawning when suitable flows exist. After spawning, these streams often exhibit low or intermittent flow. Fish-of-the-year remain in these small streams until the following year's runoff, when many descend to the main stream (Coffin 1982).

CANDIDATE AND SENSITIVE SPECIES

Of the 16 sensitive species that potentially may occur in the study area, 7 have been reported. Habitat for the remaining 9 species appears to exist, but their presence has not been documented.

Mammals

Pygmy Rabbit

Pygmy rabbits have been observed at four sites in the study area but probably occur throughout the study area in big sagebrush communities (JBR 1992g). This small rabbit usually excavates extensive burrow systems in big sagebrush habitat, often near springs. Its geographic range includes portions of Washington, Idaho, Montana, California, and Utah (Burt and Grossenheider 1976).

Preble's Shrew

Preble's shrew has not been found in the study area although attempts were made to trap this species in suitable habitat. Suitable habitat is composed of moist sedge meadows and willow communities in riparian areas of Little Jack, Coyote, and Maggie creeks.

Townsend's Big-Eared Bat

Townsend's big-eared bats were observed within the study area in abandoned mine shafts in the upper Lynn Creek drainage. Two males in active breeding condition were captured in mine shafts and bats suspected to be big-eared bats were observed flying over springs and ponds near the abandoned mine shafts (Butts 1992). This species hibernates during winter in caves, mine shafts, or sometimes in old buildings. Females with young roost in nursery or maternity colonies during the summer.

Spotted Bat

This species has not been reported for northeastern Nevada but is typically found in rough desert terrain with limestone or sandstone cliffs (Zevaloff 1988). The spotted bat appears to favor cliffs and rocks near perennial watercourses (Clark 1987). Its range extends over most of the western United States and includes all of Nevada (Burt and Grossenheider 1976).

Birds

Northern Goshawk

This species commonly nests in the Independence Mountains in conifer forests and aspen groves. One goshawk nest was observed in the study area near West Cottonwood Creek (JBR 1992g). Northern goshawk habitat is limited in the study area to forest and mountain shrub communities.

Ferruginous Hawk

Ferruginous hawks are relatively common throughout northeastern Nevada. In the study area, they usually nest in juniper trees and prey on jackrabbits and other small mammals. No nests have been found in areas that would be disturbed by the South Operations Area expansion.

Ferruginous hawks concentrate in late summer and early fall at the wet meadows along upper Maggie Creek. This area appears to be a staging area where hawks congregate to prey on large populations of small mammals prior to migrating.

Loggerhead Shrike

Loggerhead shrikes are common in the study area, where they nest in trees and shrubs and hunt for insects in open grasslands and shrublands. This species breeds throughout the western United States.

White-Faced Ibis

The white-faced ibis is a colonial nester in emergent marsh vegetation. This species was observed in spring and summer along the Humboldt River and Maggie Creek but no nests or young were found (JBR 1992g). Wet meadows along Maggie Creek, Coyote Creek, and Little Jack Creek are the only potential nesting habitat in the study area.

Fish

Lahontan Creek Tui Chub

Tui chubs occur in streams and reservoirs in a wide variety of habitats in the Humboldt River drainage. This fish was recorded from the Humboldt River near Carlin in 1938 and again in 1992 (JBR 1992f). Tui chubs also have been found in the Humboldt River at several locations about 30 miles upstream from Carlin. The Tui chub population apparently is centered in the upper reaches of the river; only occasional individuals appear downstream in the study area (JBR 1992f).

Amphibians

Spotted Frog

Spotted frogs occur in and around permanent water in middle Maggie Creek, lower Coyote Creek, and lower Little Jack Creek. In the western United States, this species occupies wetland habitats ranging from subalpine forests to lower elevation shrublands and grasslands.

Invertebrates

California Floater

The California floater is a freshwater mussel historically found in unpolluted lakes and streams in western North America from British Columbia to Mexico (Hulen 1988). This species can only survive in association with certain fish that serve as hosts for the mussel's parasitic life stage. At present, the host species are not known. When the host fish are extirpated or greatly reduced in numbers, mussel populations decline and eventually disappear (Bequaert and Miller 1973). According to Call and Gilbert (1893), California floaters were once abundant in the Humboldt River. There appears to be no recent information on the status of this mussel in the mainstem Humboldt River, but Hamlin (1992) reports its presence in the North Fork Humboldt River.

Mattoni's Blue Butterfly

This butterfly has not been reported from the study area, but could be found in habitats from the pinyon-juniper zone downslope to lower elevation shrublands and grasslands. Mattoni's blue butterfly is dependent on the plant *Eriogonum microthecum laxiflorum*, which serves as the host for the butterfly's larvae. This plant occurs on many rocky ridges in the study area, so it is possible that Mattoni's blue butterfly could be present.

Nevada Viceroy

This butterfly occupies riparian habitat along the Humboldt River in the vicinity of willows, which serve as host plants for the insect's larvae. Nevada viceroys have been observed in the study area along the Humboldt River and Maggie Creek. This species also has been reported from Dunphy, Beowawe, and Elko. It is probable that it also occurs in association with willow communities along Little Jack and Coyote creeks.

Plants

Meadow Pussytoes

Meadow pussytoes has not been reported for the study area, but could be present on seasonally moist soils in native sedge-grass meadows at elevations of 5,250 to 6,400 feet. Sedge-grass meadows occur along upper Maggie Creek, Little Jack Creek, and Coyote Creek.

Lewis Buckwheat

Lewis buckwheat has not been reported in the study area but could be present on rocky, high-elevation sagebrush ridges above 8,300 feet. It is known to occur in the Independence Mountains and Elk Mountain in Elko County. Because the study area is below 8,300 feet in elevation, this plant would not be expected to occur.

Broad Fleabane

Broad fleabane grows on thin, rocky, volcanic soils on slopes in association with sagebrush and juniper. It is known from four locations in Elko County but has not been recorded in the study area.

LIVESTOCK GRAZING

Livestock grazing is a major land use within the study area. Encompassed in part or in total within the study area are eight livestock grazing allotments (Figure 3-14). Grazing allotments are areas of public and private land used by qualified permittees for livestock grazing. Grazing within the allotment is administered by BLM. Four of the eight allotments in the study area are licensed to one permittee, and the remaining four allotments are licensed to different permittees. Existing mine area disturbance is fenced to prevent livestock use, and includes a portion of the Marys Mountain allotment. Information pertinent to each grazing allotment is presented in Table 3-29. Range improvements within the study area are presented in Table 3-30 and shown in Figure 3-14.

TABLE 3-29
Livestock Grazing Allotments in the Livestock Study Area, 1993

Allotment	Permittee	Management category[1]	Public land active preference (AUMs)[2]	Percent public land	Acres in study area[3]	Predominant range condition[4]	Percent of total land base[5]	Number of animals run	Season of use	Type of operation
Carlin Canyon[6]	Maggie Creek Ranch	C	51	100	119	mid-seral	30[9]	NA[7]	NA	commercial cow/calf
Carlin Field	Maggie Creek Ranch	I	2,445	84	23,024	UNK[7]		500-840 cow/calf pairs	April 1 to Dec 15	commercial cow/calf
Dry Susie[8]	Maggie Creek Ranch	C	NA	NA	5,838	late seral		NA	NA	commercial cow/calf
Hadley	Maggie Creek Ranch	I	4,276	50	60,401	early to mid-seral		600-800 cow/calf pairs	April 1 to Dec 15	commercial cow/calf
Horseshoe	Zeda, Inc. Horseshoe Ranch	I	1,628	46	13,111	mid-seral	25	590 cow/calf pairs	April 1 to Oct 15	commercial cow/calf
Marys Mountain	Melvin Jones Ranch	C	1,408	51	35,584	mid-seral	45	447 cows 7 horses	April 15 to Oct 15	commercial cow/calf
Palisade	Palisade Ranch	C	1,336	47	21,841	mid-seral	75	443 cow/calf pairs	April 15 to Oct 27	commercial cow/calf
T Lazy S (TS)	Elko Land & Livestock	I	12,241	43-100	91,367	early to mid-seral	19	2,939 cow/calf pairs	March 15 to Dec 31	commercial cow/calf

1 Management category definitions:
I = Improve the present unsatisfactory condition of the allotment.
C = Manage in a custodial fashion. Lands within these allotments (except for Dry Susie) are targeted for exchange or sale.

2 An AUM (animal unit month) is the amount of forage required to sustain one cow for a 1-month period.

3 These reflect both public and private lands. Will not total to number of acres within study area, as areas not included in allotments are not in this table.

4 Seral stage describes native range condition. Early, mid, and late seral equate to poor, fair, and good range condition, respectively.

5 Percent of the permittees' total deeded and leased land base that is accounted for by the allotment.

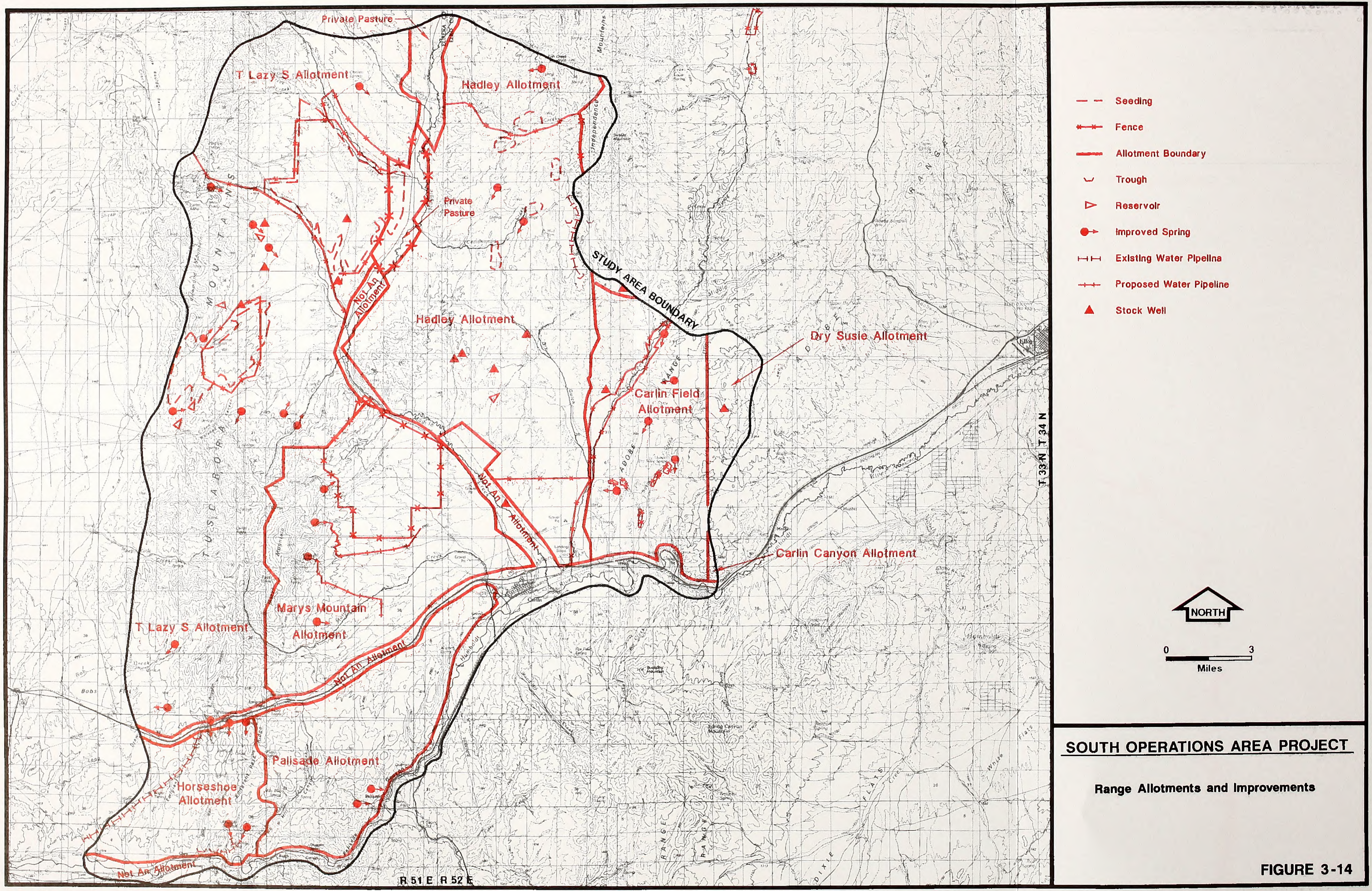
6 Carlin Canyon allotment is managed as fenced federal range.

7 NA = not available; UNK = unknown

8 Dry Susie allotment is operated under an exchange of use agreement with the BLM.

9 Carlin Field, Carlin Canyon, Dry Susie and Hadley allotments are used as one unit by the permittee, and their combined acreage constitutes approximately 30 percent of the permittees' total land base.

Source: JBR 1992c; Andrae 1992; Fahsholtz 1992; Jones 1992; Kieckhafer 1992; Stitzel 1992; Whitlock 1992.



SOUTH OPERATIONS AREA PROJECT

Range Allotments and Improvements

FIGURE 3-14

TABLE 3-30
Range Improvements of Record in the Livestock Study Area, 1993

RI[1] No.	Name	Location[2]	Remarks
Carlin Field Grazing Allotment			
0127	McKinley Land & Cattle Fence	T33N R53E	Fence between Carlin Field and Dry Susie allotments
1231	Carlin Drift Fence	T34N R52-53E	Boundary fence between Carlin Field and Hadley allotments
5413	Dry Susie Creek Exclosures 1,2, & 3	T33N R53E	Riparian exclosures located on Dry Susie Creek
5461	Hot Springs Exclosure #1	T33N R53E	Riparian exclosure around Hot Springs #1
5462	Hot Springs Exclosure #2	T33N R53E	Riparian exclosure around Hot Springs #2
5836	Susie Creek Cattleguard	T34N R53E, Sec 16	Cattleguard
Hadley Grazing Allotment			
0119	Lower Maggie Creek Fence	T33-34N R51-52E	Boundary fence between Hadley and Marys Mountain allotments
0134	Maggie Creek Fence	T34-35N R51-52E	West boundary fence along Maggie Creek
0407	Holding Corral Fence	T35N R52E, Sec 1	Holding corral for livestock
0415	Hadley Spring	T35N R52E, Sec 10	Developed spring with troughs
0685	Fish Creek Fence	T35N R52E	Pasture boundary fence
0726	Yellow Spring pipeline	T35N R52E, Sec 24	Pipeline connecting Yellow Spring with troughs
0967	Hadley Pond	T34N R52E, Sec 28	Stockwater Reservoir
1231	Carlin Drift Fence	T34-35N, R52-53E	Fence between Hadley and Dry Susie/Carlin Field allotments
5107	Susie Creek Seeding	T35N R52E, Sec 2	Bitterbrush seeding needed for deer browse in an area burned by Susie Creek fire
Marys Mountain Grazing Allotment			
0044	Marys Mountain Division Fence	T32-34N, R50-51E	Boundary fence between Marys Mountain and TS allotments
0119	Lower Maggie Creek Fence	T33-34N, R51-52E	Boundary fence along Maggie Creek
1304	Cherry Springs Pipeline	T33N R51E, Sec 21	Pipeline connecting Cherry Springs with storage tanks and troughs
4392	Marys Creek Field Fence	T32N R51E	Holding field for livestock

TABLE 3-30 (continued)
Range Improvements of Record in the Livestock Study Area, 1993

RI[1] No.	Name	Location[2]	Remarks
Horseshoe Grazing Allotment			
4286	Primeaux Pipeline	T32N R50E, Sec 15	Pipeline connecting stockwater reservoir to troughs
5322	Rattlesnake Spring & Pipeline	T31N R50E, Sec 2	Developed spring and pipeline connected to trough
5398	Palisade/Horsehoe Division Fence	T31-32N R50-51E	Boundary fence between Palisade and Horseshoe allotments
Palisade Grazing Allotment			
0230	Primeaux Fence	T31-32N R50-51E	Fence between Palisade and Horseshoe allotments
5398	Palisade/Horsehoe Division Fence	T31-32N R50-51E	Boundary fence between Palisade and Horseshoe allotments
T Lazy S Grazing Allotment			
0044	Marys Mountain Division Fence	T32-34N R50-51E	Boundary fence between Marys Mountain and TS allotments
0134	Maggie Creek Fence	T34-35N R51-52E	
0566	Pond #4	T34N R50E, Sec 22	Stockwater reservoir
0568	Pond #10	T34N R50E, Sec 2	Stockwater reservoir
0572	Pond #14	T35N R51E, Sec 30	Stockwater reservoir
0734	Hot Water Well	T34N R50E, Sec 10	Well with storage tank and trough
1080	Welches as Creek Seeding	T34N R50E, Sec 29	Fire rehabilitation project; 1964 crested wheatgrass seeding
1092	Boulder Creek Seeding	T34N R51E, Sec 3	Fire rehabilitation; 1967 crested wheatgrass seeding
1106	Boulder Creek Fire Fences	T34-35N R50-51E	Fences constructed around Welches Creek; Coyote and Antelope seedings
1107	Boulder Creek Seeding Fence	T35N R50-51E	Fence constructed in Boulder Creek complex to protect fire rehabilitation seedings
4463	Badger Hole Reservoir	T34N R50E, Sec 28	Stockwater reservoir
5659	Carlin Mine Road Fence	T34N R51E, Sec 3	Pasture fence located along mine road

1 Range improvement number.

2 TN = township north; RE = range east; Sec = section.

Source: JBR 1992c; Whitlock 1992.

RECREATION AND WILDERNESS

RECREATION

The BLM Elko District, which includes all of Elko County and parts of Eureka and Lander counties, comprises over 12 million acres, or about one-sixth of Nevada's total land area. The BLM administers 7.4 million acres of public lands within the Elko District.

The BLM Elko Resource Area (RA), which contains nearly 6 million acres, is within the Elko District. Public lands in the Elko RA provide diverse recreational activities, including fishing, sightseeing, hunting, skiing, whitewater rafting, photography, rockhounding, and off-road vehicle (ORV) use (BLM 1985). Numerous recreational areas and facilities are managed by BLM, USFS, USFWS, NDOW, U.S. Bureau of Indian Affairs (BIA), and private operators (Figure 3-15).

Approximately 98 percent of the Elko RA is open to ORV use which is dispersed throughout the RA (BLM 1987). All vehicle use in the Special Resource Management Areas (SRMAs) and Wilderness Study Areas (WSAs) is limited to designated roads and trails.

The BLM has identified six SRMAs in the Elko District. The one nearest the study area, South Fork Canyon SRMA, lies about 20 miles southeast and encompasses 3,360 acres. This SRMA does not have any developed facilities. The Zunino/Jiggs Reservoir SRMA is approximately 40 miles southeast of the study area. Facilities include picnic tables, grills, and a restroom.

The Wilson Reservoir SRMA is located 65 miles north of the study area. Facilities include a boat ramp, restrooms, a trailer dump, drinking water, and a primitive campground. The facilities at Wilson Reservoir will be improved and expanded in the near future. Wildhorse SRMA is approximately 70 miles northeast of the study area and has a BLM campground, a developed State Recreation Area, and a BIA campground and trailer park. The South Fork Owyhee River, within the South Owyhee River SRMA and Owyhee Canyon and South Fork Owyhee River WSAs, is eligible for Wild and Scenic River designation. The BLM is not presently considering a Wild and Scenic River designation, however, since further studies and environmental documentation would need to be completed prior to a congressional designation. The five SRMAs mentioned above are all in the Elko RA (BLM 1987). Salmon Falls SRMA is over 115 miles from the study area near the Idaho border in the Wells RA. The South Fork State Recreation Area (SRA) is located 25 miles southeast of the study area, adjacent to the BLM South Fork Canyon SRMA.

The USFS has three ranger districts in Elko County: Ruby Mountains, Mountain City, and Jarbidge. The Ruby Mountains District, within 20 miles of Elko and Interstate 80, experiences the heaviest use. Ruby Mountains has four campgrounds (121 campsites), two picnic areas, and two wilderness areas. The Lamoille Canyon Scenic Byway provides paved access 12 miles up the canyon. Three pullouts with interpretive signs explain many of the natural features. At the end of the road, a trailhead provides access to the 40-mile Ruby Crest National Recreation Trail and the Ruby Mountains Wilderness. The Mountain City Ranger District has three campgrounds and the Jarbidge District has two campgrounds and one wilderness. Mountain City and Jarbidge experience their heaviest use on weekends.

The BLM Back Country Byways Program identifies and publicizes scenic and historic routes to increase public awareness of recreational opportunities on public land. Interpretive messages inform users about multiple use management. In the northeast corner of the Elko District, the California Trail Back Country Byway provides over 80 miles of scenic travel paralleling the original California Trail (one of the major routes pioneers leaving the Midwest traveled to California and Oregon).

In 1987, the Parks Division of the NDCNR published a Statewide Comprehensive Outdoor Recreation Plan (SCORP) projecting supply and demand for recreational facilities in years 1990, 1995, and 2000. The plan concluded that supply exceeded demand in Elko County for tent camping sites, picnic tables, and swimming pools, but that a moderate increase in baseball and softball fields (six), golf courses (one), and tennis courts (five) would be required by year 2000. The demand for miles of fishing stream, biking trails, crosscountry ski trails, and hiking and backpacking trails exceeded the supply for all years. A new SCORP completed in 1992 did not revise the above numbers.

The communities of Carlin, Elko, and Spring Creek have a number of recreational facilities. Carlin has an archery range, two baseball fields, a park and playground area, a tennis court, and a volleyball court. Elko has six baseball fields, two bowling alleys, two athletic clubs, a golf course, three movie theaters, three parks, a rifle and pistol range, two soccer fields, six tennis courts, and a swimming pool. Spring Creek has a golf course, an indoor horse arena, and a trap and skeet range (North East Nevada Development Authority (NENDA) 1992).

WILDERNESS

The South Operations Area and vicinity was not considered as a wilderness study area (WSA) due to past mining disturbance and extensive road systems. The BLM manages 10 WSAs in the Elko District, seven of which have been recommended for wilderness designation. The Little Humboldt River WSA, located approximately 50 miles northwest of the South Operations Area, is the closest WSA to the study area that is recommended for wilderness. The upper drainage basin of the South Fork of the Little Humboldt River is included in the WSA. A wide variety of recreational opportunities are available in the Little Humboldt River WSA, including fishing, hiking, camping, hunting, rock climbing, and wildlife viewing. Portions of the Little Humboldt and Bullhead Wild Horse Herd areas are located within this WSA, providing wild horse viewing and photography. The BLM has recommended 29,775 acres of the Little Humboldt River WSA as suitable for wilderness and 12,438 acres as unsuitable for wilderness (BLM 1987).

Other WSAs in the Elko District recommended for wilderness designation are Badlands, Goshute Peak, Owyhee Canyon, Rough Hills, South Fork Owyhee River, and South Pequop. Red Spring, Cedar Ridge, and Bluebell WSAs have not been recommended for wilderness designation (BLM 1987).

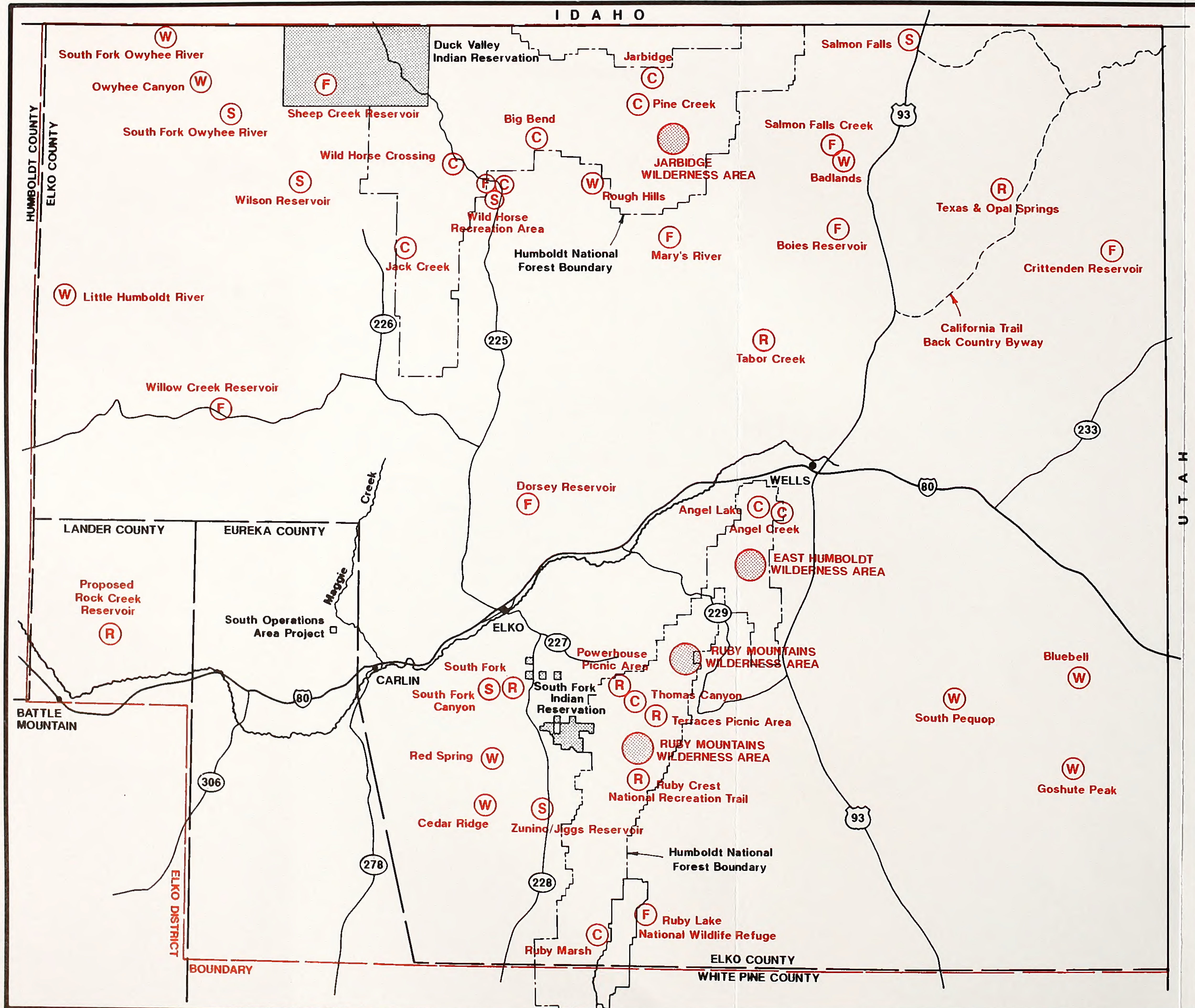
The USFS has three wilderness areas within the Elko District: Jarbidge Wilderness, 80 miles northeast of the mine area; East Humboldt Wilderness, 60 miles east of the mine area; and the Ruby Mountains Wilderness, 45 miles southeast of the mine area.

VISUAL RESOURCES

The landscape of the study area is characterized by broad, open vistas with scattered mountain ranges. The project site is located on gently rolling terrain east of the Tuscarora Mountains, which rise abruptly to over 7,500 feet. The broad, flat valley bottoms of Maggie and Susie creeks lie to the east of the South Operations Area.

Vegetation of the study area consists primarily of homogenous patterns of sagebrush-grassland. Natural vegetation patterns are disturbed by existing mining operations, agricultural fields along Maggie Creek, and urban development at Carlin. Dominant vegetation colors are beige, brown, and light green.

Soil and rock are exposed in numerous areas where vegetation cover is sparse. Soils range in color from chalky off-white to beige; when disturbed, they contrast strongly with surrounding



C Campground
F Fishing Area
R Recreation Area
S Special Recreation Management Area
W Wilderness Study Area
Wilderness Area

SOUTH OPERATIONS AREA PROJECT

Recreation and Wilderness Areas

FIGURE 3-15

vegetation. Rocks vary in color from light brown to dark brown to burnt orange.

The South Operations Area facilities create moderate contrasts with horizontal lines, smooth surfaced blocky and pyramidal forms, and lighter colors from disturbed soil and rock. When weather conditions are calm, black smoke from diesel-powered equipment is often visible above the mine site. Visibility is greatest in the morning when the project is front-lighted. Visual features within the Interstate 80 corridor include urban development (e.g., buildings, signs, parking areas, and commercial facilities), highway and railroad cuts and embankments, and powerlines.

Views of existing operations are blocked from the north by Schroeder Mountain and from the west by the Tuscarora Mountains. The project site is visible to motorists from three locations along Interstate 80. Two of these locations are in the vicinity of the Carlin East interchange and the other is just east of the Carlin West interchange. Motorists near the Carlin East interchange can see the South Operations Area for approximately 70 seconds when driving at 65 miles per hour. Views of the project site are most noticeable to westbound travelers. The project is not visible from the town of Carlin due to a low ridge north of town. Visibility of the project site is limited along State Highway 766 for a distance of about 3½ miles northwest of Carlin due to a low ridge. The only mine facility visible from State Highway 766 in the area southeast of Gold Creek Estates is the Maggie Creek Ranch Reservoir embankment in Section 29, T34N, R52E.

Potential viewers of the project site include local residents, travelers along Interstate 80, and recreationists. Traffic along State Highway 766 consists primarily of commuters and supply hauler traffic to the Gold Quarry Mine and other mines in the North Operations Area.

The BLM has developed the Visual Resource Management (VRM) system to classify visual resources based on scenic quality, visual sensitivity, and visual distance zones. Most lands in the study area are assigned to Class III and IV (Table 3-31 and Figure 3-16). Of the four VRM classes, Class IV allows the greatest modification of the landscape by disturbance or development (BLM 1986a).

Most of the project site is located in VRM Class IV lands. A small portion of the Tusc and MAC developments and the northern and southern ends of the North Area Haul Road are located within a strip of VRM Class III land which includes the Tuscarora Mountains. A 3-mile-wide low-visibility corridor along Interstate 80 has been designated and is managed as VRM Class II, reflecting the visual sensitivity of a relatively high number of motorists.

Visual resource contrast ratings (BLM 1986b) were established for the existing Gold Quarry operations. These ratings characterize the visual quality of the landscape based on basic design elements of form, line, color, and texture and allow visual contrast ratings to be made between the existing environment and the proposed action. Visual contrast ratings are based on the premise that the visual quality of a landscape depends on the visual contrast created between a project and the existing landscape.

Key observation points (KOPs) were selected for evaluating visual contrasts. Factors considered in selecting KOPs included angle of observation, number of viewers, duration of view, relative apparent size of the project, season of use, and lighting conditions (BLM 1986b). The KOPs were selected to represent locations on roads approaching the project site from which a person may be expected to view project features. In addition, KOP 3 was selected to represent the back-country recreationist's perspective of the project site from the Tuscarora Mountains. Five KOPs were identified and evaluated. Locations of the KOPs are shown in Figure 3-16. Appendix C contains Visual Contrast Rating worksheets for KOPs 1-5.

TABLE 3-31
Visual Resource Management System

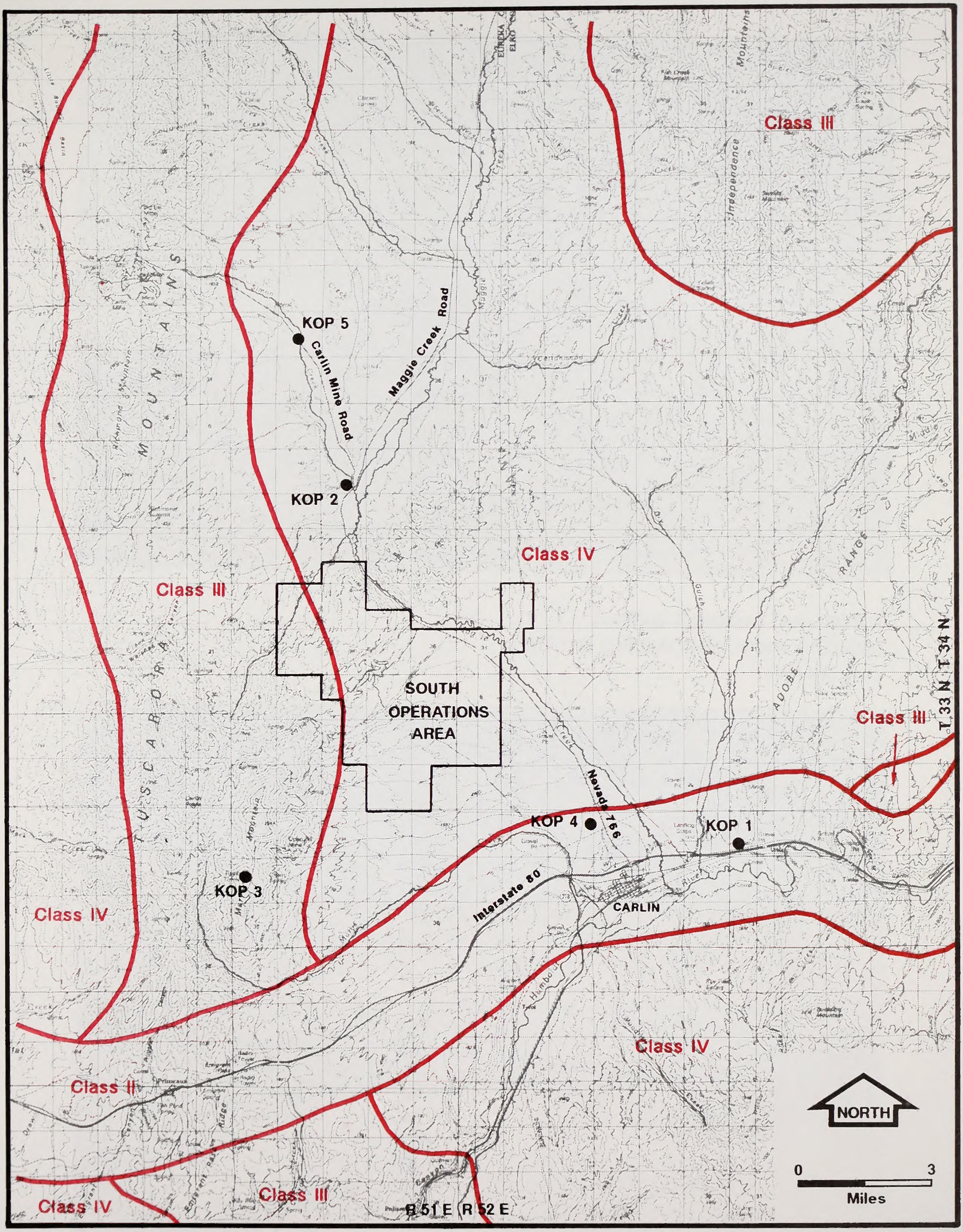
Class	Objective
I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color and texture found in the predominant features of the characteristic landscape.
III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant features of the characteristic landscape.
IV	The objective of this class is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. The impacts of these activities should be minimized through careful location, minimal disturbance and repetition of the basic elements.

Source: BLM 1986b.

KOP 1 is located along Interstate 80, a VRM Class II managed area, and represents the view seen by travelers through the region. This KOP is slightly lower than the project site and is approximately 5 miles distant. Visibility is greatest during the morning hours when the project site is front-lighted and smoke from diesel-powered equipment is more likely. KOP 1 is located at a point where westbound travelers are beginning a view of approximately 70 seconds when traveling at 65 miles per hour. Visual contrasts are moderate when the project site is front-lighted or when diesel smoke is visible. The characteristic landscape is flat to rolling, with angular forms presented by urban development in the foreground-middleground zone and existing mine facilities in the background zone. Horizontal and weak diagonal lines are stronger in the afternoon due to lighting conditions. Exposed soil colors are chalky buff and reddish tan, with vegetation colors ranging from gray-green in the foreground to gray, tan, buff, and yellowish tan in the background. Textures are generally subtle.

KOP 2 is located in a VRM Class IV area at the junction of State Highway 766 and the road to the North Operations Area (Figure 3-17). This view is typical of viewers who are traveling to the North Operations Area as well as local ranchers and hunters traveling to and from upper Maggie Creek valley. Existing mining operations are not visible from this KOP. The characteristic landscape features rolling, smoothly rounded forms with undulating, flowing lines. Vegetation offers no distinct form. Colors of exposed soil and rock range from gray and buff to tan and black. Vegetation colors are gray-green to buff with a mottled texture. Fine textures in the foreground grade into medium-coarse textures as distance increases.

KOP 3, located on the south summit of Marys Mountain, represents views by recreationists. This KOP is located near the boundary of the foreground-middleground distance zone in a VRM Class III area. Mine facilities are viewed from a much higher elevation and dominate visual



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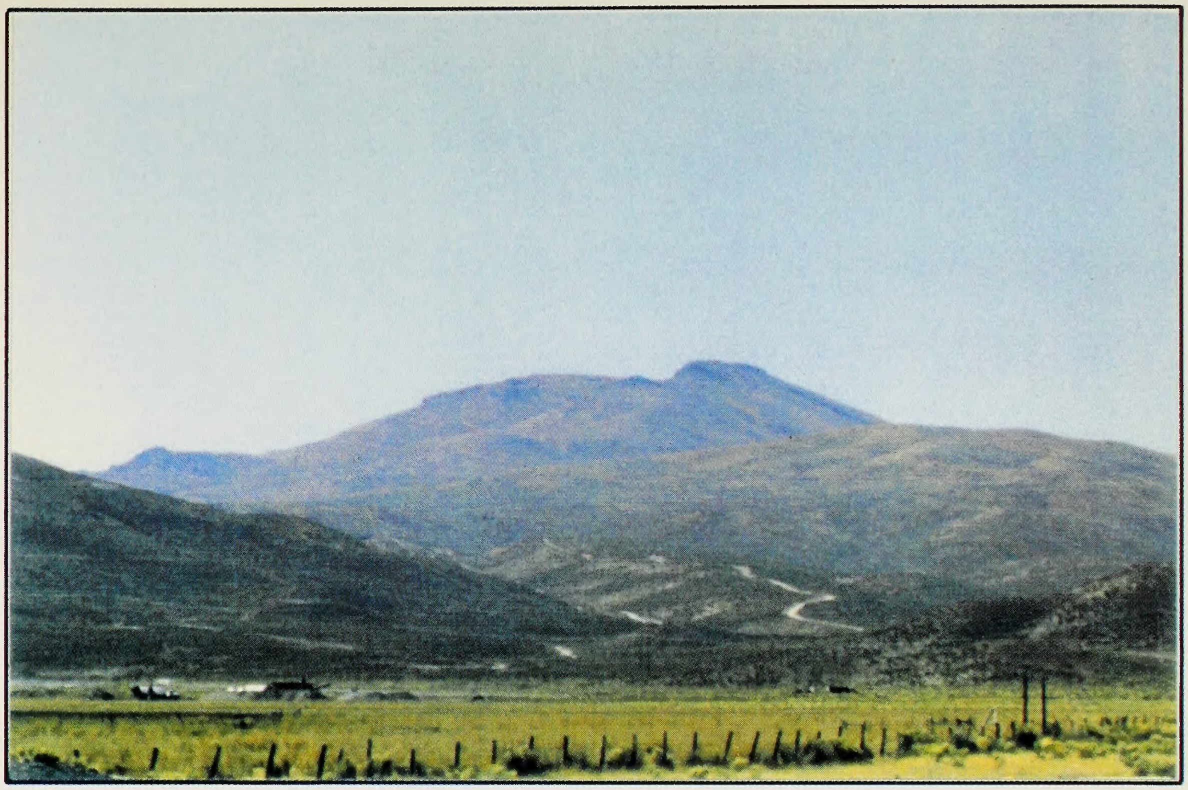
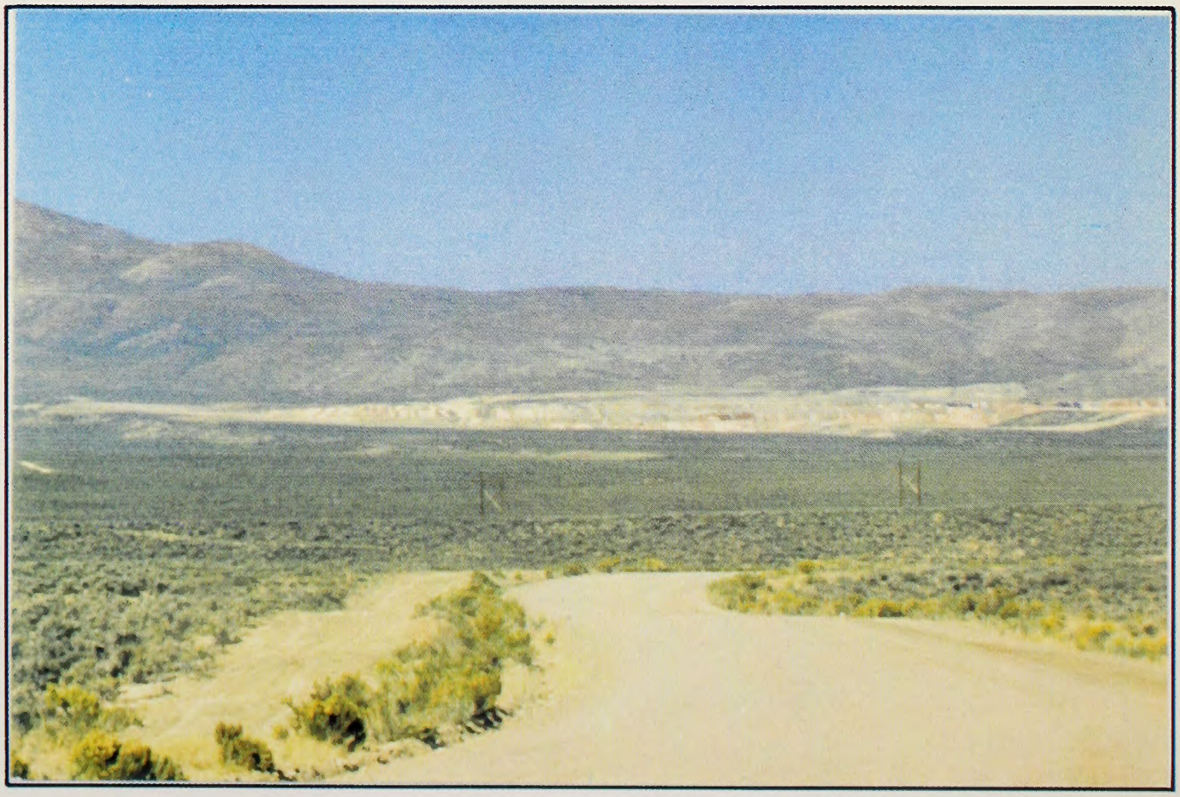
● Key Observation Point (KOP)

Visual Resource Management Class Boundary

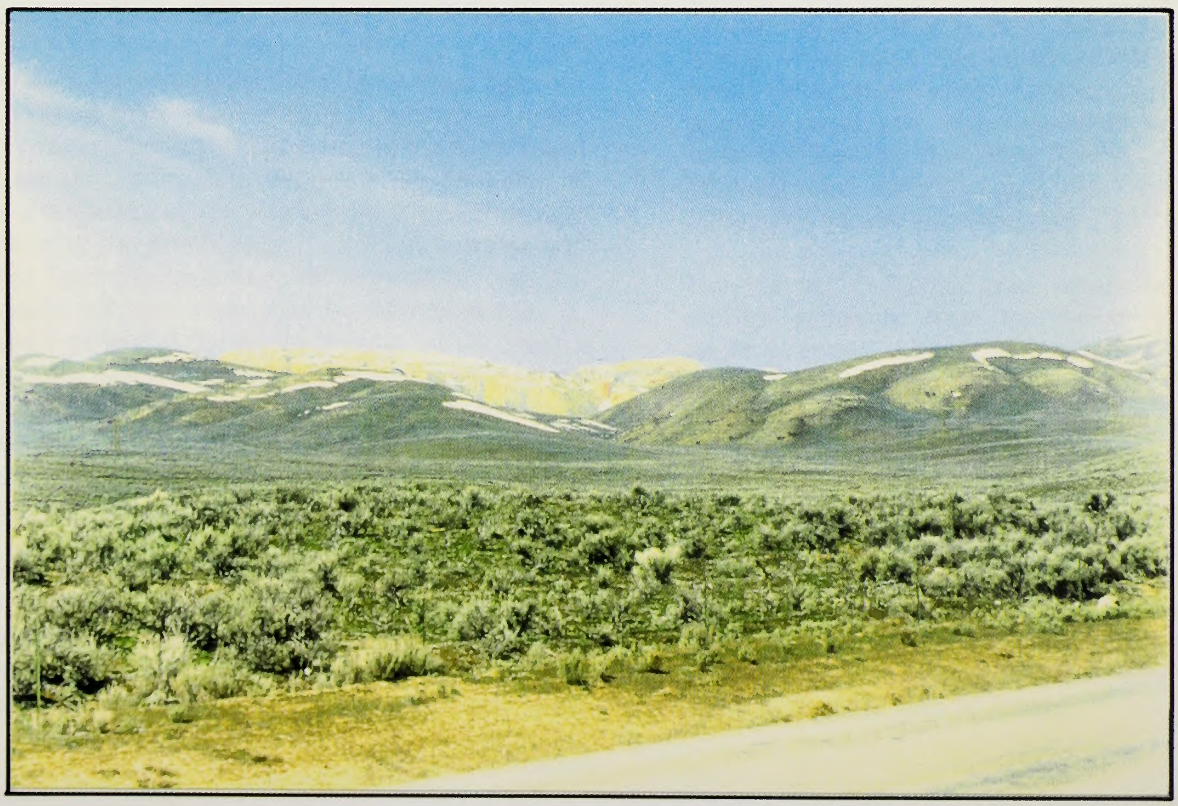
VRM Class Boundaries
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-16



Existing Condition From KOP 2
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-17



Existing Condition From KOP 4
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-18



Existing Condition From KOP 5
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-19

attention. Strong visual contrasts exist, especially in form, line, and texture. In the foreground-middleground zone, rounded, angular forms grade into flat and rolling forms. Strong diagonal lines grade into horizontal lines, with weak to moderate diagonal lines in the background zone. Coarse, contrasty textures in the foreground-middleground zone grade into smoother textures in the background zone. Predominant colors are gray, buff, gray-green, and yellowish tan.

KOP 4 is located at the junction of the Carlin landfill access road with State Highway 766. This view represents that of commuters and local residents (Figure 3-18). KOP 4 affords a horizontal view of the project site, approximately 2½ miles distant. While this KOP is located within the VRM Class II highway corridor, it is visually separated from the highway by a low ridge north of Carlin. Views are primarily to the northeast, north, and northwest, with the mine in the foreground to the northwest. The angular, geometric forms and horizontal lines of the existing mine facilities contrast moderately with the flat to rolling forms and horizontal lines of the characteristic landscape. Patchy color patterns, including dark grays and pastel reds, contrast strongly with the chalky buff and gray-green of the characteristic landscape.

KOP 5, located along Carlin Mine Road approximately 4 miles north of KOP 2, represents views by commuters and supply haulers traveling to and from the Carlin Mine (Figure 3-19). Elements of the proposed action visible from this KOP include most of the North Area Haul Road corridor and the Tusc and MAC mine developments. Two distinctly different views can be had from KOP 5. West of the KOP, the haul road would enter a canyon which is in VRM Class III. Landforms are rolling and rounded with moderate to steep slopes. Strong horizontal lines of the Carlin Mine offer moderate contrasts with the strong, broken diagonal lines of the Tuscarora Mountains. To the south and southeast, in VRM Class IV, flat to rolling forms with weak, indistinct horizontal lines in the foreground-middleground zone transition into rounded forms with smooth, undulating lines in the background zone. In both views, exposed soil and rock are reddish brown and dark gray, while vegetation colors range from gray to sage green. Textures are smooth, with moderate stippling from vegetation.

NOISE

Human perception of noise is affected by intensity, pitch, and duration. "Loudness" is measured in decibels (dB). The A-weighted sound scale (dBA) was developed for weighting the frequency spectrum to mimic the human ear. A-weighting is recommended by EPA to describe environmental noise because it is accurate and convenient and used internationally (EPA 1978). Table 3-32 contains a list of noise levels frequently experienced in daily activities.

Estimates of baseline noise at the Gold Quarry Mill 2/5 Tailing Storage Facility were made based on number and type of vehicles and machines, blasting, ore handling, and crusher operation (BLM 1991a). Actual noise measurements were not made at either the Mill 2/5 Tailing Storage Facility or the South Operations Area. Noise generated by trucks, bulldozers, and other plant site equipment ranges from 90 to 100 dBA at the source. Sound levels from blasting range from 115 to 125 dBA at 900 feet. Table 3-33 shows typical noise levels generated by mining equipment. All activities within Newmont's operations area are subject to noise regulations and guidelines imposed by the Mine Safety and Health Administration (MSHA) and the Occupational Safety and Health Administraiton (OSHA).

The nearest residential area where noise from mining activities may be heard is Carlin, approximately 7 miles from the South Operations Area. Because Interstate 80 extends along the north side of Carlin, the community is subjected to significant traffic noise. Levels of mine-generated noise (excluding blasting) were calculated to provide a cumulative baseline level of 107 dBA at a distance of 50 feet from mining activities. Estimated noise levels are 38 to 43 dBA in Carlin. Blasting occurs once a day in mid-afternoon; average noise levels are 115 to 125 dBA at a distance of 900 feet. Estimated blasting noise is 75 to 90 dBA at Carlin.

TABLE 3-32
Relative Scale of Various Noise Sources and Effect on People

Noise Level (dBA)[1]	Common Indoor Noise Levels	Common Outdoor Noise Levels	Public Reaction	Reference (70 dBA)
110	Rock band			
105		Jet flyover at 1,000 ft.		
100	Inside New York subway train		Local committee activity with influential or legal action	
95		Gas lawn mower at 3 ft.		
90	Food blender at 3 ft.		Letters of protest	4 X as loud
80	Garbage disposal at 3 ft., shouting at 3 ft.	Noisy urban daytime	Complaints likely	2 X as loud
70	Vacuum cleaner at 10 ft.	Gas lawn mower at 100 ft.	Complaints possible	Reference
65	Normal speech at 3 ft.	Commercial area, heavy traffic at 300 ft.		
60	Large business office		Complaints rare	1/2 as loud
50	Dishwasher in next room	Quiet urban daytime	Acceptance	1/4 as loud
40	Small theater, large conference room	Quiet urban nighttime		
35		Quiet suburban nighttime		
33	Library			
30	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.

TABLE 3-33
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	EPA 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] dBA = A-weighted decibel sound scale.

LAND USE AND ACCESS

LAND USE

The Study Area is located in Eureka and Elko counties, Nevada. Approximately 71 percent of Elko County is owned by the federal government and managed by federal agencies, including the BLM, USFS, and BIA. Government land is consolidated except in a wide band of "checkerboard" private and federal land on either side of the Humboldt River and Interstate 80. This checkerboard ownership was created when alternating sections of land were granted to the Union Pacific and Central Pacific railroads as an incentive to construct a transcontinental railroad.

Of the nearly 6 million acres in the Elko Resource Area, approximately 3.1 million acres are administered by BLM. The BLM, therefore, has a significant influence on resource management in Elko and Eureka counties, since its plans and policies regulate land use over much of the area. The BLM's Elko Resource Management Plan guides development of activities on these federal lands.

Typical land use in the vicinity of the study area consists of ranching, mining, and recreation. Mining is the major land use in the study area and will likely remain the principal activity for decades. Mineral exploration continues to occur throughout the area.

The proposed South Operations Area expansion involves both private and public lands. The majority of proposed facilities and mining are on private land, owned or operated by Newmont; however, portions of leach pads, waste rock piles, mining pits, and tailing impoundments extend onto public lands (see Figure 2-2).

All mining claims within the study area are owned or controlled by Newmont. Three federal oil and gas leases have been identified within the study area (N-35626, N-51688 and N-53873). A 120-kV powerline provides electricity and a natural gas pipeline supplies fuel to the South Operations Area. The following rights-of-way affecting public lands are located within the project area: Elko 1655, an aerial telephone line granted to Nevada Bell; NEV 067173, a state highway granted by Nevada Department of Transportation; N-46404, a powerline and pipeline granted to Newmont; and N-47775, a 120-kV distribution line granted to Sierra Pacific Power Co. (see Figure 2-2).

ACCESS

The Gold Quarry Mine site is located approximately 7 miles north of Carlin on State Highway 766. Highway 766 extends north from Interstate 80 along the east side of the study area parallel to Maggie Creek. Average daily traffic is estimated at 4,430 vehicles (Nevada Department of Transportation 1989).

Numerous BLM roads exist in the study area, including roads #1238, #1239, #1388, and #1390 at the Gold Quarry site. Public access on roads #1238 and #1239 (James Creek roads) has been blocked by the Gold Quarry Mine in Sections 1, 2, 10, and 12, T33N, R51E; in Sections 7, T33N, R52E; and in Section 36, T34N, R52E. BLM roads #1237 and #1391 provide access to areas north of the study area. Areas east of the study area can be accessed by BLM roads #1392, #1393, and #1394 (BLM 1986c). Access to areas west of the mining area is possible by alternate routes. The BLM roads identified on the BLM transportation system map may provide physical access but not necessarily legal access.

SURFACE WATER USE

Permitted surface water use in the project area is limited to irrigation; however, all claimants holding an irrigation water right are entitled to use the water for stock and domestic purposes if they are in priority (Hennen 1964). Surface water of the entire Humboldt River system, including all surface water in the study area, has been fully appropriated for these purposes (Hennen 1964). In most cases, withdrawal of surface water for irrigation in the study area is permitted to take place between March 15 and September 15 of each year. Water may not be withdrawn for irrigation outside of that period. However, all water right holders in the project area may withdraw water at any time of year for stock and domestic uses. Water availability for storage during the nonirrigation season has not been adjudicated (Hennen 1964).

Surface water rights in the Gold Quarry dewatering area are summarized in Table 3-34. Water rights in the study area are in effect for Maggie Creek, James Creek, Marys Creek, and the Humboldt River (NDCNR 1992c; Newmont 1992g). Surface water rights in the study area allow withdrawal of approximately 5,398 acre-feet per irrigation season (Table 3-34). This volume does not include the Humboldt River downstream from the town of Carlin. Newmont currently owns part of the Maggie Creek Ranch; historically, about 268 acres have been irrigated at this ranch.

The original allocation of water rights in the Humboldt River system depended on substantial contribution of return flows from irrigated lands. Because of increased use of storage and ditches, the percentage of water returned to the system is steadily declining. As a result, many water right holders, especially those in the lower reaches of the system, have been unable to withdraw their full appropriation.

Spring water is appropriated according to rate rather than volume. Appropriated springs in the study area are summarized in Table 3-34. Water rights for six springs in the study area have a combined appropriation rate of 4.914 cfs throughout the year. Four of the springs are appropriated by the town of Carlin and are associated with the Carlin spring system. There are water rights for springs associated with the Humboldt River adjudication that are not listed separately in the state's water rights records.

Public Water Reserve (PWR) springs claimed by BLM as federal reserved rights are located within the study area; these springs are reserved for domestic and stock purposes. If there is water in excess of BLM's needs for stock and domestic purposes, then the additional water is available for appropriation and wildlife.

GROUNDWATER USE

Groundwater in the project area is withdrawn primarily for irrigation, mining/milling, and municipal purposes (NDCNR 1992c). Groundwater has been utilized for mining/milling in the South Operations Area since 1985. Water for these purposes is produced from siltstone and carbonate aquifers and is currently withdrawn from six wells located in and near the mine pit. Cumulative production from these wells averages approximately 11.1 cfs, or 5,000 gpm (Newmont 1992f). All municipal wells are located in or near the city of Carlin.

A total of 66 water rights have been granted for use of groundwater from 83 wells in the project area. Total volume of groundwater in the study area currently appropriated as Nevada Division of Water Rights (NDWR) permits and certificates is 75.835 cfs. All wells with water rights, excluding mining/milling and construction wells, are shown in Figure 3-20 and summarized in Table 3-35. Water rights issued for each use category are summarized below:

Irrigation and Stock. The project area contains 24 wells permitted for irrigation and stock use (Table 3-35). Three of these wells are located in or near the city of Carlin, two are located adjacent to Marys Creek, 14 wells are located in the Maggie Creek drainage system, and five wells are within the Susie Creek drainage. Irrigation and stock watering wells also may be used for domestic purposes. The total withdrawal rate appropriated for irrigation and stock watering by groundwater wells in the project area is 8.548 cfs during the irrigation season.

Municipal. The project area contains six wells permitted for municipal use (Table 3-35); four of these wells are owned by the city of Carlin. All wells with municipal water rights are located near the mouths of Marys Creek and Maggie Creek (Figure 3-20). Total withdrawal rate of groundwater appropriated for municipal use by wells in the study area is 6.117 cfs.

TABLE 3-34
Surface Water Rights - South Operations Area

Water Right ID Number	Source	Location[1]			Appropriation		Ownership
		Sec	TN	RE	Acre-Feet	cfs[2]	
00224	Humboldt River (Linebarger Ditches)	34, 35	33	52	583.46		Jones
	Marys Creek				628.77		
00224	Humboldt River (Griffin Ditches)		33	52	512.84		Jones
	Maggie Creek				55.77		
00226	Humboldt River (Griffin Ditches)	33	33	52	1278.71		Tomera
00227	Humboldt River Hot Springs (Geo. Arthur Ditches)	28, 33	33	52	240.45		Jones
					35.19		City of Carlin
45509	James Creek (Geo. Arthur Ditches)	10	33	51	84.27		Jones
00322	Maggie Creek (Palmer Ditches)	26	33	52	96.00		Puett
					96.00		Elko Land and Livestock Co.
00325-00329	Maggie Creek	14, 15, 22, and 23	33	52	906.50		Elko Land and Livestock Co.
		2, 10, 11, 15, and 22	34	51	879.81		Maggie Creek Ranch
31193	Effluent	26	33	52		1.500	City of Carlin
50434	Carlin Springs	28	33	52		0.144	City of Carlin
50437	Carlin Springs	28	33	52		1.000	City of Carlin
50438	Carlin Springs	28	33	52		3.000	City of Carlin
50439	Carlin Springs	28	33	52		0.770	City of Carlin
01582	Spring	28	33	52		--	Central Pacific Railway
54712	Spring	16	34	53		--	Maggie Creek Ranch

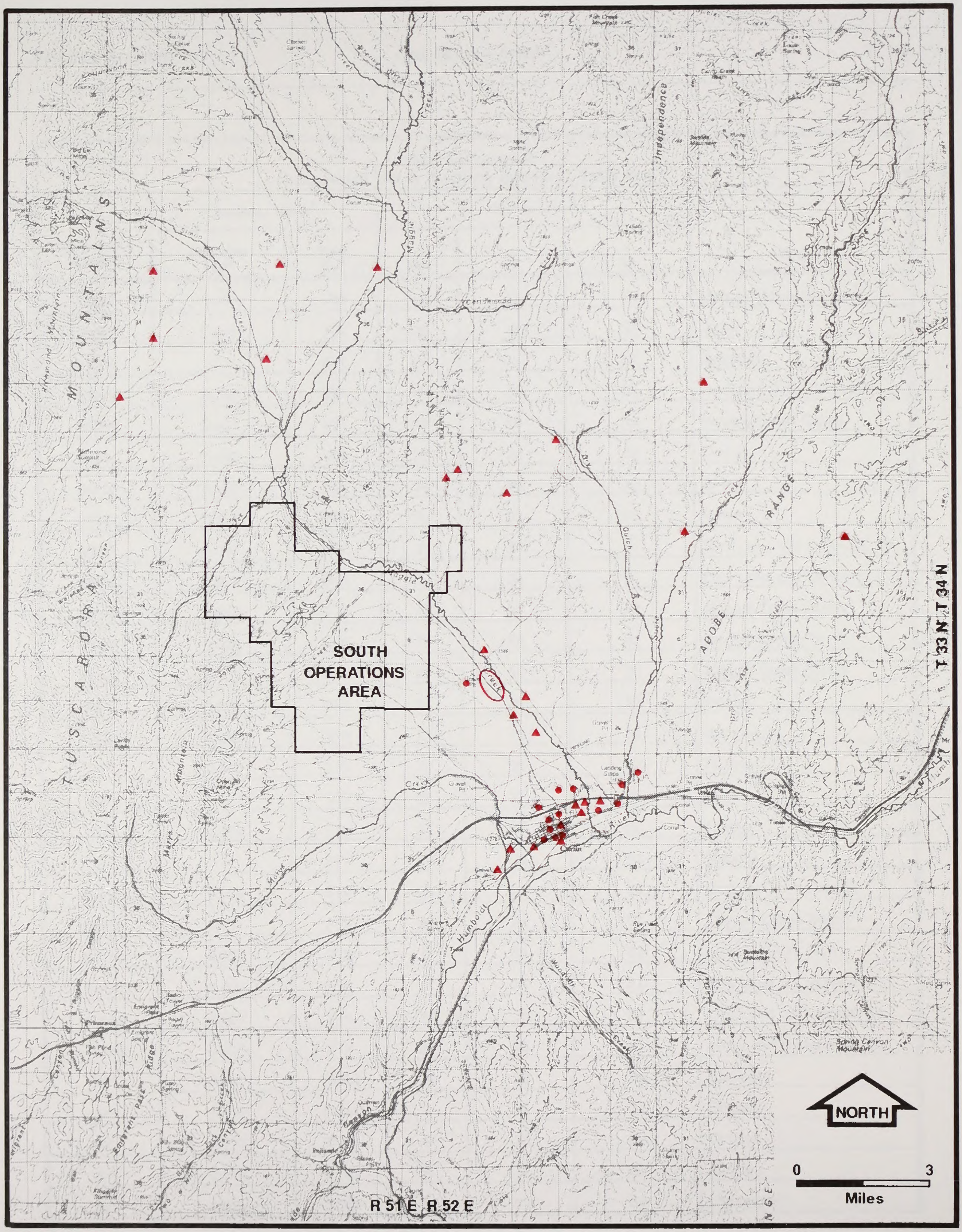
1 Sec = section; TN = township north; RE = range east.
2 cfs = cubic feet per second.

Source: NDCNR 1992c.

Domestic. Eleven domestic wells are clustered in Section 9, T33N, R52E, approximately 2 miles east of the South Operations Area (Figure 3-20 and Table 3-35). These domestic wells were installed in a subdivision development (Goldview Estates) that has subsequently been acquired by Newmont. Wells in the subdivision are screened in the range of 107 to 150 feet below ground surface and are no longer used for domestic purposes (Newmont 1992g). Two additional domestic wells are located just west of Goldview Estates and two domestic wells are in the city of Carlin. With few exceptions, a water right is not required to produce from a domestic well in Nevada.

Industrial and Commercial. The project area also contains five wells permitted for industrial, commercial, and other purposes. These wells are also located in the vicinity of the city of Carlin and have a combined appropriation of 3.097 cfs.

Mining/Milling and Construction. All wells permitted under this category in the study area are owned by Newmont, with a total of 34 wells permitted for mining and milling and one well permitted for construction. The majority of wells are located at the South Operations Area. Total rate of withdrawal currently appropriated by Newmont for mining/milling wells in the study area is 53.159 cfs. The construction well is located in the vicinity of the Maggie Creek Ranch Reservoir and is permitted for 0.5 cfs.



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▲ Irrigation or Stock Well

● Municipal, Domestic, Commercial, Industrial, or Other Well

⬭ Cluster of Domestic Wells

Groundwater Use
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-20

TABLE 3-35 (continued)
Groundwater Use in the South Operations Study Area[1]

Appropriation Number	Permitted Limits[2]		Well Location[5]			Owner
	Flow Rate (cfs)[3]	Major Use[4]	Sec.	TN	RE	
18551	5.000	IRR	16	33	52	Maggie Creek Ranch
20227	0.045	IRR	26	33	52	Jones
22214	0.011	IRR	26	33	52	Meierhoff
31273	0.040	IRR	9	33	52	Newmont Gold Company
48256	2.061	IRR	15	33	52	Maggie Creek Ranch
30987	0.280	IRR	27	33	52	Eklund
34410	0.009	IRR	34	34	52	Jones
35107	0.897	IRR	33	33	52	Jones
39872	0.009	STK	7	34	51	Elko Land and Livestock Co.
46045	0.009	STK	3	34	51	Elko Land and Livestock Co.
49319	0.012	STK	20	34	52	Maggie Creek Ranch
39438	0.026	STK	15	34	52	Maggie Creek Ranch
46662	0.045	STK	21	34	52	Maggie Creek Ranch
30971	0.040	STK	27	33	52	Eklund
42982	0.015	STK	33	34	52	Barrows
NP[6]	0.040	STK	10	34	52	Hadley
NP	--	STK	26	33	52	Puett
NP	0.034	STK	17	34	52	Hadley
NP	--	STK	26	33	52	Maudlin
49317	0.009	STK	30	34	53	Maggie Creek Ranch
52372	0.034	STK	26	34	53	Maggie Creek Ranch
53179	0.008	STK	9	34	53	Maggie Creek Ranch
39874	0.045	STK	31	35	51	Elko Land & Livestock Co.
46041	0.009	STK	27	35	51	Elko Land & Livestock Co.
46046	0.097	STK	30	35	51	Elko Land & Livestock Co.
NP	0.067	DOM	26	33	52	Carpenter
NP	0.012	DOM	9	33	52	Crouse
NP	0.112	DOM	9	33	52	Quillian
NP	0.112	DOM	9	33	52	Mathis
NP	0.033	DOM	9	33	52	Limberger

TABLE 3-35 (continued)
Groundwater Use in the South Operations Study Area[1]

Appropriation Number	Permitted Limits[2]		Well Location[5]			Owner
	Flow Rate (cfs)[3]	Major Use[4]	Sec.	TN	RE	
NP	0.112	DOM	9	33	52	Derrick
NP	0.027	DOM	9	33	52	Lloyd
NP	0.040	DOM	9	33	52	Wagnet
NP	0.034	DOM	9	33	52	Teel
NP	--	DOM	9	33	52	Sharp
NP	0.034	DOM	9	33	52	Sharp
NP	--	DOM	24	33	52	Eklund
NP	--	DOM	9	33	52	Hadley
NP	--	DOM	8	33	52	Callahan
NP	--	DOM	8	33	52	Sharp
49637	0.034	IND	25	33	52	Thatcher Chemical Co.
47027	1.000	IND	27	33	52	Southern Pacific Trans.
57117	0.500	CON	29	34	52	Newmont Gold Company
54522	0.066	COM	26	33	52	Anschutz Marketing
51981	2.000	MUN	29	33	52	City of Carlin
54522	2.000	MUN	22	33	52	City of Carlin
43131	0.167	MUN	24	33	52	Meta-Tantay, Inc.
51576	0.500	MUN	24	33	52	Nevada Prisons Dept.
50436	0.834	MUN	27	33	52	City of Carlin
52266	0.066	MUN	27	33	52	City of Carlin
47028	1.000	OTH	27	33	52	Southern Pacific Trans.
47234	1.000	OTH	27	33	52	Elko County School District

1 This table does not include 34 wells currently permitted for mining and milling by Newmont with a total appropriated withdrawal rate of 53.159 cfs.

2 Permitted limits are further limited by a total annual volume combined duty of all Newmont Gold Company water rights in the South Operations Area, currently 10,660.42 acre-feet per year.

3 cfs = cubic feet per second (flow rates from domestic wells are limited by flow capacity).

4 IRR = irrigation; STK = stock; DOM = domestic; IND = industrial; CON = construction; COM = commercial; MUN = municipal; OTH = other.

5 Sec = section; TN = township north; RE = range east.

6 NP = No water right permit required or obtained for use.

Source: NDCNR 1992c.

CULTURAL RESOURCES AND ETHNOGRAPHY

CULTURAL RESOURCES

Cultural resources are locations of past human activity, occupation, or use identifiable through inventory, historical documentation, or oral evidence. Cultural resources include archaeological, historic, or architectural sites, structures, places, objects, and artifacts (BLM 1989). Cultural resources enable an understanding of past societies' lifestyles and behaviors within an environment and not as isolated features. A cultural resource is considered more important or significant if it retains qualities associated with past events, places, and people. Cultural resources are known to exist within the South Operations Area (Figure 3-21).

Cultural History

Several overviews of the regional prehistory have been completed in the past 20 years (Tipps 1988; Elston and Budy 1990; Elston and Drews 1992). In many ways, these studies update the earlier overview of prehistory by James (1981).

Prehistory of the Great Basin can be divided into four periods: The Pre-Archaic (also called the Paleo-Indian Period) occurred prior to 8000 years before present (B.P.); the Archaic is the period from 8000 to 1450 B.P.; Late Prehistoric is considered to be from 1450 to 650 B.P.; and Protohistoric is the period from about 650 to 100 B.P. These dates are calculated back from the year 1950 A.D.

Pre-Archaic people probably depended more on hunting big game animals than on plant and seed gathering and processing. Their tool kits included Clovis, Folsom, and Great Basin stemmed projectile points, which are usually found on the surface. In Nevada, the tool kit also included large bifacial knives, crescent-shaped tools, gravers, scrapers, and chopping tools; these tools resemble those of the Plains and Southwestern Paleo-Indians (Aikens 1978; Elston 1986; Elston and Drews 1992). Living sites tend to be located along drainages and on playas next to extinct lakes. There are no known Pre-Archaic cultural deposits within the study area.

By the beginning of the Archaic, people of the Great Basin made the change from a big game hunting economy to an economy based in plant gathering. New projectile point types appear along with seed-processing tools such as manos and metates. Additional tools and materials included the atlatl, choppers, scrapers, bifaces, basketry, cordage, textiles, and skin artifacts. Locations of sites indicate that the people preferred to live along rivers and streams rather than lakes. During this period, caves and rockshelters were used for storage of goods and equipment and for burials.

The Archaic has been further divided into several phases. The earliest is called the No Name Phase (7000 to 4500 B.P.) and is not yet well understood in the area. Humboldt Series or large, side-notched projectile points occur early in the No Name Phase while Gatecliff Series projectile points appear during the last 500 years of the period (Elston and Drews 1992).

The South Fork Phase (ca. 4500 to 2800 B.P.) straddles the "boundary" between the Early and Middle Archaic. At the James Creek rockshelter, which was archaeologically excavated prior to development of the Gold Quarry pit, the oldest artifacts (ca. 3200 to 2800 B.P.) belong to this phase, including Gatecliff Series projectile points, an Elko Series projectile point, debitage, small mammal bone, and small charcoal stains. It is believed the rockshelter was used by individual hunters who visited it during the day (Budy and Katzer 1990).

Use of the James Creek Shelter continued through the James Creek Phase (ca. 2800 to 1250 B.P.), which is coincident with Late Archaic and may extend into Late Prehistoric (Budy and Katzer 1990). At the James Creek Shelter, Elko Series projectile points, hide and bone artifacts, specialized stone tools, debitage, large and small mammal bone fragments, possible grass-lined sleeping areas, and bone beads have been identified. Hearth sizes and charcoal quantities, along with the entire tool kit, indicate that use of the site had changed to a longer term campsite or base camp. The South Fork Shelter is another rockshelter in Elko County where bows, arrows, and Rosegate projectile points appeared sometime between 1630 and 1210 B.P. (Spencer et al. 1987). There is evidence that several distinct ethnic groups occupied the Great Basin during the Late Prehistoric Period. Two of these groups are the horticultural peoples who are now known as the Fremont and Anasazi. Fremont and Anasazi pottery sherds have been found at Newark Cave, Lowe Shelter, Civa Shelter II, Slivovitz Shelter, and Bronco Charlie Cave (Elston 1986). The ancestors of Shoshonean people now living in the Great Basin may have begun to infiltrate the region from the southwest (Panamint Valley, California) during the Late Prehistoric Period (Elston and Budy 1990; Bettinger and Baumhoff 1982; Young and Bettinger 1992). Remains of sagebrush, windbreak-like features associated with bison bones, overlapping hearths, and grass-lined features were found in Late Prehistoric levels of the James Creek Shelter.

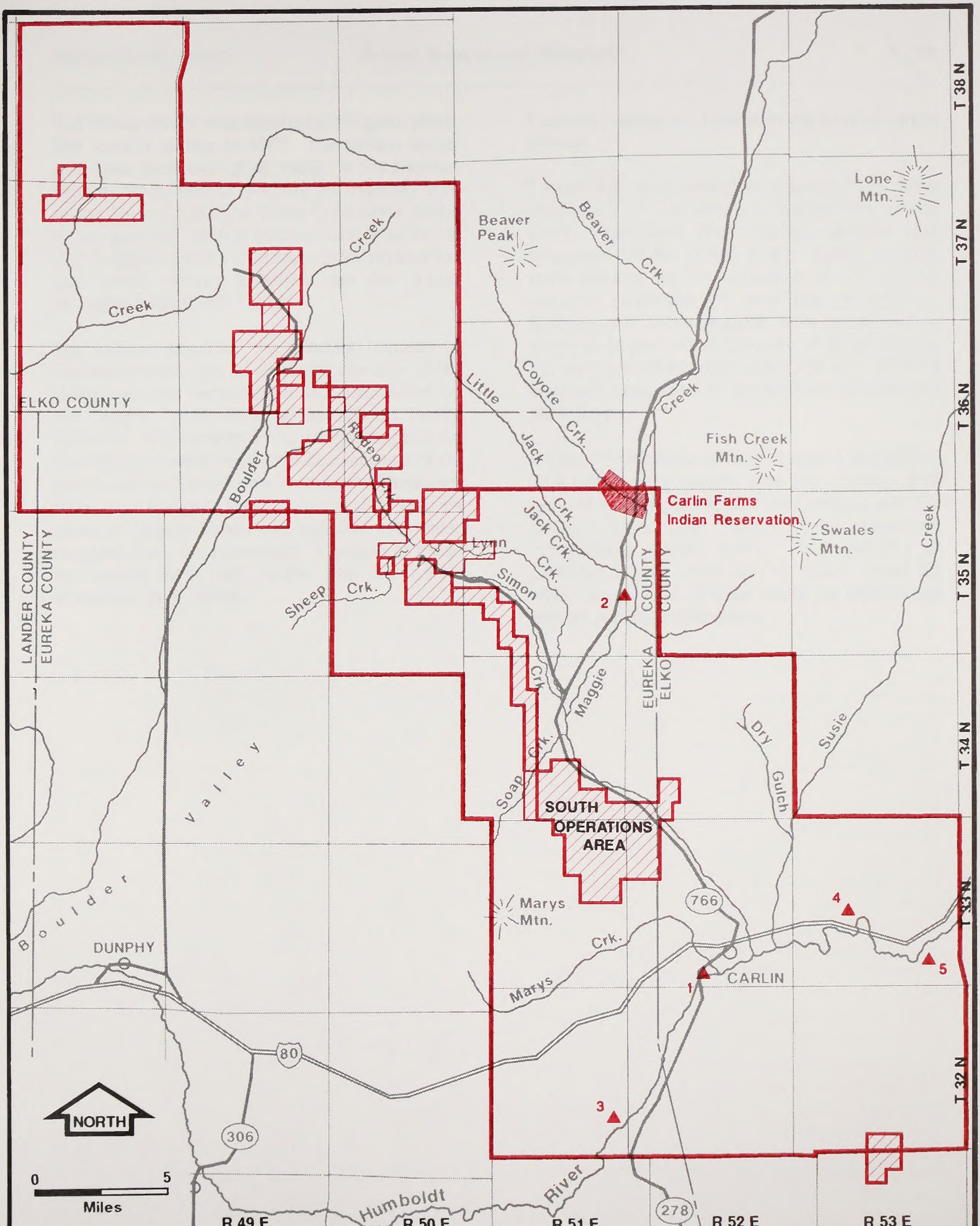
By 650 B.P., Numic peoples were living in north-central to northeastern Nevada. This date is generally used to mark the beginning of the Protohistoric Period. Their tool kits included the Desert Series (Desert side-notched and Cottonwood Series) projectile points and Shoshone brownware pottery (Shutler and Shutler 1963; Zeier 1985; Tipps 1988). A widespread population displacement in the entire Great Basin seems to have occurred at this time. This has led to an important debate in archaeology over what kind of economy is best adapted for survival in the region and how it can be identified in the ethnographic and archaeological record (Steward 1938; Bettinger and Baumhoff 1982; Simms 1983; Tipps 1988; Young and Bettinger 1992). European economic elements such as the horse infiltrated native economies within the Protohistoric Period.

The Nevada portion of the Great Basin remained unexplored by Europeans until the end of the 18th century when Mexican civil and church authorities became concerned about British and Russian activity on the periphery of their territory. The arrival of European settlers had the same effects on the Shoshonean peoples of Nevada that it had on native populations throughout the United States. Control of resources shifted from Native Americans to whites and the native populations were settled on reservations (Malouf and Findlay 1986).

By the 1830s, Americans Jedediah Smith and Peter Skene Ogden had also made exploratory incursions into Nevada in pursuit of new beaver trapping territories. Ogden's treks into Nevada resulted in his describing and mapping the Humboldt River from its source to the Humboldt Sink as well as the river's drainage system, which includes the Maggie Creek drainage. Through the 1840s, Europeans passed through Nevada on their way to California or Oregon, but it was not until about 1850 that Europeans came into Nevada to stay (Elliot 1987). The first white settlers in Nevada were traders who established trading posts supplying the needs of California-bound emigrants. Farmers, miners, and railroad workers arrived in Nevada soon after the traders came.

The first cattle and sheep to enter northeastern Nevada were passing through on their way to California. It was not until the 1870s that a ranching economy was established. Conflicts over grazing rights between cattle and sheep ranchers arose in Elko and Eureka counties. By the mid-1890s, range wars had come to northeastern Nevada, but they drew to a close after P. B. Kennedy's 1902 report on range condition successfully argued that cattle and sheep were not in competition for rangeland resources (Patterson 1969; Ulph 1969).

Mining in the Carlin area began with lignite and oil shale extraction in the 1860s and 1870s. This early mining was less than profitable and did not last long. Metals mining in the Carlin Trend began in earnest during the early 20th century.



Mining Disturbance

Study Area Boundary

▲ Winter Village

1. Badukoi, Carlin District
2. Maggie Creek District
3. Palisades District
4 and 5 Elko District

Cultural Resources and Ethnography
SOUTH OPERATIONS AREA PROJECT
FIGURE 3-21

The Midas district was developed for gold, silver, and copper mining in 1907. Production lasted until 1942 (Patterson et al. 1969). In the Ivanhoe district, production of mercury from opalite ores at the Silver Cloud and Butte Quicksilver mines began just after 1910 and lasted until after World War II (Zeier 1987). Currently, gold exploration and other mining activities can be found throughout the Carlin Trend.

The railroad provided the greatest impetus to European settlement of northeast Nevada. Both Carlin and Elko were platted and established by the Central Pacific Railroad as railroad facility locations. The need for ice to refrigerate produce heading for market resulted in development of ice ponds and an ice industry on both the Humboldt River and Maggie Creek near Carlin. The ice pond on Maggie Creek was supplied with water pumped from the Humboldt. Vestiges of these ice ponds were still visible into the 1960s (Patterson et al. 1969).

Cultural Resource Projects in the Area of Direct Effects

Twenty-two archaeological projects have been conducted on or within a quarter-mile of the South Operations Area existing facilities and proposed actions (Table 3-36). These projects have resulted in the recording of 77 cultural resource properties (41 sites and 36 isolates). Seventeen of these projects were conducted in whole or in part within the area of direct effects. For purposes of this discussion, the area of direct effects is comprised of all proposed actions and alternatives.

Of the 77 recorded cultural resource properties, 13.4 percent are historic sites and isolates, 84.2 percent are prehistoric sites and isolates, and 2.4 percent have both historic and prehistoric components (Table 3-37). The majority of prehistoric sites could not be dated; those for which some kind of date could be determined had an Archaic component.

TABLE 3-36 Cultural Resource Inventories Performed In and Around the South Operations Area of Direct Effects					
BLM Inventory Report Number	**Author and Date**	**Acres**	**Sites Found**	**Sites Revisited**	**NRHP Eligible**
1-330(N)	Nelson 1980	0.75	0	[illegible]	0
1-525(N)	Moore 1981	251	0	0	0
1-642(P)	Gallagher 1982	274/23[1]	0[2]	[illegible]	0
1-682(P)	Clerico 1983	1760	10[2]	0	0
1-727(P)[3]	Clerico et al. 1983	N/A	0	[illegible]	[illegible]
1-525(N)	Polk 1984	163.6/87.7[1]	0	0	0
1-967(P)	Metranga 1985	330.75	[illegible]	[illegible]	[illegible]
1-164[illegible](P)	Dailey 1987	10.62	1	0	0
1-1126(P)[3]	Johnson 1987	256.8	0[2]	[illegible]	0
1-1324(P)	Popek et al. 1990	640	0	0	0
1-1340(P)[3]	Popek et al. 1990	640	[illegible]	0	0
1-1341(P)	Popek et al. 1990	1,276[4]	9	0	[illegible]
1-1403(P)	Lennon et al. 1991	1,943	[illegible]	0	0
1-1501(P)	Hause 1991	60	0[2]	0	0
1-1505(N)	Popek 1991	38	0	[illegible]	0
1-1584(P)[3]	Elston et al. 1990	N/A	6	1	1
1-1606(N)[3]	Moore 1981	390	0	[illegible]	0
1-1626(N)[3]	Newsome 1992	80	0	[illegible]	0
1-1640(P)	Newsome 1992	505	[illegible]	0	0
1-1722(P)	Kice 1992	756	6	0	[illegible]
1-1725(P)	Newsome 1992	1,395	8	[illegible]	[illegible]
1-1746(N)	Tipps 1993	87	0	0	0
	TOTAL	**10,770.52/ 10,530.62**	**41**	**7**	**6**

[1] Total number of acres inventoried/acres of inventory within the South Operations Area.
[2] Cultural resources were found outside the South Operations Area.
[3] Conducted on Newmont property but not in area of direct effects.
[4] 192 additional acres were "intuitively" inventoried due to slope and previous disturbance.

TABLE 3-37 Cultural Resource Types within the Area of Direct Effects		
Cultural Resource Type	**Number of Cultural Resources**	**Percentage of Total**
Prehistoric Isolate	29	37.8
Historic Isolate	7	8.6
Rockshelter/Lithic Scatter	1	1.2
Lithic Scatter	34	45.2
Lithic Scatter/Historic Component	2	2.4
Corral/Fence	1	1.2
Mining Camp	1	1.2
Trash Scatter	2	2.4
TOTAL	**77**	**100.0**

Data presented in Table 3-37 show that 46.4 percent of the cultural resources found in the area of direct effects are isolates, another 45.2 percent are lithic scatters, and 8.4 percent are a variety of historic/prehistoric sites.

Review of the numbers of cultural resource properties represented by various artifact classes indicates the most frequently occurring class of artifact is debitage; the second most frequently occurring class of artifact is the biface and the third most frequently found class of artifact is the bottle. The presence of hearths at only the James Creek Shelter and the absence of features on other sites suggests that most prehistoric cultural resource properties represent ephemeral activity and not recurrent long-term occupations.

Cultural Resource Projects in the Study Area

One hundred thirty-seven cultural resource projects have been conducted in the Study Area. Class III level cultural resource inventories account for the majority of these projects. Approximately half of all projects are mining and minerals exploration related.

As a result of the 137 projects, 1,811[1] cultural resources were identified and recorded. Information about cultural resource types are summarized in Tables 3-38, 3-39, and 3-40. Of the 1,811 cultural resources, 292 (16.4 percent) are historic sites and isolates, 1,488 (81.6 percent) are prehistoric sites and isolates, and 31 (2.0 percent) contain both prehistoric and historic components. The majority of prehistoric cultural resources could not be dated; however, most of those that could be dated are from some time in the Archaic Period.

[1]One project resulted in the documentation of 150 cultural resource properties for which no data are available (Armentrout and Hanes 1986). Consequently, these properties were not calculated for this analysis. Conversely, the two hundred nineteen prehistoric "localities" and 242 historic "features" recorded within site 26EK3032, the Tosawihi Quarries Archaeological District (Elston et al. 1987; Zeier 1987), are included in this total."

TABLE 3-38
Prehistoric Cultural Resource Types in the Study Area

Prehistoric Cultural Resource Type	Number of Cultural Resources	Percent of Total Prehistoric Cultural Resources	Percent of Total Cultural Resources
Isolate	394	26.4	21.5
Campsite	17	1.2	0.9
Lithic Scatter	839	56.3	46.1
Lithic Scatter and Campsite	10	0.1	0.9
Lithic Scatter and Processing Locale	14	0.9	0.7
Rockshelter/Cave	38	2.5	2.0
Rockshelter with Lithic Scatter and Rock Art	1	0.1	0.1
Quarry/Lithic Procurement	151	10.1	2.0
Quarry and Rockshelter	10	0.6	0.5
Quarry and Campsite	1	0.1	0.1
Unspecified Artifact Scatter	6	0.4	2.0
Unspecified Artifact Scatter with Rock Art/Cupule Boulders	1	0.1	0.1
Processing Locale	2	0.2	0.2
Cache	2	0.2	0.2
Unknown	2	0.2	0.2
TOTAL	**1,488**	**100.0**	**81.6**

TABLE 3-39
Dual Component Cultural Resource Types in the Study Area

Dual Component Cultural Resource Type	Number of Cultural Resources	Percent of Total Dual Component Cultural Resources	Percent of Total Cultural Resources
Prehistoric Isolate with Historic Feature(s)	1	3.2	0.1
Lithic Scatter and Trash Scatter	16	51.6	0.9
Lithic Scatter and Camp with Trash Scatter	3	9.7	0.2
Lithic Scatter with Historic Component	3	9.7	0.2
Lithic Scatter with Camp with Historic Feature(s)	1	3.2	0.1
Lithic Scatter with Unspecified Historic Component	3	9.7	0.2
Prehistoric Campsite with Trash Scatter	2	6.5	0.1
Quarry with Historic Isolate	1	3.2	0.1
Quarry with Trash Scatter	1	3.2	0.1
TOTAL	**31**	**100.0**	**2.0**

TABLE 3-40
Historic Cultural Resource Types in the Study Area

Historic Cultural Resource Type	Number of Cultural Resources	Percent of Total Historic Cultural Resources	Percent of Total Cultural Resources
Isolate	18	6.2	1.0
Trash Scatter/Dump	19	6.5	1.0
Trash Scatter and Feature	1	0.4	0.1
Mine/Mining Camp	5	1.0	0.3
Mining Related Features[1]	242	82.8	13.4
Railroad Grade and Trash Scatter	1	0.1	0.1
Railroad Structure/Facility	3	1.0	0.2
Industrial Structure/Facility (Nonrailroad)	1	0.4	0.1
Bridge	1	0.4	0.1
Fence/Corral	1	0.4	0.1
TOTAL	**292**	**100.0**	**16.4**

[1] Historic sites in Tosawihi Quarries Archaeological District only.

ETHNOGRAPHY

Since general ethnographic inquiry tends to be broad in scope, the following discussion addresses ethnographic issues relevant to both the area of direct effect and the area of cumulative effect. Consequently, neither the area of direct effect nor the area of cumulative effect has been discussed individually.

Newe/Western Shoshone History

The South Operations Area (area of direct effect) is within both the traditional territory of the Newe/Western Shoshone and the geographic boundaries established under the Ruby Valley Treaty of 1863.

At contact, the Newe/Western Shoshone groups located nearest the South Operations Area were the Palisade, Carlin, Elko, and Maggie Creek districts (Steward 1938) (Figure 3-21). These districts were made up of small family groups living independently. Each district's territory included several semi-permanent camps where members of various families joined together for festivals and communal harvesting of plants, animals, and fish (Steward 1938; Elston and Budy 1990; Thomas et al. 1986).

The Maggie Creek District had a winter village midway up Maggie Creek about 20 miles north of the Humboldt River (Figure 3-21). There are no historic population estimates for the Maggie Creek District, but early sources note that people from both the Snake River and the Upper Humboldt occasionally wintered in Independence Valley, immediately north of Maggie Creek. Historic documents specifically mentioning the Newe/Western Shoshone along Maggie Creek or elsewhere within the area are scarce. In 1829, Peter Skene Ogden, a Hudson Bay Company fur trapper, reported a large group of Indians living along Maggie Creek (Williams 1971 in Elston and Budy 1990).

The Newe/Western Shoshone gathered a variety of seeds and roots including cattail, arrowcane, tule, chenopod seeds, prickly-pear, wild onion, bitterroot, and yampa. Animals harvested included deer, antelope, bighorn sheep, small game, beaver, ducks, groundhogs, gophers, and rats. Prior to the development of irrigation, Lahonton cutthroat trout were also present throughout the Maggie Creek Drainage (Elston and Budy 1990).

Historically, the Newe/Western Shoshone farmed and continued to hunt and gather in the Maggie Creek area. They worked on Euro-American farms and ranches in Carlin. According to Clemmer (1990a), they continued to use winter camps along Maggie Creek and there was competition with white settlers over water and cultivated land.

The Carlin Farms Indian Reservation was created in 1873 and terminated in 1876. It occupied 52.61 acres along Coyote Creek at its juncture with Maggie Creek (Figure 3-21) (Inter-Tribal Council of Nevada 1976). Descendants of the people who farmed on the Carlin Farms Reservation can be found in Battle Mountain and on the Duckwater Reservation.

Land claim disputes, specifically interpreting The Ruby Valley Treaty, remain an ongoing social and political issue among the Newe/Western Shoshone. Although the U.S. Supreme Court in 1985 determined that the Western Shoshone had been paid for the lands covered by the Treaty of Ruby Valley, many Newe/Western Shoshone argue that the land has never been ceded to the U.S. Government. The ideology of this movement is further reflected through Newe/Western Shoshone traditionalism wherein there is a link to the aboriginal territories geographically defined by the Ruby Valley Treaty.

Newe/Western Shoshone Worldview

According to Newe/Western Shoshone traditional theology, when they became humans, everything was under water except the tops of the mountains. When the water receded, people descended to the foothills where there were springs (Saggie Williams in Western Shoshone Sacred Lands Association 1982). The people were then told, "Anything that comes to the world after the drying up of the water shall be your relative" (Tom Austin in Lowie 1925). Consequently, plants, animals, and spirits (e.g., Little Men and Water Babies) are considered by the Newe/Western Shoshone to be their relatives.

According to Newe/Western Shoshone spiritual beliefs, the world is permeated by "Puha", a power that flows over the landscape and has an affinity for water. Puha is attracted to all life, and remains present in places where people lived; this includes archaeological sites and especially graves (Rusco and Raven 1992). Even though this power is diffused throughout the landscape, it also concentrates "in web-like currents linked to mountain peaks and water sources" (Miller 1983). The Newe/Western Shoshone visit springs to gather medicinal herbs and water and to show their respect to such spirits as Water Babies (female spirits who live in artesian springs). Spirits "travel widely in all forms of water, even irrigation ditches" (Miller 1983) and influence the well-being of the Newe/Western Shoshone.

Traditional Newe/Western Shoshone society is made up of a network of economic and social activities as well as kin ties (Steward 1938). Spiritual as well as economic ties extend to plants and animals considered to be relatives of the Newe/Western Shoshone. Newe/Western Shoshone spiritual activities center on acquiring and properly using Puha and maintaining the proper relationship among humans, plants, animals, sun, earth, water, and spirits. The most frequent expression of traditional Newe/Western Shoshone peoples' spiritual relationship to their environment is through prayer. Prayer is important at localities where spirits are believed to live and where Puha is concentrated (i.e., power spots). Power spots are commonly associated with water (springs, lakes, water holes, rivers, and creeks), mountains, mountain passes, hidden valleys, caves, or the tops of prominent, isolated rock formations (Clemmer 1990a, 1990b; Harris 1963; Hultkrantz 1986; Janetski 1981; Liljebald 1986; Malouf and Smith 1947).

Tosawihi chert, found at prehistoric quarries in the northernmost portion of the cumulative effects area, is a source of Puha for Newe/Western Shoshone who identify themselves as Tosawihi (Clemmer 1990a, 1990b). Tosawihi Shoshone territory traditionally included "the Humbolt River Valley around Battle Mountain, the lands drained by Rock Creek, and other northern tributaries of the Humbolt from as far west as Golconda or Winnemucca and east to the Independence Mountains" (Rusco and Raven 1992). Tosawihi chert is collected and used in doctoring, as a protective charm, and is carried by participants in the Sun Dance (i.e., the Sioux).

Consultation

Formal consultation with members of the Newe/Western Shoshone community was undertaken to assess the effect of the proposed South Operations Area expansion on Newe/Western Shoshone traditional values, practices, properties, and/or human remains and cultural items. This consultation consisted of a detailed review of historic ethnographic literature and interviews with Newe/Western Shoshone individuals knowledgeable about traditional and/or spiritual ways.

Consultation initially took the form of letters. This was followed up with phone conversations and face to face interviews. Because some of the Newe/Western Shoshone people contacted were unable to visit the project area, a videotape of the area and its associated archaeological sites was made available. Thirty-three individuals located throughout Idaho, Utah, Wyoming, and Nevada were contacted. The results are detailed in a report entitled *Consultation With The Western Shoshone Regarding the Proposed Expansion of Newmont's Gold Quarry Mine Carlin, Nevada* (Deaver 1993).[2]

[2]One traditional Newe/Western Shoshone group that requested to visit the project area was unable to do so due to poor weather conditions. It is anticipated that this field visit will take place in April of 1993. Pending the results of this consultation, revisions to the document may occur.

Based on the consultation, the following statements characterize the general concerns of Newe/Western Shoshone traditionalists as they pertain to mining activities:

1. Ground-disturbing activities associated with mining can disrupt the flow of spiritual power (Puha) as well as the distribution or disposition of spirits (e.g., Little Men and Water Babies). Maintaining access to undisturbed concentrations of Puha (power spots) and continuing relationships with the spirits is integral to spiritual life.

2. Dewatering efforts, with the resultant reduction or loss of flow to springs, could alter the distribution or disposition of spirits associated with water. Maintaining a relationship with these spirits is integral to spiritual life. Spring water is also used as a sacrament, medicinally, for drinking, in prayer, etc.

3. Ground disturbance results in the loss of plants gathered and used by Western Shoshone traditionalists.

4. Cultural resource inventories conducted by archaeologists prior to mining activities often result in collection of artifacts that Western Shoshone traditionalists consider to be powerful/sacred objects (e.g., complete projectile points and items of Tosawihi chert). Current curation practices can prevent traditionalists from securing these items for use in healing practices, etc.

SOCIAL AND ECONOMIC RESOURCES

The socioeconomic study area encompasses Elko and Eureka counties and the communities of Elko, Carlin, and Spring Creek, and the Elko Band Colony. Because the South Operations Area project is located in Eureka County and will receive increased tax revenues, the county has been included in the study area. It is anticipated that most employees and their families would not reside in Eureka County due to long commuting distances between the mine and Eureka County communities. Baseline conditions of Eureka County are addressed for fiscal conditions and not social life and community services because of the negligible impact anticipated on social life and community services.

SOCIAL LIFE

History

The social and economic character of Elko County and surrounding northeastern Nevada reflects a history of occupation and nomadic use by Indians followed by an influx of explorers and settlers who initiated agricultural and industrial development and founded permanent communities. Agriculture and mining developed concurrently in the Humboldt Valley. Coal was mined in limited quantities in 1869 from the Humboldt Valley Coal Mine south of Elko. Prospectors discovered the Cave Creek deposits on the east side of the Ruby Range in 1869, which later produced gold, silver, copper, lead, and zinc. Mining booms developed with the discovery of gold in the Tuscarora, Lone Mountain, Cope, and Railroad mining districts.

The second major mining boom in Elko County began in 1969, a century after the rich strikes of the late 1800s, with the opening of the Cortez, South Beowawe, and Carlin Gold mines. Newmont's Carlin Mine pioneered the extraction of submicroscopic gold from ore through cyanide leaching. Cyanide leaching technology has expanded along the Carlin Trend.

Social Well-Being

History of human interaction in Elko County has had a strong influence on today's community structure and social fabric. Influx of Euro-Americans, Basques, Chinese, and Hispanics into the area for mining and other economic purposes has resulted in cultural diversity. Historic conflicts between Indians and nonIndians over natural resource use and land remain a cultural and land management issue that has persisted for decades and contributes to social distance between some Indians and nonIndians. The cultural distinctiveness of the Basques has been retained in Elko County through language, customs, and shared historical experience and ancestry.

The history of mining with its booms and busts and influxes of people of varied nationality and ethnic background has shaped the social and economic character of Elko County. Mining is a way of life for many county residents and the colorful past of northeastern Nevada's mining towns has contributed to the area's cultural richness.

Over the last decade, rapid population growth in Elko and Carlin due to mining and associated development has been the dominant force shaping the social and economic character of these communities. Influx of new residents has led to changes in some features of daily life such as increased traffic, overcrowded parks, and higher crime rates. Increased economic development also has resulted in low rates of unemployment, a greater range of services, and increased business opportunities.

Residents of the Study Area value the small-town atmosphere of Elko, Carlin, and surrounding residential areas. Quiet neighborhoods, friendly neighbors, and peaceful country living are qualities often attributed to the Elko area. Residents generally are proud of the area in which they live and believe that there is a sense of "community" among most residents. Outdoor recreational opportunities (e.g., hunting, camping, fishing, and four-wheeling) and the natural environment are also important to many residents.

Negative features of the area identified by Elko residents include high retail prices, insufficient selection of goods and services, isolation from major population centers, and few organized social and recreational activities for young people. Some people do not like the harsh climate, dust, lack of trees, and environmental changes brought about by mining.

Most residents perceive the local economy as growing as a result of mining and associated developments and believe that jobs are relatively abundant, but not necessarily in higher paying occupations. Although the economy is thought by many residents to be "booming," an often-mentioned downside to the rapid growth is that prices of homes and other commodities have greatly increased. Increased prices stress those on fixed incomes or with relatively low-paying jobs.

Social problems in the study area include domestic violence, alcohol or other drug abuse, and excessive gambling. People generally perceive that the community is dealing with these problems through law enforcement, but that other measures are necessary to bring about significant improvements. Increased access to counseling and expanded recreational opportunities, particularly for young people, are thought to be measures that would help reduce social problems.

Many residents believe that positive changes have occurred in the study area over the past 5 years. More shopping with greater diversity of goods, improved recreational opportunities, more services such as banking, improved maintenance of roads and other community services, and better law enforcement are positive changes often mentioned by residents. Negative changes perceived by residents over the past 5 years include increased criminal activity, alcohol and other drug abuse, and traffic.

Social stratification in the study area is associated with income levels, length of residence, educational attainment, and ethnic background. People in higher income brackets are considered to have the most influence in the community.

Social processes of the study area are influenced by factors and interests outside the area. Decisions concerning development of mines are made by corporations and regulatory agencies with little affinity for Elko and Eureka counties. Local residents perceive that state government, county commissioners, and large corporations have the most power in deciding the future of the area.

Residents of the Study Area have social and commercial ties to Elko County, primarily because it is their place of residence, but many people travel to Salt Lake City, Utah; Twin Falls, Idaho; and Reno, Nevada to make major purchases (e.g., cars, mobile homes, and furniture) and obtain specialized medical care. The social and economic sphere of study area residents encompasses a large geographic area because of the great distances from Elko to other major population centers.

POPULATION TRENDS AND DEMOGRAPHIC CHARACTERISTICS

Nevada's population grew by 50 percent (401,325 individuals) during the 1980-90 decade, from 800,508 in 1980 to 1,201,833 in 1990. The majority of this increase can be attributed to in-migration associated with jobs generated by the gambling-related service sector, mining industry, and construction sector.

The population of Elko County grew at an even faster pace (94 percent) during the 1980-90 period, from 17,269 in 1980 to 33,530 in 1990. The increase was primarily due to renewed exploration and mining along the Carlin Trend. During this 10-year period, Elko grew by 68 percent to a population of 14,736, Carlin by 80 percent to 2,220, and Spring Creek by an estimated 193 percent to 5,866.

Demographic characteristics of Carlin differ slightly from Elko County, Elko, and Spring Creek. Carlin has a higher percentage of males, more residents in the 18- to 44-year-old age category, fewer residents (25 years old and older) with more than a high school education, and fewer family households. These differences could be due to a larger population of miners in Carlin than in the other communities.

The Elko Band Colony, part of the Te-Moak Indian Reservation situated within the city limits of Elko, also grew in population between 1986 and 1990, from 519 to 1,158 (BIA 1986, 1991). This increase was due to construction of HUD housing at the Colony and increased opportunities for employment created by the mining industry (Woods, J. 1992). In 1990, 27 percent of Colony residents were under 16 years of age, 66 percent were between 16 and 64 years of age, and 7 percent were 65 years and older. Approximately 95 percent of the people living at the Colony are Native American (Gonzales 1992).

Nevada's population is projected to continue its upward trend, increasing 32 percent by 1997 to a population of 1,582,320 (University of Nevada, State Demographer's Office 1992). Similarly, Elko County will continue to grow in population, reaching 39,740 people in 1997, an increase of 19 percent over the 1990 population.

COMMUNITY SERVICE PROVIDERS

Education

There are seven elementary schools in the socioeconomic study area serving kindergarten through grade 6. Four elementary schools are located in Elko (Elko Grammar School #2, Mountain View, Northside, and Southside), two in Spring Creek (Sage and Spring Creek), and one in Carlin. Elko Junior High School serves grades 7 and 8, while Elko High School provides education to students in grades 9 through 12. Carlin High School serves students enrolled in grades 7 through 12. Private educational facilities include the Ruby Mountain Christian School in Spring Creek and the Christian Academy of Elko.

In 1990, the Elko County School District reported an increase of 2,800 students since 1986 due to employment associated with extensive mining activity in the Carlin Trend, with 2,100 of these students housed in temporary portable classrooms (Nevada State Department of Education, Planning, Research, & Evaluation Branch, no date). Mountain View Elementary School in Elko was a modular facility for 4 years before being replaced with a permanent building in the fall of 1991 (Nevada State Department of Education, Planning, Research, & Evaluation

Branch, no date). The State of Nevada recommends that there be no more than 15 students per teacher in grades 1 and 2, but does not set standards for other grades. School districts that exceed this limit must obtain permission from the state to do so. The Elko County School District is at or over these state recommendations in grades 1 and 2 (Billings 1993).

To meet the demand of expanding school enrollment, the school district purchases modular classrooms each year. An estimated 3,000 students are currently being taught in temporary quarters (modular schools). In general, funding is not available to construct new schools; however, a junior/senior high school facility is currently under construction in Spring Creek. The school district also plans to construct two additional elementary schools in Elko, but without additional funding, this may not go beyond the planning stage (Billings 1993).

According to Superintendent Billings (1993), the increase in number of students is associated with the increase in mining activity and a younger population moving into the Elko area. Even without an influx of population into Elko, an estimated 450 new students would enroll in the school district next school year.

Although school enrollment increased dramatically during the 1980s, enrollment decreased between 1989 and 1991 in all elementary schools except Mountain View and Elko Grammar School #2, which experienced enrollment increases of 51 percent and 12 percent, respectively. Enrollment in Elko Junior High, Elko High, and Carlin High schools experienced increases of 20 percent, 24 percent, and 3 percent, respectively, during the 3-year period (1989 to 1991).

Education of children from the Elko Band Colony is provided through the Elko County School District. A Headstart Program is housed and operated at the Colony for children between the ages of 3 and 5 and a 5-week summer school for school-aged Indian children operates at the Colony through the Elko County School District. The Elko Band Council, under contract with the BIA, provides higher education and an adult vocational program at the Colony.

Law Enforcement

Law enforcement services are provided by the Nevada Highway Patrol, Elko County Sheriff's Department, Elko City Police, Carlin City Police, and the Te-Moak Tribe of Western Shoshone Indians of Nevada. The Highway Patrol restricts its law enforcement activities to state highway systems, the Sheriff's Department is responsible for the entire county including the unincorporated towns, the Elko City Police is limited to the Elko city limits, the Carlin City Police is accountable for Carlin city limits, and the Te-Moak Tribe of Western Shoshone Indians is responsible for law enforcement on the Colony.

The number of crimes in Elko County increased significantly from 640 in 1981 to 1,491 in 1991, and the number of patrol miles traveled by Elko County Sheriff's Department officers increased from 263,263 to 433,458 during this same period (Elko County Sheriff's Department 1992). In general, law enforcement agencies within the socioeconomic Study Area are understaffed to adequately meet this increased demand for services (Harris 1992; Forbes 1992; Kranovich 1992).

The County Sheriff's Department operates the county jail, built in 1987. The jail was initially constructed to house 65 inmates, each with individual cells; however, before construction was completed, the inmate population began to increase and steps were taken to double-bunk each cell to increase the inmate housing capacity. Present staffing level of the jail is 14 deputies, 10 jailers, and one civilian control room clerk (Harris 1992).

Fire Protection

Fire protection within the socioeconomic Study area is provided by the Elko Fire Department, BLM, BIA, Nevada Division of Forestry, and Northeastern Fire Protection Department. The

Elko Fire Department, primarily serving residents within the Elko city limits and the Elko Band Colony, maintains mutual aid agreements with the Nevada Division of Forestry, BIA, and BLM. In general, the agreements specify that firefighters will assist outside of their respective jurisdictions, but recognize that their own jurisdictions have first priority (BLM no date).

The Elko Fire Department employs 15 firefighters who are also trained emergency medical technicians (EMTs) and has a 20-member volunteer firefighting unit. The fire department responds to approximately 850 medical and fire calls a year with an estimated two-thirds of the calls being for medical assistance and the remaining one-third divided among public assistance, fire, and gas spill calls (Jarvie 1992). ISO Community Risk Services, Inc., inspects the adequacy of fire departments nationwide to determine ratings for property covered by insurance companies. On an ISO scale from 1 to 10, with class 1 being the highest rating and 10 being virtually unprotected, the Elko Fire Department has a class 5 fire protection rating. The equipment and emergency vehicles used by the department are adequate, but the department could use more paid firefighters (Jarvie 1992).

The seven paid staff and 27 volunteers of the Northeastern Fire Protection Department serve the unincorporated areas of Elko and Eureka counties. More firefighters are needed to adequately serve these communities (ENSR Consulting and Engineering 1991).

Ambulance Services

The Elko County Ambulance Service, operating out of Elko General Hospital, is staffed by 32 volunteers. All volunteers are trained EMTs, a requirement of the State of Nevada; most are EMT-IIs, which qualifies them to operate defibrillator equipment, and some have received training for emergency mine rescue. Overall, the area is adequately covered by the existing number of volunteers; however, during special events (e.g., county fair, Basque Days), more volunteers are needed (Webb 1992).

The Elko County Ambulance Service is operated and financed through county funding and fees for service. The two county ambulances are in good condition. Although there is usually an adequate number of ambulances to serve the Elko area, one more vehicle is needed when there are special events (Webb 1992). No fixed-wing air ambulance service is available in Elko; however, fixed-wing aircraft from Salt Lake City are used approximately 99 percent of the time and from Reno 1 percent of the time to transport patients in need of specialized services.

The Carlin Ambulance Service, a city-run operation, is financed by the city and payment of fees for services. The service is staffed by 15 to 20 volunteer EMTs, some with emergency training for mine rescue. Two ambulances are maintained by the Carlin Ambulance Service.

Due to the close proximity of Carlin to the proposed South Operations Area, the Carlin Ambulance Service would be the first to respond to emergency requests at the mine. Newmont has no licensed ambulance and therefore is not legally authorized to transport patients from the mine site to an emergency medical facility (Webb 1992). Newmont staffs EMTs on all shifts at the mine to stabilize patients until the ambulance arrives from Carlin.

Health Care

Elko General Hospital is the only licensed hospital within Elko County. The 50-bed facility has 24 active physicians with hospital privileges to provide medical care, 92 registered nurses, 12 licensed practical nurses, 6 certified nursing assistants, 30 administrative personnel, and 15 ward clerks (Woods, M. 1992). One physician is available in the emergency room 24 hours a day (Riding 1992). The hospital offers full surgical and medical services and has an intensive coronary care unit, an obstetrics unit, and respiratory, radiology, and physical therapy departments.

There is an insufficient number of physicians in the Elko area to meet the demand for health care. Elko General Hospital is petitioning the State of

Nevada to designate Elko as "medically understaffed." In addition, the hospital and Elko Regional Medical Center are trying to recruit physicians to the area by offering $10,000 to physicians who relocate to Elko to practice medicine. The shortage of physicians has created long waits for patients scheduling appointments and long office hours for physicians treating patients. Many patients travel to Twin Falls, Salt Lake City, or Reno for medical care rather than waiting to be treated by physicians in Elko (Elko Free Press 1993).

Approximately 16 physicians are on staff at the Elko Regional Medical Clinic and two more physicians will be hired at the clinic in the near future (Phillips 1993). The clinic has a fully-equipped laboratory and X-ray facility. Physicians at the clinic offer specialties including internal medicine, obstetrics and gynecology, orthopedic surgery, pediatrics, physical therapy, urology, cardiology, family and general practice, general surgery, and ear, nose, and throat (Holdren 1992). Appointments with the physicians usually are scheduled within 2 to 3 weeks unless it is a serious problem in which case the clinic tries to schedule the patient as soon as possible (Phillips 1993).

Spring Creek Clinic, a satellite office of Elko Regional Medical Clinic, employs a general practitioner, an internal medicine physician, and a nurse practitioner. Most appointments with the general practitioner are scheduled on the same day, although in some cases it may take up to a week; appointments with the internal medicine physician usually are scheduled within 2 weeks; and appointments with the nurse practitioner are generally on the same day (Houston 1993).

The Eureka County Medical Clinic, located at Carlin, employs one physician assistant. Most patients are able to schedule an appointment on the same day. The clinic also sees walk-in patients (Podborny 1993).

Eight dentists, including an endodontist and an orthodontist, offer dental services in Elko. One dentist offers family dental care in the community of Spring Creek. No dental services are available in Carlin. Eye care in the Elko area (including Carlin) is provided by three optometrists and one ophthalmologist.

Out-patient mental health services are provided by the Elko Community Mental Health Center associated with the Rural Clinic Division of Nevada Mental Hygiene and Mental Retardation. In addition to out-patient services, the clinic provides primary emergency services to the Elko General Hospital and the Elko County Jail for patients who may be a threat to themselves or others.

Three psychiatrists, based in Reno, provide mental health services in Elko for a total of 1 day each month (two psychiatrists visit once a month and one psychiatrist visits the center twice a month). The state-funded facility is understaffed to meet the mental health demands of the community, but there is no funding available to increase the number of psychiatrists or number of hours provided by the psychiatrists (Kendall 1992).

Comprehensive medical care through the Indian Health Service is provided by the Health Center at the Elko Band Colony which opened in July 1992. The facility houses a pharmacy, a two-chair dental operatory with a laboratory, and other support services such as community health nurse, alcohol/drug prevention, and after-care programs (Gonzales 1992).

Public Assistance

Public assistance in Elko County is provided by Elko County Human Services and the Nevada Welfare Department. The General Assistance Program of Elko County Human Services assists with rent, groceries in the form of food vouchers, utilities, medical services, and food commodities. The Nevada Welfare Department offers food stamps, Medicaid, aid to families with dependent children (AFDC), low-income medical assistance, child protective services, and food supplements to pregnant women and women with infants (WIC). The Elko County Human Services is understaffed, with only two employees to dispense services to approximately 1,960 family caseloads a year (Churchill 1992). Funding for the agency is through county funds and grants. The agency is faced with a budget decrease in the county general assistance fund of $71,000 in 1993.

Under contract with the BIA, the Elko Band Council Program provides Indian general welfare assistance, adult institutional care, Indian child welfare (including foster care and institutional placements), indigent burial assistance, counseling services, and assistance with social security benefits, disability benefits, death benefits, and state Medicare and Medicaid benefits. The Elko Band Council operates two nutritional programs at the Colony--an Elders Nutritional Program and the Summer Food Service Program for Children (Gonzales 1992).

Water Supply

Elko municipal water is obtained from 18 wells. The existing system has a maximum flow capacity of 15 million gallons per day (mgpd), with peak summer usage of 12 mgpd and low usage in January of 3 mgpd. Water is stored in six storage tanks (three 3-million-gallon tanks, two 1-million-gallon tanks, and one 1.5-million-gallon tank). If the community continues to grow, the municipal water system will need to be expanded (Vega 1992).

Carlin receives its public water supply from a deep well and a spring. The water system is in good condition and has never experienced water shortages (Aiazzi 1992). Water is stored in a 2-million-gallon tank.

Wastewater Treatment Facilities

The Elko wastewater treatment facility, located west of the city, is a "fixed-film" biological sewage plant. This facility, which has undergone two upgrades since 1984, is designed to treat 3.3 mgpd and presently treats 2.3 mgpd. The system can accommodate a population of up to 26,000, or approximately 11,000 more than the existing Elko population (Williams 1992).

The Carlin wastewater treatment facility, constructed in 1990 at a cost of $2 million, is designed to serve 5,000 people (about twice the present Carlin population) at full capacity. This facility treats waste in settling ponds and disposes of treated water through a flood irrigation system (Aiazzi 1992).

Solid Waste

Currently there are seven county-maintained landfills within Elko County, including three landfills within the study area (Elko, Spring Creek, and Carlin). Since many of the landfills are approaching capacity, the county has decided to regionalize the landfills into a central landfill for the more populated areas of the county. A consultant has been retained by the county to conduct a feasibility study for regionalization of the landfills and to assist in site selection of a central landfill (Boucher 1992).

Housing

Housing in the Elko area today is expensive and limited. In the mid-1980s, due to a significant increase in mining in the Carlin Trend and subsequent influx of people into the area, people lived in overcrowded conditions, in parked cars on private property, federal land, in parking lots, and in motels and tents. To satisfy the demand for housing, developers responded with increased construction of houses and apartment complexes.

In 1990, there were 5,817 housing units in the city of Elko, of which 5,419 were occupied. Of the 5,419 occupied housing units, 61 percent were owner occupied and 39 percent were renter occupied. Fifty-one percent of the housing units were one-unit structures, 12 percent were two to four units, 10 percent were five or more units, and 27 percent were "other," including mobile homes (U.S. Bureau of the Census 1991).

In the unincorporated community of Spring Creek, there were 1,914 housing units in 1990, with 1,811 occupied units (86 percent owner occupied and 14 percent renter occupied). Forty percent of the housing units were one-unit structures, 2 percent were two- to four-unit structures, and 58 percent were "other," including mobile homes (U.S. Bureau of the Census 1991).

In 1990, there were 888 housing units in Carlin with 90 percent (or 799) units occupied. Seventy-one percent of the 799 housing units were owner occupied and 29 percent were renter occupied. Of these units, 42 percent were one-unit structures, 6 percent were two or more unit structures, and 52 percent were "other," including mobile homes (U.S. Bureau of the Census 1991).

In 1990, 87 percent of the homes sold in Elko County were in the $30,000 to $90,000 range; within this range, 38 percent were between $70,000 and $80,000 and 23 percent were between $80,000 and $90,000. A recent study indicated that 56 percent of the population in Elko County could afford a home priced at or below $70,000, but only 27 percent of the homes sold in Elko County during 1990 were $70,000 or less (University of Nevada 1991). Median rent in the City of Elko was $407 a month in 1990 compared with $470 in Spring Creek and $376 in Carlin (U.S. Bureau of the Census 1991).

Total number of active listings by the Elko County Board of Realtors as of February 1993 was 498. The average list price of homes in Elko was $110,333 for three bedrooms, $108,500 for four bedrooms, and $85,900 for five or more bedrooms. The average number of days on the market for homes in Elko was 41 days for three bedrooms, 159 days for four bedrooms, and 455 days for five or more bedrooms (Century 21 - Jensen Realty 1993).

In Spring Creek, the average list price of homes was $36,000 for two bedrooms, $73,134 for three bedrooms, $83,617 for four bedrooms, and $119,200 for five or more bedrooms. The average number of days on the market for homes in Spring Creek was 93 days for two bedrooms, 92 days for three bedrooms, 74 days for four bedrooms, and 57 days for 5 or more bedrooms (Century 21 - Jensen Realty 1993).

In 1992, there were 1,746 mobile home spaces in Elko County with 81 percent occupied, 7 percent vacant, and 12 percent owned spaces. Of this county total, there were 936 mobile home spaces in Elko with 92 percent occupied, 1 percent vacant, and 7 percent owned spaces. In Carlin, there were 128 mobile home spaces with 48 percent occupied, 23 percent vacant, and 29 percent owned spaces in 1992 (Nevada Department of Commerce 1992).

Housing is limited at the Elko Band Colony. There are 221 single-family housing units and a senior citizens/handicapped apartment complex with 10 apartments. Construction of additional housing at the Colony is not anticipated in the near future (Gonzales 1992).

Newmont's workers camp and RV park, located just outside Carlin, has 424 single-male quarters and 66 RV spaces. In January 1992, 13 percent of the single units were occupied and 65 percent of the RV spaces were occupied. During January, when construction activities are minimal, occupancy at the workers camp is low. In 1992, when Barrick was at peak construction, 28 percent of the single units were occupied and the RV park was full (Kinyon 1993).

Government and Public Finance

Primary governing bodies in Elko County are the Elko County Commissioners, the Elko County Planning Commission, the Elko County School District, the City of Elko, and the Tribal Council of the Elko Band Colony-Te-Moak Tribe of the Western Shoshone Indians. Three elected Elko County Commissioners administer funds for community services and maintenance of the infrastructure. The Elko County School District, also governed by an elected board, administers the largest portion (approximately 38 percent) of the Elko County budget. Eureka County, like Elko County, is governed by an elected board of county commissioners. The cities of Elko and

Carlin are each governed by a mayor and council which administer funds for community services (e.g., streets, water, law enforcement, fire protection, parks, and recreation).

Nearly half of Nevada's general fund revenues are derived from a 6 percent state tax on winnings from gaming. Other state taxes include a sales tax, gas tax, cigarette and liquor taxes, drug manufacturers tax, estate and lodging tax, and net proceeds of minerals tax. Nevada has a 6.5 percent sales tax of which 2 percent is retained by the state, 2.25 percent goes to local governments and school districts, and 2.25 percent goes to cities and counties.

The minerals industry is the only industry in Nevada that pays taxes to state and local governments on the basis of net proceeds. Mineral producers are allowed to deduct direct costs of production, such as mining and milling, and are taxed on the remaining amount (Nevada Department of Minerals 1991). All Nevada businesses pay sales and use taxes based on the purchase of goods.

Total assessed valuation of property collected by the state for Eureka and Elko counties in fiscal year (FY) 1990 was about $422 million and $535 million, respectively. In Eureka County, $220 million of this amount was attributable to net proceeds of minerals tax, while in Elko County, $92 million was attributable to net proceeds of minerals tax.

Over the last decade, annual tax revenues from gaming collected by the state in Elko County have increased from $37.6 million to $106.1 million. The gold mining boom in Elko County is generally responsible for increased gaming activity (Nevada Department of Administration 1990).

The biggest share of revenues for Elko County, approximately 41 percent, comes from intergovernmental transfers from federal, state, and local sources (Table 3-41). About $139,195 of intergovernmental transfers was gaming tax revenues received from the state in FY 1991 (Ritter 1993). Property and other taxes, including net proceeds of minerals tax, provide about 33 percent of Elko County revenues followed by charges for services (7 percent), fines and forfeitures (6 percent), licenses, fees, and permits (6 percent), and miscellaneous (8 percent). Of $3,740,198 received by Elko County in property tax revenues, $336,618 was net proceeds of minerals, and of the $1,069,509 from county licenses, permits, and fees, $187,693 was from gaming licenses and fees (Ritter 1993).

Approximately 49 percent of Eureka County revenues are derived from property taxes, including net proceeds of minerals tax, ($1,538,129), followed by intergovernmental transfers (39 percent) of which $140,462 was gaming tax revenues received from the state (Rebealetti 1993). Of the $14,496 of revenues from county licenses, fees, and permits, $8,467 was from county gaming licenses and fees (Rebealetti 1993).

Eureka County receives more revenues from property taxes than Elko County, primarily because of the extensive development in Eureka County (see Table 3-41). The lack of sharing of Eureka County taxes with Elko County, where many of the mining families reside, is considered a fiscal constraint by many Elko County officals and residents and an inequitable distribution of tax revenues (University of Nevada, College of Human and Community Services 1991).

In 1991, Newmont paid taxes totalling $20.3 million, with $18.4 million going to Eureka County and $1.9 million going to Elko County. Approximately 50 percent of Eureka County taxes are attributable to the Gold Quarry operations (ENSR 1991). Of the total taxes paid by Newmont in 1991, $10.1 million was derived from net proceeds of minerals tax, $2.4 million from property taxes, and $7.8 million from sales and use taxes.

Intergovernmental transfers account for the largest share (48 percent) of revenues of the city of Elko. Almost 3 percent ($117,685) of

TABLE 3-41
Revenues and Expenditures
Elko County, Eureka County, and City of Elko
(Year Ending June 30, 1992)

Revenues/Expenditures	Elko County	% of Total	City of Elko	% of Total	Eureka County	% of Total
Revenues						
Property taxes	3,740,198	21.2	839,419	9.2%	4,226,008	49.0
Other taxes	2,048,873	11.6	524,690	5.7%	--	--
Licenses, permits and fees	1,069,509	6.1	728,520	8.0%	14,496	0.2
Intergovernmental transfers	7,313,730	41.3	4,371,447	47.8%	3,355,356	38.9
Charges for services	1,181,408	6.7	714,911	7.8%	475,138	5.5
Fines and forfeitures	971,578	5.5	133,343	1.5%	54,157	0.6
Miscellaneous	1,349,688	7.6	1,834,064	20.1%	503,466	5.8
Total Revenues	**17,674,984**	**100.0**	**9,146,394**	**100.0**	**8,628,621**	**100.0**
Expenditures						
General government	4,497,448	25.9	532,939	4.2%	1,836,875	34.4
Judicial	3,635,561	20.9	69,749	0.6%	312,285	5.9
Public safety	1,666,071	9.6	2,955,561	23.5%	918,219	17.2
Public works	3,453,028	19.9	5,630,130	44.8%	1,392,779	26.1
Health and sanitation	102,938	0.6	358,251	2.9%	366,824	6.9
Welfare	768,102	4.4	12,205	0.1%	51,816	1.0
Culture and recreation	1,823,595	10.5	1,260,626	10.0%	283,817	5.3
Community support	289,236	1.7	38,983	0.3%	--	--
Intergovernmental	74,492	0.4	465,098	3.7%	149,000	2.8
Airport general operation	10,796	0.1	87,566	0.7%	--	--
Airport terminal	--	--	29,785	0.2%	--	--
Miscellaneous	--	--	726,931	5.8%	--	--
Debt Service	350,000	2.0	--	--	24,786	0.5
Principal	682,575	3.9	195,805	1.6%	--	--
Interest	2,365	<0.1	200,252	1.6%	--	--
Total Expenditures	**17,356,207**	**100.0**	**12,563,881**	**100.0**	**5,336,401**	**100.0**

Source: Nevada Department of Taxation, Local Government Finance, Carson City, Nevada. 1993.

intergovernmental transfers is received from Elko County gaming licenses and fees. Approximately 10 percent ($76,325) of revenues from licenses, permits, and fees is from city gaming licenses and fees (Lipparelli 1993).

EMPLOYMENT

Employment in Nevada in 1991 was dominated by service industries, which accounted for approximately 44 percent of the state's jobs. Retail and wholesale trade, the next largest employment sector, provided about 20 percent of jobs statewide. Approximately 2 percent of jobs statewide were in the mining industry (Nevada Employment Security Department 1992a).

In 1990, mining directly employed approximately 13,500 workers and indirectly provided jobs for 30,000 or more workers (Nevada Department of Minerals 1991). Indirect employment from mining includes jobs that supply materials and services to miners such as tires, fuel, equipment, drilling, and consulting. In 1991, Newmont employed 1,415 workers at the Gold Quarry operations.

Employment in Elko and Eureka counties differs from the state as a whole. In 1990, of the 15,130 workers in Elko County, 9 percent were employed in mining (Nevada Employment Security Department 1991a). Of Eureka County's 3,890 workers, 93 percent were employed in mining. Miners in Eureka County made up about 27 percent of the state's employment in mining, whereas miners in Elko County made up 10 percent. Residence of the 2,155 active workers employed at the South Operations Area as of March 1, 1993 was: Elko County, 97.4 percent; Eureka County, 0.3 percent; State of Nevada (not in Elko or Eureka counties), 1.4 percent; and out-of-state, 0.9 percent (Newmont Gold Company 1993h).

In 1990, the largest employer in Elko County was the service industries sector, employing 41 percent of the county's workers. This was followed by the trade sector (20 percent) and government (16 percent). Average annual unemployment rates for Elko and Eureka counties for 1992 were 5.6 and 1.9 percent, respectively (Benson 1993).

The Elko Band Council, the Te-Moak Tribe, the Te-Moak Housing Authority, the Bureau of Indian Affairs, and the U.S. Indian Health Service are the basic employers of the Elko Band Colony (Gonzales 1992). The rate of unemployment is 18 percent for the labor force 16 years of age and older, able to and seeking work (BIA 1991).

INCOME

Service industries in Nevada provided approximately 40 percent of the statewide payroll in 1991, while mining provided about 4 percent (Nevada Employment Security Department 1991b). In Elko County approximately $55 million (17 percent of the total county payroll of $318 million) came from mining, whereas in Eureka County approximately $140 million (91 percent) of the total county payroll of $154 million came from mining. In 1992, Newmont's estimated payroll in Elko and Eureka counties was $100.7 million with $45.9 million paid to workers at the South Operations Area. Ninety-seven percent of the payroll paid to workers at the South Operations Area was to residents of Elko County, less than 1 percent to residents of Eureka County, and 2 percent to residents of either the State of Nevada (not in Elko or Eureka counties) or to out-of-state residents (Newmont Gold Company 1993h).

Per capita income in Nevada in 1988 was $17,521, compared with $15,052 for Elko County and $22,139 for Eureka County. Eureka County had the highest per capita income in the state, whereas Elko County ranked eleventh of 17 counties (Nevada Department of Administration 1990). In 1990, the average wage of people working directly in the mining industry was $36,000 per year, the highest of any sector of the state (Nevada Department of Minerals 1991).

CHAPTER 4

CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

INTRODUCTION

This chapter discusses anticipated direct and indirect impacts of the Proposed Action, three alternatives, and the No Action Alternative for the South Operations Area Project. In addition, irreversible and irretrievable commitment of resources, residual adverse effects, and cumulative effects are described. The Proposed Action is described in Chapter 2. A comparison of impacts between the Proposed Action and alternatives is summarized at the end of this chapter.

The three alternatives considered are: (1) operation of a cooling tower with the water treatment plant such that Humboldt River water is maintained within 2° C of ambient temperature near the mouth of Maggie Creek; (2) backfilling the MAC open-pit mine with waste rock generated from the Tusc open-pit mine; and (3) discharge of groundwater from the mine dewatering system directly to the Humboldt River by pipeline.

The Agency Preferred Alternative includes the Proposed Action and a modified version of Alternative 3. This alternative would require construction of a pipeline to transport dewatering flows which exceed Maggie Creek's bankfull capacity of 80 cfs.

Potential mitigation and monitoring measures developed in response to anticipated impacts are discussed for each resource. All actions listed as mitigation measures have been developed by BLM and are not part of Newmont's proposed action. These measures could be required by BLM or other regulatory agencies as a condition or stipulation of approval and authorization of the Plan of Operations.

Irreversible and irretrievable commitment of resources and residual adverse effects that would likely occur as a result of the proposed action and alternatives are discussed for each resource. Continued operation, closure, and reclamation of the South Operations Area would result in an irreversible or irretrievable commitment of various resources. These resources would either be consumed, committed, or lost during and after the life of the project. Nonrenewable resources, such as minerals in the ore, would be irreversibly committed during ore-processing operations. Irretrievable commitments are those that are lost for a period of time. Residual adverse effects would be those impacts remaining after implementation of mitigations. Cumulative effects result from incremental effects of the action when added to other past, present, and reasonably foreseeable actions.

Impacts associated with the Agency Preferred Alternative would include those discussed under the Proposed Action and Alternative 3. Some of these impacts, however, would be reduced by implementation of the Agency Preferred Alternative because Alternative 3 would be modified to transport only a portion of the mine water directly to the Humboldt River. The Agency Preferred Alternative would also include modification of the lower Maggie Creek channel to minimize erosion and sedimentation that would occur as a result of increased flows in the creek. This would necessitate a Section 404 Permit from the U.S. Army Corps of Engineers. Selected mitigation measures identified in this chapter for the Proposed Action and Alternative 3 would be required by BLM in the Record of Decision.

GEOLOGY AND MINERALS

SUMMARY

Direct impacts of the Proposed Action and alternatives (except the No Action Alternative) on geologic and mineral resources would be limited to excavation and relocation of waste rock and processed ore and the removal of gold. Alternative 2 (backfilling of the MAC Mine pit) would reduce the likelihood of future recovery of 70,000 to 80,000 ounces of known gold reserves. These direct impacts would not be mitigated.

Indirect impacts would involve potential discharge of acidic water from waste dumps and refractory ore stockpiles. Ongoing and proposed waste encapsulation and monitoring programs would be expected to adequately detect and mitigate these potential indirect impacts. Potential instability of waste dumps, tailing storage facilities, and pit slopes would be mitigated through proper design and construction.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Direct impacts of the Proposed Action of the Gold Quarry, MAC, and Tusc mines on geologic and mineral resources would include relocation of approximately 181 million tons of waste rock and 151 million tons of processed ore to various waste disposal areas, tailing storage facilities, and leach pads. In addition, approximately 7 million ounces of gold would be extracted from the geologic resource.

Indirect impacts of the Proposed Action could arise from placement of potentially acid-producing material in waste rock disposal areas and refractory ore stockpiles. Rain and snowmelt infiltrating through waste rock and ore piles could potentially cause an acidic discharge through contact with these materials.

Newmont has estimated that approximately 44 million tons of the waste rock produced over the life of the proposed South Operations Area Project may be potentially acid producing. Table 4-1 describes six types of waste rock from the Gold Quarry pit and identifies two as potentially acid producing (Knight Piesold and Co. 1992).

To further investigate the acid-producing potential of the Gold Quarry waste rock, a composite sample was subjected to a 10-week humidity cell test. This procedure is similar to the more definitive testing required under the existing waste rock monitoring plan (see Chapter 2, Existing Operations). The composite sample included equal amounts of all rock types except limestone (Table 4-1), which was purposely omitted to eliminate carbonate neutralization. Table 4-2 presents acid-producing potential of the composite sample and Table 4-3 depicts results of the humidity cell test (Knight Piesold and Co. 1992). Although the composite sample shows a strong potential to produce acid, the humidity cell test did not indicate net production of acid (no lowering of pH or increase in acidity). These results indicate that mixed waste rock characterized as potentially acid producing, even in the absence of strongly neutralizing limestones, may not generate acid.

TABLE 4-1 Ore/Waste Rock Acid-Producing Potential					
Sample No.	**Rock Type**	**AGP[1]**	**ANP[2]**	**NANP[3]**	**Acid[4] Producing?**
1	Carbon Sulfide Refractory, Unoxidized Ore/Waste	87.5	4.2	-83.3	Yes
2	Silica Sulfide Refractory, Unoxidized Ore/Waste	25.6	5.6	-20.0	Yes
3	Dolomitic Limestone, Oxidized Waste	0.6	768.	+767.	No
4	Carbon Sulfide Refractory Limestone, Unoxidized Waste	8.1	809	+801.	No
5	Silica Sulfide Refractory,Oxidized Ore/Waste	1.2	18.1	+16.9	No
6	Hydrothermally Altered Siltstone Waste	0.3	1.0	+0.7	No

[1] AGP = acid-generating potential (tons $CaCO_3$/1000 tons material).
[2] ANP = acid-neutralizing potential (tons $CaCO_3$/1000 tons material).
[3] NANP = net acid-neutralizing potential (ANP - AGP).
[4] Newmont's criterion for potentially acid producing is a negative NANP.
[4] Newmont's criterion for potentially acid-producing is a negative NANP.

Source: Knight Piesold and Co. 1992.

TABLE 4-2 Composite Waste Rock Sample Acid-Producing Potential					
Sample No.	**Rock type**	**AGP[1]**	**ANP[2]**	**NANP[3]**	**ANP/AGP[4]**
1	Carbon Sulfide Refractory, Unoxidized Ore/Waste	87.5	4.2	-83.3	0.05
2	Silica Sulfide Refractory, Unoxidized Ore/Waste	52.6	5.6	-20.0	0.22
5	Silica Sulfide Refractory, Oxidized Ore/Waste	1.2	18.1	+16.9	15.08
6	Hydrothermally Altered Siltstone Waste	0.3	1.0	+0.7	3.33
Composite Sample Average Values		**28.7**	**7.2**	**-21.5[5]**	**0.25[5]**

[1] AGP = acid-generating potential (tons $CaCO_3$/1000 tons material).
[2] ANP = acid-neutralizing potential (tons $CaCO_3$/1000 tons material).
[3] NANP = net acid-neutralizing potential (ANP - AGP); Newmont's criterion for potentially acid producing is a negative NANP.
[4] ANP/AGP = ratio of ANP to AGP; Nevada Division of Environmental Protection criterion for potentially acid-producing material is ANP/AGP < 1.2.
[5] Values obtained from AGP and ANP composite sample averages.

TABLE 4-3 Composite Waste Rock Sample Humidity Test Cell Results For pH and Acidity					
Week	**pH**	**Acidity (mg/L $CaCO_3$)**	**Week**	**pH**	**Acidity (mg/L $CaCO_3$)**
1	8.48	<10	6	8.65	<10
2	8.34	<10	7	7.82	<10
3	8.42	<10	8	8.78	<10
4	7.92	<10	9	8.57	<10
5	8.45	<10	10	8.49	<10

Source: Knight Piesold and Co. 1992.

Two samples from beneath the proposed waste rock disposal areas were analyzed for acid-neutralizing potential. The samples were determined to have substantial neutralizing capacity (66.4 and 98.6 tons $CaCO_3$/1,000 tons material) (Knight Piesold and Co. 1992) and therefore may contribute additional neutralizing capacity for acidic conditions.

The proposed South Operations Area Project operating plan includes encapsulating approximately 6.3 million tons of potentially acid-producing waste rock in the Mill 2/5 tailing dam. The remaining 38.0 million tons of potentially acid-producing waste rock would be encapsulated in the South Waste Rock Disposal Area. This area would be monitored for both waste rock chemistry and discharge of acidic water.

Because tests show the refractory ore to be potentially acid producing (Table 4-1), ore stockpiles may be a source of acid drainage (and elevated heavy metal concentrations) over the life of the operation. These stockpiles are not expected to exist after project closure, and thus have relatively short-term potential for producing acid drainage. The following factors are expected to adequately mitigate or detect potential formation and discharge of acid water: (1) the area's arid climate, acid-neutralizing soils, and relatively deep groundwater table; (2) construction of compacted clay pads beneath stockpiles; (3) temporary closure of stockpiles older than 2 years; and (4) Newmont's monitoring program.

Because oxide ore would be mined from the MAC and Tusc pits, neither the pits nor the waste rock disposal areas are expected to be potential sources of acid drainage.

Design and construction procedures that prepare waste rock dumps, tailing storage facilities, and mine pit slopes for normal conditions as well as earthquakes (see Chapter 3, Geology and Minerals, Area Seismicity) are expected to adequately mitigate the potential for instability.

Alternatives 1, 2, and 3

Direct and indirect impacts on geologic and mineral resources for the three alternatives would be the same as those for the Proposed Action with the exception of an additional direct impact associated with Alternative 2. If Alternative 2 (backfilling the MAC pit with waste rock from the Tusc pit) is implemented, the likelihood of further mining of the MAC geologic ore reserve would be reduced and may be cost-prohibitive. As a result, an estimated 70,000 to 80,000 ounces of known gold reserves that are economically recoverable at a gold price of $400 per ounce would be retained in the geologic resource (Newmont 1993h).

No Action Alternative

The No Action Alternative eliminates proposed future expansion and avoids potential direct and indirect impacts of the proposed action. It also eliminates the recovery of approximately 7 million ounces of gold from the geologic resource.

POTENTIAL MITIGATION AND MONITORING MEASURES

The following mitigation and monitoring measures are required for the Proposed Action and alternatives:

- Continuation of the existing waste rock monitoring program as defined by the Mill 2/5 Water Pollution Control Permit (NDEP 1991).
- Finalization and NDEP acceptance of the Draft Refractory Stockpile and Waste Rock Dump Monitor Plan (Newmont 1993a) as stipulated in the Mill 2/5 Record of Decision (BLM 1991b).

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Approximately 7 million ounces of gold would be removed from the geologic resource.

RESIDUAL ADVERSE EFFECTS

No unmitigated residual adverse impacts to the geologic resource would be expected.

PALEONTOLOGICAL RESOURCES

SUMMARY

Impacts on paleontological resources potentially would result from physical disturbances associated with expansion of the South Operations Area and excavation of the MAC and Tusc pits. Where appropriate, Newmont would identify and preserve fossil remains discovered during mine-related activities.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Vertebrate and invertebrate paleontological resources have been documented to occur within the study area, primarily in Tertiary sediments (Carlin Formation). Neither vertebrate nor invertebrate fossils are unique or site-specific to the study area. Impacts on fossils would usually be direct, caused by physical disturbance.

Because fossils are usually buried, there is no way of confirming their location or distribution until excavation occurs. Most excavation associated with the proposed action would be shallow, primarily affecting the unconsolidated soil surface. The exception to this would be expansion of the Gold Quarry Mine pit and excavation of the MAC and Tusc pits.

Potential impacts on paleontological resources from the Proposed Action would be limited to areas of disturbance. Activities that disturb Tertiary sediments should be conducted with an awareness that vertebrate fossils may be present.

Alternatives 1, 2, and 3

Impacts on paleontological resources resulting from any of these alternatives would be the same as those discussed under the Proposed Action. Impacts would be limited to areas of development.

No Action Alternative

The No Action Alternative would eliminate potential impacts on paleontological resources in areas of proposed development. Closure and abandonment of the South Operations Area would involve soil replacement, regrading, recontouring, and other reclamation activities that may cover or uncover previously unknown fossils, depending on the location and type of disturbance.

POTENTIAL MITIGATION AND MONITORING MEASURES

When fossils are discovered during mine development or operational activities, steps would be taken to identify them and preserve them when appropriate. Newmont would contact the BLM to determine the steps necessary for recovery of fossils.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible and irretrievable commitment of paleontological resources would occur as a result of the proposed action if fossils are encountered. The majority of paleontological resources identified to date in the BLM Elko District are invertebrate fossils and have been assigned the lowest (S-3) significance rating by Firby and Schorn (1983). Only those in the James Creek locality have warranted further study, and they were collected by Firby (1990) prior to construction of the James Creek Tailing Storage Facility.

RESIDUAL ADVERSE EFFECTS

No residual adverse effects on paleontological resources are anticipated as a result of the Proposed Action or alternatives.

AIR RESOURCES

SUMMARY

Mining, ore-processing, and construction activities at the South Operations Area would be a source of suspended particulates and diesel exhaust. Overall, air quality would remain at or near present levels since the mining rate would not change. Additional gaseous pollutants from the proposed refractory ore roaster would not be expected to exceed national ambient air standards. Mitigation and monitoring measures beyond those currently employed at the South Operations Area are not proposed.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Air quality in the study area would be affected by operation of the Gold Quarry Mine, MAC and Tusc Mines, and the refractory ore roaster. Other nearby mining and ore-processing operations would also affect local air quality. Mining and construction activities would be a source of both total suspended particulates (TSP) and 10-micron-or-smaller (PM-10) particulates. Ore-processing operations and diesel exhaust from heavy equipment would be the primary sources of gaseous pollutants such as sulfur dioxide, oxides of nitrogen, and carbon monoxide.

Emissions from the Gold Quarry, MAC, and Tusc mines would remain at or near present levels since the mining rate would remain the same. Air pollutants resulting from ore processing would increase with the addition of a refractory ore roaster. The ore milling rate would not increase appreciably; however, the roaster would increase gaseous pollutants.

Particulates

Particulate emissions from mining and construction would be caused by drilling, blasting, excavation, loading, hauling, and dumping of waste rock and ore. Particulate emissions from ore processing would result from crushing, handling, and storage of ore. Measures to reduce emissions include minimizing drop heights during loading, watering and chemical stabilization of haul roads, and use of water spray, water fog, or baghouse fabric particulate control during crushing and ore handling. In addition to particulates resulting from construction, mining, and ore processing, ambient particulates from wind erosion, traffic on unpaved roads, home heating, agricultural operations, and other sources exist within the study area.

Ore from the Gold Quarry Mine contains minor amounts of metals. No air quality data for metals are available for the Gold Quarry Mine ore and waste rock. However, metal concentrations in air from rock at the Betze Mine have been less than half the significance level established by NDEP.

During roasting operations, mercury would be removed through use of the Boliden Norzinc process, which relies on reaction of metallic mercury vapor in the gas with mercury chloride, $HgCl_2$, to form Hg_2Cl_2 or calomel. The process uses a reactor vessel, pump tank, settling and reaction tanks, bulk chlorine, zinc dust, and agitator and storage tanks. There would be no air emission stacks in the process and therefore no mercury emissions.

Gaseous Emissions

Natural background levels for gaseous pollutants are low with no significant sources. The proposed South Operations Area roaster would be a source of gaseous air pollutants including sulfur dioxide, carbon monoxide, oxides of nitrogen, and volatile organic compounds. Other sources of these pollutants would include vehicle exhaust, emissions from ammonium nitrate and fuel oil (ANFO) used as blasting agents, and operation of the Barrick-Betze autoclaves northwest of the South Operations Area.

In the existing heap leach process, sodium cyanide solution is maintained at a pH in excess of 10 through use of lime and caustic. If the pH were allowed to drop, hydrogen cyanide gas (HCN) could form and be released to the atmosphere. By maintaining a high pH level, HCN emissions from the leach pads would be minimized.

Air Quality Model

As part of its application for a construction permit from the Nevada Bureau of Air Quality, Newmont utilized dispersion models to analyze impacts on air quality from existing and proposed ore-processing operations at the South Operations Area. The models addressed all milling and leaching operations which include: mills, kilns, crushers, boilers, and dryers. These models utilized meteorological data collected on-site along with actual terrain information associated with a network of receptors. Predicted concentrations of PM-10 particulates, carbon monoxide, sulfur dioxide, ozone, and nitrogen dioxide are shown in Table 4-4, along with national ambient air quality standards (NAAQS) for these parameters. None of the predicted air pollutant concentrations approach or exceed the NAAQS. Additional PM-10 concentrations resulting from the proposed South Operations Area expansion would be minimal. Since the nearest PSD Class I area (Jarbidge Wilderness)is located 60 miles away, no effects from the project are expected on Class I air quality or visibility.

Alternatives 1, 2, and 3

Impacts on air resources resulting from any of the three alternatives would be the same as those discussed under the proposed action. Ambient air standards would not be expected to be exceeded. Elevated TSP and PM-10 levels may result from short-term construction activities.

No Action Alternative

The South Operations Area is permitted to conduct mining operations through December 1994. Impacts on air resources resulting from the No Action Alternative would be the same as those discussed under the proposed action until mine closure begins in January 1995. Subsequent activities would include recontouring, regrading, topsoiling, and revegetation of waste rock disposal, mill tailing storage, and all other disturbed areas. These activities would likely generate PM-10 and TSP emissions until reclamation is complete.

POTENTIAL MITIGATION AND MONITORING MEASURES

No mitigation or monitoring measures beyond those presently employed are proposed.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

No irreversible and irretrievable commitment of air resources would result from the Proposed Action or alternatives.

RESIDUAL ADVERSE EFFECTS

No residual adverse effects on air resources would be anticipated as a result of the Proposed Action or alternatives. With cessation of mining and completion of reclamation activities, air quality would be expected to approach pre-mining conditions.

TABLE 4-4
Air Quality Concentrations Associated With South Operations Area Ore Processing

Pollutant	NAAQS[1] ($\mu g/m^3$)	Averaging Time	Predicted Concentrations ($\mu g/m^3$)[2]
Carbon Monoxide	6,670 40,000	8 Hours 1 Hour	15 35
Nitrogen Oxide	100	Annual	1
Sulfur Dioxide	80 365 1,300	Annual 24 Hours 3 Hours	1 11 44
PM-10[3]	50 150	Annual 24 Hours	1 19
Ozone	235	1 Hour	2

[1] NAAQS = national ambient air quality standards.
[2] $\mu g/m^3$ = micrograms per cubic meter.
[3] PM-10 = 10-micron particulate size.
Source: Newmont 1992e.

WATER RESOURCES

SUMMARY

Expansion of the South Operations Area would require dewatering as the mine pit deepens and ultimately extends approximately 800 feet into the groundwater system. Declining groundwater levels surrounding the mine pit would create a cone of depression that would affect flows of some springs, seeps, and streams in the study area. When dewatering ceases at the end of year 2001, the Gold Quarry Mine pit would begin to fill with groundwater; water depth would eventually approach the pre-mining water table elevation. Flows from impacted springs, seeps, and streams would begin to recover in about year 2005.

Most springs in the mountains are perched and therefore are not likely to be affected by mine dewatering. Based on the extent of groundwater drawdown predicted by a numerical groundwater model, up to 25 spring and seep sites could be adversely impacted through reduced or lost flows in the vicinity of the Gold Quarry Mine pit. Some of these sites include more than one spring or seep located in a group. The Carlin "Cold" Spring system used by the town of Carlin as a water supply source is predicted to have a significant reduction in baseflow. Some groundwater wells also would be impacted by the cone of depression; however, only one existing private well is predicted to be completely dewatered. Water table drawdown would extend in a generally circular pattern approximately 5 to 10 miles from the mine pit. Maximum impacts on springs, seeps, and groundwater levels would occur roughly between years 1998 to 2005, followed by groundwater recovery to within 10 feet of pre-mining levels by year 2042.

Excess water from the dewatering system would be treated and discharged to Maggie Creek under the Proposed Action. Primary impacts associated with this discharge of excess water would include stream erosion and changes in water temperature. Flow in lower Maggie Creek and the Humboldt River could increase by up to about 104 cfs during the dewatering period. Significant erosion would occur in the lower Maggie Creek channel as a result of the mine discharge, and sediment load would increase in the Humboldt River below the Maggie Creek confluence. Temperature of surface water in lower Maggie Creek and the Humboldt River would increase down to Palisade for the proposed action during the dewatering period. No adverse impacts on surface water quality would be expected because a proposed water treatment facility would be employed to meet standards to be established in a pending NPDES permit.

The cone of depression would reduce flows in some streams in the project area during and/or after the dewatering period. Affected streams would include middle and lower Maggie and Susie creeks, and lower Marys Creek (primarily the Carlin "Cold" Springs). Some reaches of Maggie Creek tributaries north and west of the mine, including James, Soap, Simon, and Lynn creeks, also could experience loss of or reduction in streamflow. Flow in the Humboldt River between Carlin and Palisade would be reduced by as much as 19 cfs after dewatering ceases. These reductions in surface water flow would be most significant during the first 10 to 20 years after cessation of mining. It may take nearly 100 years for flows to completely recover to pre-mining conditions.

Alternatives that would affect water resources include operation of the water treatment plant cooling tower to maintain ambient Humboldt River water temperatures near the mouth of Maggie Creek (Alternative 1) and direct discharge of mine water to the Humboldt River via pipeline (Alternative 3). Operation of the cooling tower associated with Alternative 1 would reduce the temperature of water discharged to Maggie Creek and the Humboldt River to near ambient conditions. The alternative of direct discharge to the Humboldt River would eliminate adverse impacts to lower Maggie Creek caused by discharge of mine water. However, baseflow in lower Maggie Creek and Susie Creek would be reduced during dewatering.

The Gold Quarry Mine pit would eventually fill with groundwater to an ultimate depth of 800 feet. Most of the pit lake would form during the first 10 to 20 years after the dewatering system is discontinued. A study utilizing laboratory tests and computer models was conducted to predict the quality of water that would collect in the mine pit. Ultimate quality of mine pit water is predicted to be similar to or better than existing groundwater in the ore zone because of: (1) carbonate rock in the pit that prevents development of acidic conditions; (2) removal of the mineralized zone and associated groundwater during mining; and (3) adsorption and deposition of trace metals on ferric hydroxide.

Additional direct and indirect impacts associated with the Proposed Action could occur as a result of new or expanded mine facilities. Disturbed areas such as waste rock disposal sites, ore stockpiles, leach pads, mine pits, pipeline corridors, roads, and ancillary facilities would have increased erosion potential. Waste rock and ore stockpiles also would have potential for generating acidic drainage.

DIRECT AND INDIRECT IMPACTS

Direct and indirect impacts on groundwater and surface water resources would result from the South Operations Area Project. These impacts would be associated primarily with the dewatering activities necessary to allow mining below the groundwater table.

Proposed Action

Dewatering System

Groundwater currently is pumped from wells at the South Operations Area for purposes of dewatering, milling, processing, environmental controls, and other related activities. The rate of groundwater pumping would increase for the proposed expansion as the mine pit deepens and intercepts greater amounts of groundwater. Dewatering of the mine pit would be required until the end of year 2001, after which groundwater withdrawal would be significantly reduced to meet continued ore processing and reclamation demands through year 2009. Predicted groundwater withdrawal rates until the end of year 2001 are presented in Figure 4-1. Some water would be allowed to flow into the mine pit and would be collected by sumps.

A hydrogeologic-based numerical model was developed to predict necessary dewatering rates at the Gold Quarry Mine (Hydrologic Consultants, Inc. (HCl) 1992a, 1992c). The model predicts total groundwater to be pumped, consumed, and discharged would range from an initial rate of less than 22 cfs (approximately 10,000 gpm) in 1993 to a maximum of 94 cfs (approximately 42,000 gpm) prior to the end of dewatering.

Excess water from the dewatering system would be routed to the proposed water treatment plant prior to discharge in Maggie Creek below Maggie Creek Canyon. During periods of high natural flow in Maggie Creek, excess mine water could be temporarily stored in the Maggie Creek Ranch Reservoir.

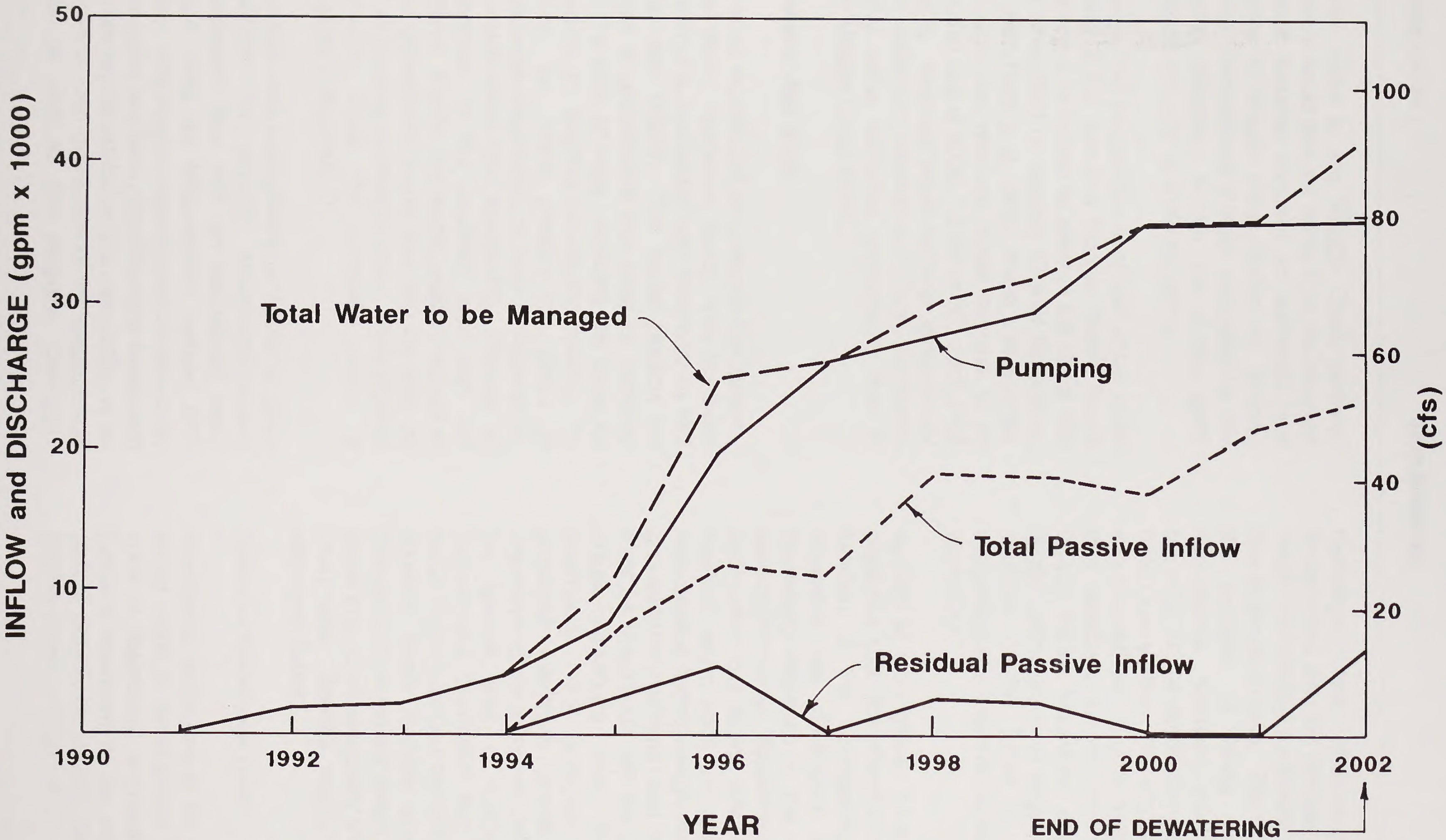
Water Treatment System

Dewatering discharge would be treated to a quality that meets National Pollutant Discharge Elimination System (NPDES) requirements to be determined by the Nevada Department of Conservation and Natural Resources (NDCNR). This permit application has been submitted by Newmont to the State of Nevada. Groundwater from several mine pit wells was used to conduct bench-scale treatability tests with five laboratories and evaluate options for water treatment. Arsenic and selenium were the metals of primary concern. Based on the five treatability tests, a chemical precipitation process was selected for the South Operations Area Project. Water quality standards specified in the NPDES permit would dictate final design of the water treatment system.

Water Storage Reservoir

The existing Maggie Creek Ranch Reservoir has a capacity of 2,700 acre-feet. Newmont's Proposed Action would increase this reservoir's capacity to 6,000 acre-feet. The reservoir would allow Newmont to withhold discharge to Maggie Creek during high-flow periods. For discharge rates of 56 cfs (25,000 gpm) and 94 cfs (42,000 gpm), the 6,000 acre-foot Maggie Creek Ranch Reservoir would provide storage capacity for approximately 54 and 32 days, respectively, assuming no storage capacity for precipitation or flood inflow. Based on a drainage area of 2,468 acres, the Maggie Creek Ranch Reservoir and spillway are designed to contain or pass the calculated 100-year, 24-hour peak discharge of 820 cfs and flood volume of 185 acre-feet (Golder Associates, Inc. 1992). Any flood waters that exceed the capacity of the reservoir would be discharged to the unnamed tributary of Maggie Creek through the spillway. If such a release were to occur, it could cause additional erosion of the Maggie Creek channel during the period of release; however, similar erosion would occur if the dam were not present due to high flows in the channel.

Stored water in the reservoir would be released to Maggie Creek by pipeline during the remainder of the year in order to make storage available for the following spring runoff period. A water management plan would be developed to optimize operation of the reservoir and periods of discharge. A maximum rate of about 10 cfs (4,500 gpm) of water could be released from the reservoir if discharge from the full reservoir is distributed evenly during a 10-month period each year. A discharge structure containing a stilling basin and channel constructed with riprap would



Source: HCI 1992a
cfs =cubic feet per second
gpm=gallons per minute

Predicted Components of Dewatering
Gold Quarry Mine
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-1

transfer water to the Maggie Creek channel. Releases would also be made from the reservoir to meet irrigation demand on additional land adjacent to Maggie Creek during the growing season. The amount of water estimated for this irrigation diversion is 5.3 cfs (2,400 gpm) averaged over a 4- to 6-month period.

Seepage and evaporation of stored water at the existing 2,700 acre-foot Maggie Creek Ranch Reservoir is projected to average 0.9 cfs or 400 gpm when filled to capacity (Golder Associates, Inc. 1992; Pettit et al. 1992). Water loss from the 6,000 acre-foot reservoir would increase to an estimated rate of about 1.3 cfs or 600 gpm at full capacity. Seepage would recharge groundwater in the underlying alluvium and Carlin Formation, causing some additional groundwater flow in lower Maggie Creek Basin.

Groundwater Flow Model

Numerical modeling of groundwater flow systems in the South Operations Study Area has been conducted in conjunction with Newmont by HCI (1992a and 1992c). The model predicts the amount of groundwater that must be removed from the mine pit area, providing the basis for designing an effective dewatering system. In addition, the model predicts the extent of groundwater drawdown, or cone of depression, that would result from dewatering. Impacts on streamflows in the modeled area also are predicted. Finally, the model predicts the rate at which groundwater would flow into the mine pit after dewatering operations cease. More detailed information about the numerical model is contained in Appendix D.

The model uses a proprietary computer program "*MINEDW*" to predict three-dimensional groundwater flow with an unconfined water surface using the finite-element method (HCI 1992c). This program was recently developed by HCI to solve problems related to mine dewatering and has special attributes (e.g., simulation of an excavation and calculation of the seepage face on the pit wall) for that purpose. Geologic, hydrologic, and climatological data were incorporated into the conceptual hydrogeologic model describing groundwater and surface water flow in the study area. The *MINEDW* model is in the process of being verified for mine applications. Newmont and HCI have provided evidence for the application of the model to the Gold Quarry Mine. The model was calibrated to known conditions, such as recharge values, water level elevations, stream baseflows, and hydraulic testing results (drawdown and recovery tests). Model calibration is an ongoing activity and will continue in the future to refine predictive capabilities and improve efficiency of dewatering operations.

As with all groundwater models, *MINEDW* is a predictive tool, the effectiveness of which is a function of the hydrogeologic data utilized. Newmont has developed a comprehensive hydrologic database in the mine pit area to support the model. Supplemental USGS regional information was incorporated into the numerical model in areas, such as boundary regions, that lack detailed hydrogeologic data. Predictions of groundwater drawdown and streamflow impacts must be considered with the understanding that actual conditions may deviate from the predictions. For purposes of this EIS, the predicted maximum extent of the 10-foot drawdown contour line was selected to represent the general area of hydrogeologic impact. Groundwater drawdown from mine dewatering would occur outside of the 10-foot drawdown line; however, these changes would be difficult to distinguish from natural variations in groundwater levels that occur seasonally and long-term in the study area. Specific results of the model are discussed below.

Impacts on Groundwater Levels

Dewatering operations at the Gold Quarry Mine would result in development of a groundwater cone of depression surrounding the mine pit. Extent of drawdown for the water table using the 10-foot drawdown contour for years 1996 and 2005 is shown in Figure 4-2.

Maximum extent of groundwater drawdown would occur in year 2005 (HCI 1992a). This water would come from groundwater storage and continued decrease in natural groundwater discharge. Water table drawdown greater than 10 feet would extend in a generally circular pattern approximately 5 to 10 miles from the Gold Quarry Mine pit (Figure 4-2). Groundwater drawdown of several hundred vertical feet would occur close to the mine pit. Drawdown would also occur outside of the 10-foot contour line shown in Figure 4-2; however, water level changes in these areas would be difficult to distinguish from seasonal or long-term variations in natural conditions. Total volume of groundwater removed by the South Operations Area dewatering system during the period 1993 through 2001 would be approximately 500,000 acre-feet (Figure 4-1).

After year 2005, the cone of depression would diminish as the pit fills with water and groundwater levels rise toward pre-mining conditions (Figure 4-2). Initial rate of water recovery in the mine pit would be relatively rapid, followed by a decreasing rate of pit infilling as hydraulic gradients into the pit decline. Groundwater in the mine pit would recover to approximately 95 percent or within 40 feet of the pre-mining level 18 years after dewatering ceases (HCI 1992a). The numerical model predicts that there would be less than 10 feet of residual drawdown throughout the Study Area within 40 years of completing dewatering operations, or year 2042 (HCI 1992a). Complete recovery of the water table may take nearly 100 years as natural recharge and discharge of groundwater in the basin come closer to equilibrium.

Some localized increases in groundwater levels would occur in alluvial material underlying the Maggie Creek Ranch Reservoir and lower Maggie Creek. Groundwater level changes below the reservoir would occur only when there is water in the impoundment. When lower Maggie Creek has additional flow during the dewatering period, groundwater levels in this area could increase.

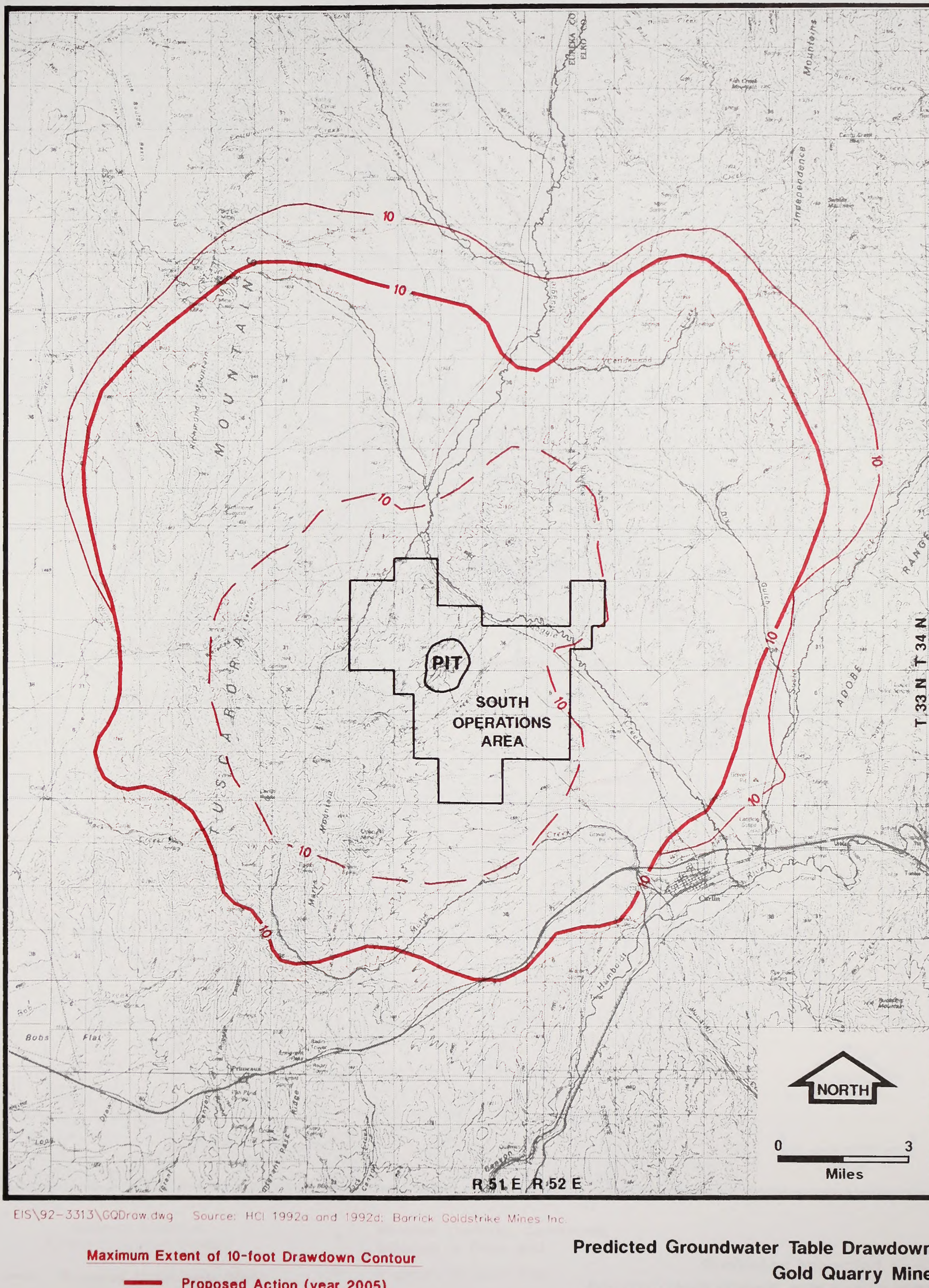
Impacts on Wells

Drawdown of groundwater due to dewatering activities would have limited impacts on some wells in the vicinity of the South Operations Area. Impacts could include decreased water yield, increased pumping costs, or possibly lowering the water level below the well or screen interval. The extent of impact would depend on the magnitude of drawdown with respect to well depth and type of aquifer(s) affected.

Locations of known wells, excluding Newmont's mining, milling, production, and monitoring wells, are shown in Figure 4-3, along with maximum extent of the 10-foot drawdown contour for the water table system. Wells outside this contour line would be relatively unaffected due to limited groundwater drawdown. After year 2005, groundwater levels within the cone of depression would begin to rise and approach pre-mining conditions.

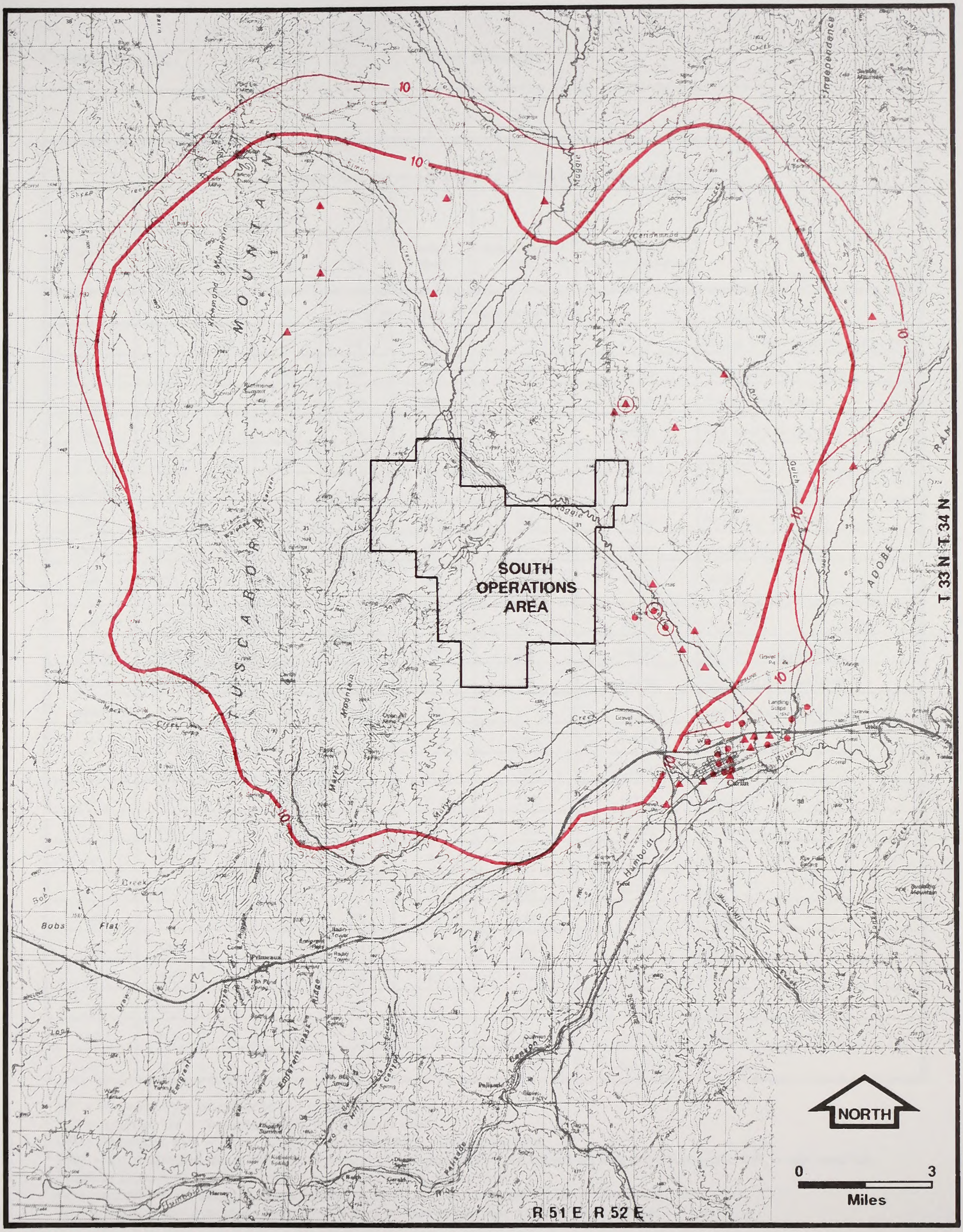
There are 13 known stock and irrigation wells and 11 domestic wells located within the maximum 10-foot drawdown contour (Figure 4-3). Depths of well screen and static-groundwater levels are reported in Table 4-5 for wells with available information. The difference between well screen depth and static water level generally is the available drawdown for withdrawal of water from a well. Table 4-5 shows that available drawdown for the stock and irrigation wells within the 10-foot drawdown area ranges from 36 to 235 feet. The cluster of 10 domestic wells shown in Figure 4-3 are located within a subdivision (Goldview Estates) owned by Newmont between the town of Carlin and the South Operations Area; these wells are no longer used. Available drawdown in these wells ranges from 52 to 125 feet (Table 4-5).

Based on the numerical model, maximum predicted groundwater drawdowns for the 24 wells located within the 10-foot drawdown area are presented on Table 4-5. These data show that only one well (Hadley stock well; Section 17, T34N, R52E) with a known total depth is likely to



EIS\92-3313\GQDraw.dwg Source: HCI 1992a and 1992d; Barrick Goldstrike Mines Inc.

Predicted Groundwater Table Drawdown
Gold Quarry Mine
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-2



EIS\92-3313\PIWells.dwg Source: HCI 1992a and 1992d; Barrick Goldstrike Mines Inc. 1993

Maximum Extent of 10-foot Drawdown Contour

- Proposed Action (year 2005)
- Alternative 3 (year 2005)
- Municipal, Domestic, Commercial, Industrial, or Other Well
- Irrigation or Stock Well
- Predicted Impacted Well

Predicted Impacted Wells
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-3

TABLE 4-5
Groundwater Wells Potentially Impacted by Gold Quarry Mine Dewatering

Application/ Permit Number[1]	Well Location[2]				SWL[4] (feet)	Bottom Screen[5] (feet)	Available/ Predicted Drawdown (feet)	Owner
	Major Use[3]	Sec.	TN	RE				
Wells Within 10-ft Drawdown Contour								
18551	IRR	16	33	52	37	115	75/30	Maggie Creek Ranch; Hadley Permit
31273	IRR	4	33	52	15	100	117/60	Newmont Gold Company
48256	IRR	15	33	52	25	200	175/20	Maggie Creek Ranch
39872	STK	7	33	51	NR	NR	NR/30	Elko Land and Livestock
46045	STK	9	34	51	NR	NR	NR/25	Elko Land and Livestock
49319	STK	20	34	52	NR	NR	NR/70	Maggie Creek Ranch
39438	STK	15	34	52	NR	NR	NR/30	Maggie Creek Ranch
46662	STK	21	33	52	220	395	107/50	Maggie Creek Ranch
NP	STK	10	33	52	32	No Casing; TD=100	68/30	Hadley
NP	STK	17	34	52	54	90	36/70	Hadley[6]
39874	STK	31	35	51	15	280	235/20	Elko Land and Livestock
46041	STK	27	35	51	NR	NR	NR/15	Elko Land and Livestock
46045	STK	30	35	51	NR	NR	NR/15	Elko Land and Livestock
NP	DOM	9	33	52	11.5	121	111/50	Crouse
NP	DOM	9	33	52	11.5	121	110/50	Quilliam
NP	DOM	9	33	52	11.5	1[illegible]	113/50	Mathis
NP	DOM	9	33	52	10	100	110/50	Umberger
NP	DOM	9	33	52	10	125	115/50	Derrick
NP	DOM	9	33	52	15	122	107/50	Lloyd
NP	DOM	9	33	52	14	115	125/50	Wagner
NP	DOM	9	33	52	75	107	52/50	Teel[7]
NP	DOM	9	33	52	54	150	70/50	Sharp[7]
NP	DOM	9	33	52	47	133	83/50	Sharp
NP	N/A	9	33	52	8	Plugged	NR/50	Hadley
NP	DOM	8	33	52	NR	TD=133	NR/50	Callahan

[1] NP = no water right permit required or obtained for use.
[2] Sec = section; TN = township north; RE = range east.
[3] IRR = irrigation; STK = stock; DOM = domestic; N/A = not applicable.
[4] SWL = approximated static water level as feet below ground surface based on well log information; NR = not reported.
[5] Depth of bottom of screened interval in feet below ground surface.
[6] Well predicted to be completely dewatered as a result of groundwater cone of depression.
[7] Well with predicted maximum drawdown within 20 feet of reported screen bottom depth.

be entirely dewatered. An additional two wells listed in Table 4-5 have predicted maximum drawdowns that are within 20 feet of the reported screen bottom depth. These three wells predicted to be impacted are highlighted on Figure 4-3. Maximum water level drawdowns would occur roughly between years 1998 to 2005, followed by recovery to within 10 feet of pre-mining levels by year 2042. Wells located near Maggie Creek may not experience water level declines during the dewatering period because of groundwater recharge from dewatering flows added to the creek.

Several private and public wells are located in or near the town of Carlin (Figure 4-3). One of these wells is part of the town's public water supply. This well is 654 feet deep with a water level approximately 165 feet below ground surface. Another well is used by the town of Carlin for irrigating a park and is approximately 100 feet deep (Ballew 1992). Maximum groundwater drawdown in these two wells and other wells in the Carlin area from the South Operations Area cone of depression is expected to be less than 10 feet; therefore, use of these wells should not be significantly impacted. The Carlin "Cold" Spring system used as a public water supply source in Carlin is discussed below.

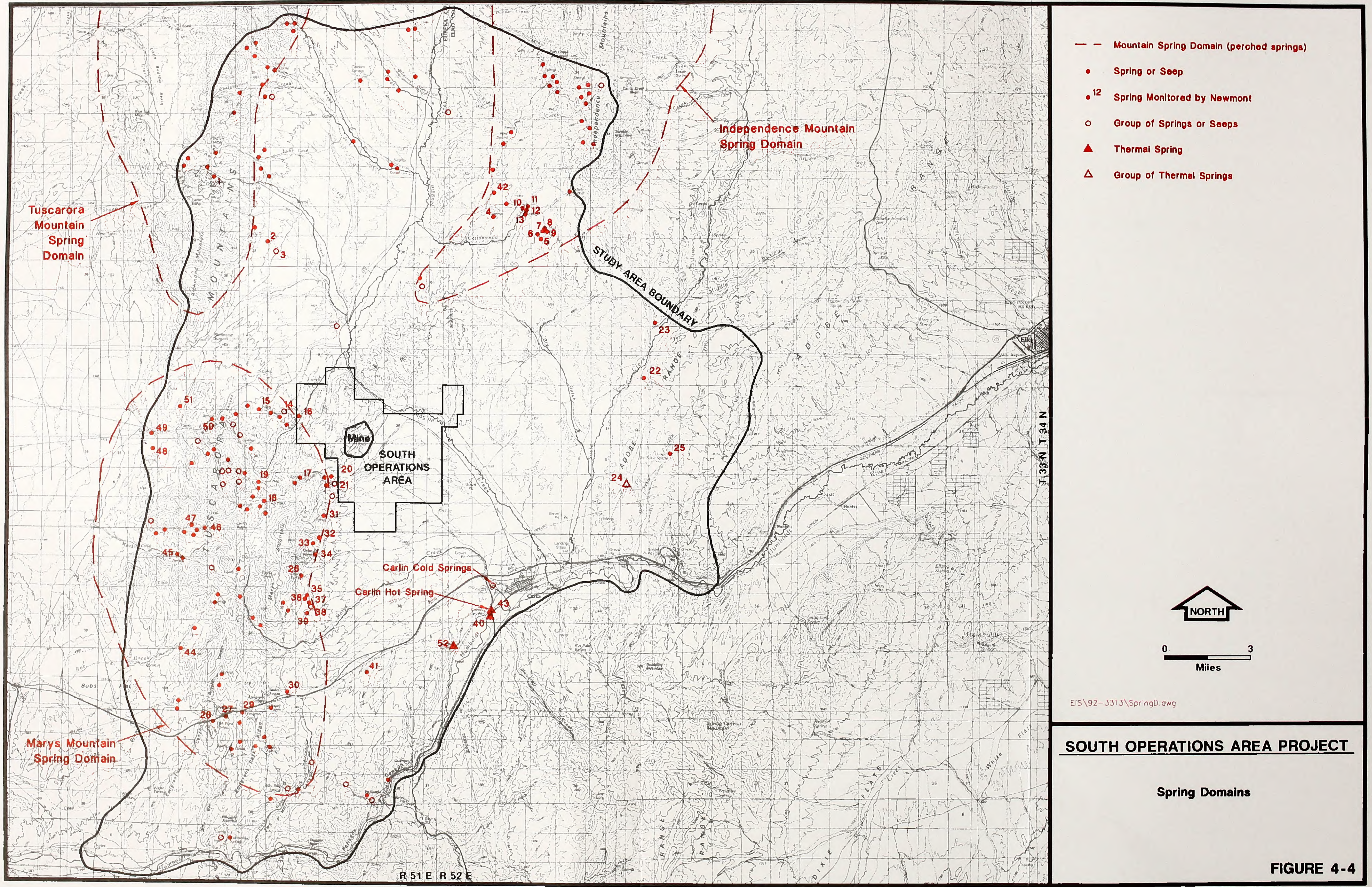
Impacts on Springs and Seeps

There are numerous springs and seeps in the South Operations study area that are important to the area's ecosystem (see Chapter 3, Water Resources). Springs are categorized into two main types: (1) perched springs located primarily in mountainous areas and separated from the water table system due to elevation and geologic conditions, and (2) water table springs associated with regional groundwater systems and generally located at lower elevations. This division is generalized and there may be some mixture of spring types in the mountain and valley areas.

Semiannual surveys of selected springs in the study area have been conducted for 3 years to establish baseline conditions. The surveys include flow measurements, water quality sampling and analysis, and vegetation descriptions (see Appendix A). Additional inventories of springs and seeps have been conducted by JBR (1992b) and BLM. Studies of springs and seeps in the study area have been conducted to evaluate potential impacts from dewatering activities at the South Operations Area (Balleau Groundwater Consulting 1992; Zimmerman 1992a). These studies include an evaluation of spring type, hydrogeologic setting, water elevations, numerical models, and water chemistry.

Three spring "domains" (Marys Mountain, Tuscarora Mountains, and Independence Mountains) represent the general area of mountain springs in the Study Area (Figure 4-4). Surface traces of the Tuscarora fault zone and other basin-bounding structures help define the mountain spring domains in the Maggie Creek Basin. In addition, the eastern boundaries of the Tuscarora and Marys Mountain spring domains coincide closely with an elevation of 6,000 feet; this elevation is believed to be a general division between the higher perched springs and the lower water table springs (Balleau Groundwater Consulting 1992). Perched springs located within the mountain domain areas would not be affected by mine dewatering. Springs not located within the domains generally are associated with the regional water table system that would be intercepted and dewatered by the Gold Quarry Mine.

Groundwater elevation contours in the study area are relatively closely spaced along the fronts of Marys, Tuscarora, and Independence Mountains (see Figure 3-9). The Tuscarora Fault and associated faults along the east side of the Tuscarora Mountains in the South Operations Area behave as hydrologic barriers to pumping activities at the Gold Quarry Mine. Drawdowns of up to 40 feet have been observed in wells east of the fault system, whereas wells west of the faults have shown no response to pumping at the Gold



SOUTH OPERATIONS AREA PROJECT

Spring Domains

FIGURE 4-4

Quarry Mine (Zimmerman 1992a). Water chemistry data including stable isotopes (deuterium and oxygen ^{18}O), tritium, strontium, specific conductance, and chloride also indicate physical separation of the perched and water table flow systems (Balleau Groundwater Consulting 1992; Zimmerman 1992a). These data reflect the source and age of water from the springs and seeps.

Figure 4-5 shows maximum extent of the 10-foot drawdown contour line associated with the groundwater cone of depression resulting from dewatering at the Gold Quarry Mine (HCl 1992a). Springs and seeps located within this contour line that are not part of the perched spring domains would more likely be impacted from Gold Quarry Mine dewatering. Some of these springs, however, are located adjacent to the spring domain boundaries and may be associated with the perched spring system. Magnitude of impact on any affected spring can vary from minor reduction in flow to complete elimination of flow. Location of each spring or seep in relation to the cone of depression and the spring's water pressure or head would determine the magnitude of impact.

Four spring or seep sites shown in Figure 4-5 are located within the 10-foot drawdown contour line and are not adjacent to the mountain domains. Approximately 21 additional spring and seep sites within the 10-foot drawdown line are located adjacent to the spring domain boundaries and therefore could be part of the perched spring systems unaffected by dewatering (Figure 4-5). For purposes of this EIS, the total of 25 spring and seep sites are presumed to be impacted by the groundwater cone of depression (Table 4-6). Some of these spring sites are groupings of two or more springs that are located adjacent to each other.

The four spring and seep sites within the 10-foot drawdown contour that are not adjacent to the mountain domains have reported flows ranging from <1 to 30 gpm (Table 4-6). The 21 spring sites located adjacent to the domain boundaries range in flow from <1 to 40 gpm. None of the four thermal springs shown on Figure 4-4 are located within the 10-foot drawdown contour.

The numerical hydrogeologic model indicates flow at the Carlin "Cold" Springs (Carlin water supply source) would be reduced from an average of 2.8 cfs to as low as 0.2 cfs gradually during the dewatering period (HCl 1992a; Zimmerman 1992a). An additional spring of concern near the 10-foot drawdown line (spring no. 52; Figure 4-5) is discussed in Chapter 4, Aquatic Habitat and Fisheries; this spring has warm water and harbors a potentially rare species of springsnail. The Carlin Hot Spring located adjacent to the Humboldt River just west of Carlin also could be impacted.

Quality of spring and seep water is not expected to be affected by the South Operations Area dewatering operations. No significant changes in the hydrogeologic system that controls water quality would occur as a result of the proposed mine expansion. Predicted mine pit water quality after cessation of mining is discussed in a later section. After year 2005, impacted spring and seep flows would begin to approach pre-mining conditions as groundwater levels begin to rise. Most recovery of spring flows would occur within the first 10 to 20 years after cessation of dewatering. Complete recovery of some springs and seeps, however, may take nearly 100 years.

Impacts on Streamflow

Flows in some streams within the Study Area would decrease as a result of Gold Quarry Mine dewatering operations. In addition, flow in lower Maggie Creek and the Humboldt River would increase during the dewatering period as a result of water discharged directly to Maggie Creek below Maggie Creek Canyon from the water treatment plant and the Maggie Creek Ranch Reservoir. Streamflows would decrease in areas where the cone of depression intercepts groundwater that discharges naturally to the streams. Reductions in streamflow can occur outside of the 10-foot drawdown contour where groundwater flow that discharges to streams is intercepted by the cone of depression.

For example, Susie Creek is outside of the 10-foot drawdown contour; however, flows are predicted to be reduced in lower Susie Creek because groundwater recharge to this stream would be reduced by the cone of depression.

During the dewatering period, water would be discharged to lower Maggie Creek at rates of up to 104 cfs (46,500 gpm). The maximum rate of 104 cfs is based on a predicted maximum dewatering rate of 94 cfs (42,000 gpm) plus an average discharge rate from the reservoir of 10 cfs (4,500 gpm). The higher discharge rates would occur during the last 2 to 3 years of mine operation. During periods of naturally high streamflow, mine water could be routed to the Maggie Creek Ranch Reservoir for storage until streamflows have subsided.

Average monthly flow in Maggie Creek is approximately 100 cfs during April and May, and less than 10 cfs from July through January based on a 1913-24 period of record (see Table 3-9). Bankfull capacity of Maggie Creek below the canyon is approximately 80 cfs (35,900 gpm) (Rosgen 1992). Maximum flow recorded on Maggie Creek was 2,440 cfs on February 12, 1962 (French et al. 1992). Approximately 2 cfs is predicted to infiltrate through the Maggie Creek channel and recharge the underlying groundwater system during the period of mine water discharge to Maggie Creek (HCI 1992a).

When dewatering and associated discharge cease, baseflow of Maggie Creek would decline as a result of the cone of depression that extends over a portion of the Maggie Creek Basin (Figure 4-2). Baseflow is defined as streamflow during the late fall and early winter period when cultural diversions and evapotranspiration are minimized and groundwater contributions to streamflow are not influenced by seasonal runoff. Baseflow measurements typically are made during the month of October. Low flow generally occurs during the mid- to late-summer period when evapotranspiration is high, irrigation withdrawals are occurring, and seasonal runoff is minimal. Data collected near the mouth of Maggie Creek from 1913-24 and 1989-92 show that average monthly flow generally is at or below about 4 cfs during the period July through December; periods of no flow also occurred at this location during these months (USGS 1992). At the gaging station located on Maggie Creek just below the canyon, flow generally is less than 4 cfs or dry during the period July through October.

Flow in Maggie Creek from about 5 miles upstream of the canyon to its confluence with the Humboldt River would be temporarily reduced by about 2 to 4 cfs after cessation of dewatering (HCI 1992a) (Figure 4-6). Lower Maggie Creek is intermittent and loses flow naturally below the canyon. In recent years, this condition has likely been influenced by groundwater pumping at the South Operations Area and drought. Streamflows in upper Maggie Creek above the canyon are influenced by springs from the mountain domain areas. Therefore, impacts would be associated primarily with a reduction in baseflow for the reach immediately above the Maggie Creek Canyon. Maximum reductions in Maggie Creek streamflow are predicted to occur in 2005, followed by a gradual increase in affected baseflow (Figure 4-6). The 2 to 4 cfs decrease in streamflow would occur primarily within a period of about 20 years after dewatering ceases.

Tributaries to Maggie Creek that are located within the 10-foot drawdown contour include James Creek, Simon Creek, Lynn Creek, Soap Creek, and East Cottonwood Creek (Figure 4-2). Upper reaches of these streams generally are perennial, flowing continuously due to springs in the mountain areas. The lower reaches of these streams are ephemeral or intermittent and generally flow only in response to snowmelt runoff and precipitation. Some springs in the lower reaches of these streams provide continuous flow to short segments. Baseflow in portions of these streams would be reduced or lost for a period during and after dewatering at the South Operations Area. Other tributaries of Maggie Creek that are outside the 10-foot drawdown contour include Jack and Little Jack Creeks, and Coyote Creek. Potential impacts on these streams are discussed in Chapter 4, Cumulative Impacts.

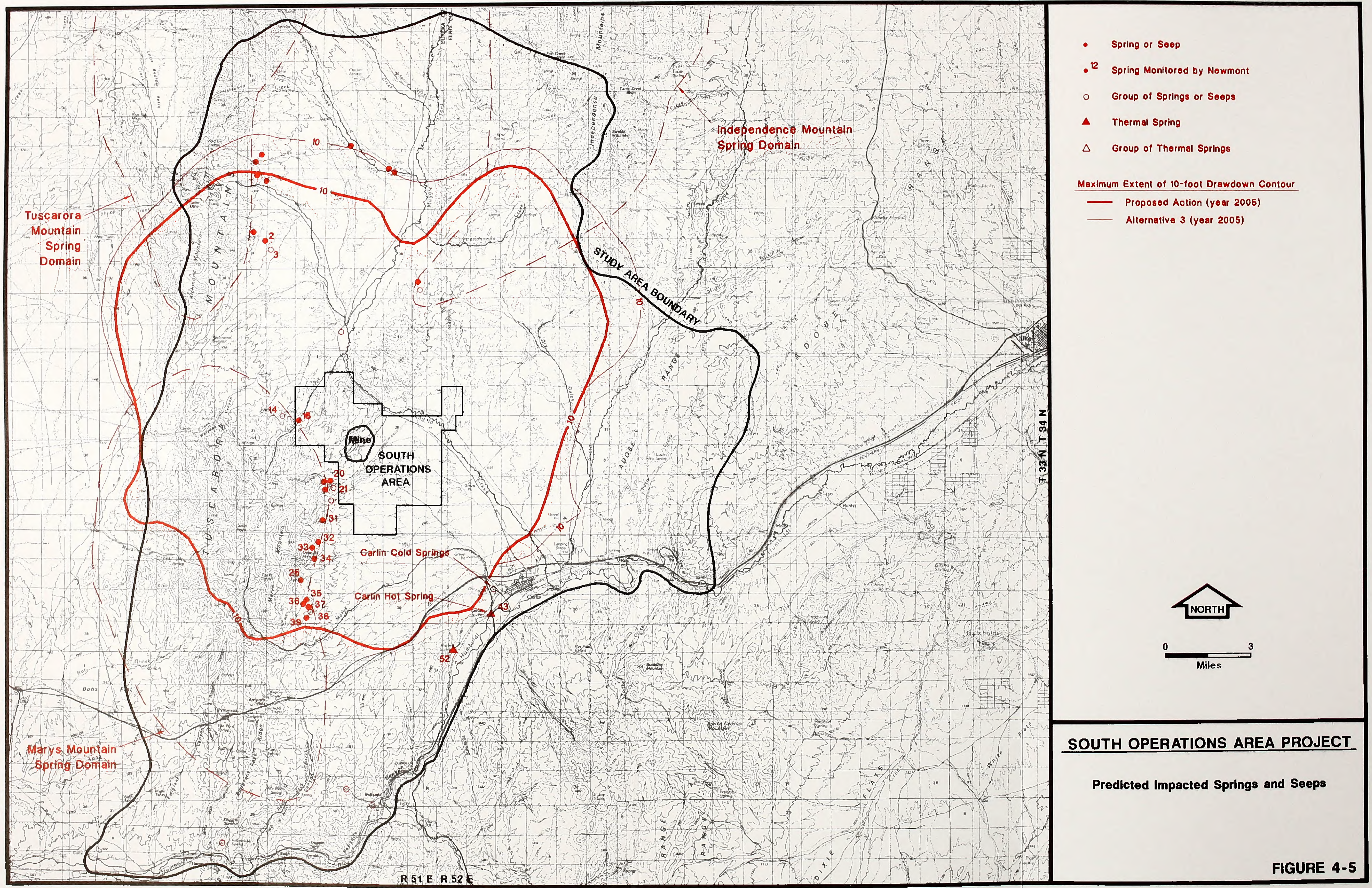

Spring or Seep
12 Spring Monitored by Newmont
Group of Springs or Seeps
Thermal Spring
Group of Thermal Springs
Maximum Extent of 10-foot Drawdown Contour
Proposed Action (year 2005)
Alternative 3 (year 2005)
Independence Mountain Spring Domain
Tuscarora Mountain Spring Domain
Marys Mountain Spring Domain
STUDY AREA BOUNDARY
SOUTH OPERATIONS AREA
Mine
Carlin Cold Springs
Carlin Hot Spring
TUSCARORA MOUNTAIN
ADOBE RANGE
NORTH
0 3
Miles
T 33 N T 34 N
R 51 E R 52 E
SOUTH OPERATIONS AREA PROJECT
Predicted Impacted Springs and Seeps
FIGURE 4-5

TABLE 4-6 Springs and Seeps Potentially Impacted by Gold Quarry Mine Dewatering				
Location[1] TN/RE - Section - 1/4,1/4	Newmont Inventory No.[2]	Elevation (feet)	Developed[3]	Comments[4]
Springs Within 10-ft Drawdown Contour and Not Adjacent to Spring Domains				
35/51-18-SE,SE		5,700		Simon Creek tributary; <1 gpm
35/51-30-SE,SE	Spring 2	5,550	Developed	Pond at base of spring; 1 gpm on BLM spring list
35/51-32-NW,NW	Spring 3	5,440	Developed	Group of 2 springs and pond; <1 gpm
34/51-10-NW,SE		5,100		Series of springs feeding wet meadow; 20-30 gpm
Springs Adjacent to Spring Domain Boundaries				
35/51-18-SE,NW		5,890		Simon Creek tributary; <1 gpm
35/51-30-NE,SE		5,550		On BLM spring list
34/52-6-NW,SW		5,400		Group of springs on hillside; <1 gpm
34/52-6-SW,NW		5,100		Spring leading to meadow; 1 gpm
34/51-29-SW,SE	Spring 14	5,560		Series of springs flowing to 3 ponds; 20 gpm
34/51-33-NW,NW	Spring 16	5,540	Developed	Seep on hillside; pond 1/4-mile downstream; <1 gpm
33/51-9-NE,NE		6,000		Spring in channel near James Creek; 1-2 gpm
33/51-10-NW,SW		5,800		Series of springs near James Creek; PWR; <1 gpm
33/51-10-SE,NW		5,890		Hillside spring; <1 gpm
33/51-10-NE,NW	Spring 20	5,550		Altered spring on top of hill; 2-3 gpm
33/51-15-SW,NW	Spring 21	5,560		3 springs flowing to James Creek; PWR; 30-40 gpm
33/51-15-SW,NW	Spring 34	5,950	Developed	Willow grove and meadow; 1-2 gpm
33/51-21-NW,NE	Spring 32	5,900		<1 gpm
33/51-21-SE,NE	Spring 33	6,050		1-3 gpm
33/51-21-SW,SE	Spring 34	6,050	Developed	Cherry Spring; artesian spring; 2 ponds; 1+ gpm
33/51-28-SE,NW	Spring 26	6,120		Seep at confluence of 2 drainages; <1 gpm
33/51-33-NE,NW	Spring 35	6,000		Seep on hillside; <1 gpm
33/51-33-NE,NW	Spring 36	6,050		Seep on hillside; <1 gpm
33/51-33-SE,NW	Spring 37	6,040		Seep on hillside; <1 gpm
33/51-33-SW,NE	Spring 38	6,020		2 hillside springs flowing to breached pond; 2-3 gpm
33/51-33-NW,SE	Spring 39	6,040		Seep draining to pond; <1 gpm

[1] TN = township north; RE = range east; ¼ section of ¼ section.
[2] Spring number assigned by Newmont as part of its periodic monitoring program; see Chapter 3, Water Resources.
[3] Developed means that spring/seep has undergone a man-made modification, primarily for stock watering purposes.
[4] gpm = gallons per minute; cfs = cubic feet per second; PWR = public water reserve designation by BLM.

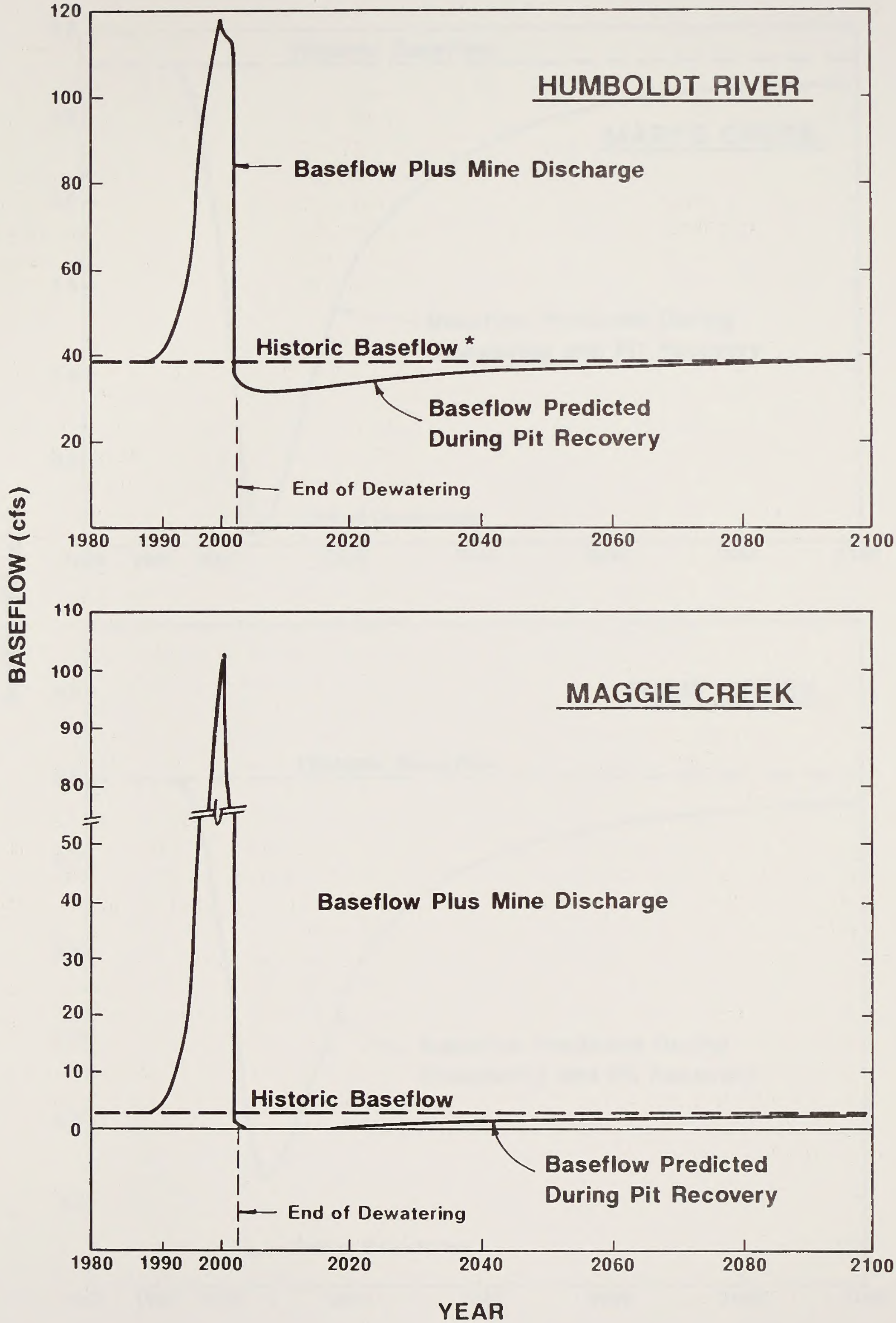
Based on the numerical model predictions, streamflow in lower Susie and Marys creeks would be reduced or lost as a result of dewatering. Reductions in flow are predicted to be greatest in year 2005, followed by a gradual return to pre-mining conditions (Figure 4-7). Baseflow in Susie Creek is expected to be reduced by up to 0.5 cfs during and after the dewatering period (HCI 1992a). Average annual flow measured in Susie Creek approximately 16 miles above its mouth during the period 1956-58 was 6 cfs, with average monthly flows ranging from 0.11 to 29.3 cfs (USGS 1963). Historic baseflow of Susie Creek at this location is about 0.8 cfs (HCI 1992a). These effects on Susie Creek flow are expected to be seen from approximately midway on the creek to its confluence with the Humboldt River. However, Susie Creek also loses flow in its lower reaches and is periodically dry in this area.

The predicted effect on flow in lower Marys Creek is shown in Figure 4-7. Flow at the mouth of Marys Creek generally consists almost entirely of discharge from the Carlin "Cold" Springs. The numerical model predicts that baseflow near the mouth of Marys Creek would decrease by as much as 2.5 cfs during and after dewatering (HCI 1992a), reducing flow at the Carlin "Cold" Spring complex. Average annual flow of Marys Creek at its confluence with the Humboldt River is 2.5 to 3.0 cfs. Little or no impact on ephemeral flows in upper Marys Creek is expected from dewatering because the sources of this surface water are primarily precipitation and perched springs in the vicinity of Marys Mountain. Again, impacts on flow in lower Marys Creek (i.e., the Carlin "Cold" Springs) would be greatest in about year 2005, followed by a gradual return to ambient conditions (Figure 4-7).

During the dewatering period, flow in the Humboldt River downstream of Maggie Creek would increase with the input of mine water flowing down Maggie Creek. This increase in flow would range from about 56 to 102 cfs after accounting for stream loss in Maggie Creek. Average monthly flow in the Humboldt River at Palisade has the following general characteristics: (1) exceeds 500 cfs during the period March through June; (2) ranges from 100 to 500 cfs in January, February, and July; and (3) is less than 100 cfs from August through December. Lowest average monthly flow occurs in September and October at a rates of 32 and 47 cfs, respectively. Maximum and minimum flows recorded at Palisade are 17,000 and 9 cfs, respectively.

Newmont has evaluated flow in the Humboldt River between the Carlin Tunnels gage and Rye Patch Reservoir to quantify the potential contribution from Gold Quarry Mine dewatering discharge (Zimmerman 1992b). The Humboldt River between the Carlin Tunnels and Palisade gages has an annual average gain in flow of 50 cfs and an average baseflow gain (October) of 19 cfs (Figure 4-8). Between Palisade and Rye Patch Reservoir, the Humboldt River shows an average annual loss of 126 cfs and an average baseflow loss of 15 cfs (Figure 4-8). The addition of mine water to the Humboldt River, therefore, would temporarily help offset reductions in flow that occur in the Humboldt River downstream of Palisade. The magnitude of changes in river flow that would occur and the length of stream that would be affected below Palisade are difficult to predict because of complex river dynamics, including inflow, outflow, bank storage, evapotranspiration, and irrigation withdrawals. Figure 4-9 is a representative cross-section showing excess mine discharge water plotted with baseflow and bankfull flow in the Humboldt River immediately downstream from the Maggie Creek confluence. This flow increase in the Humboldt River is well within the active channel for low and moderate flows, and is undetectable during high flows.

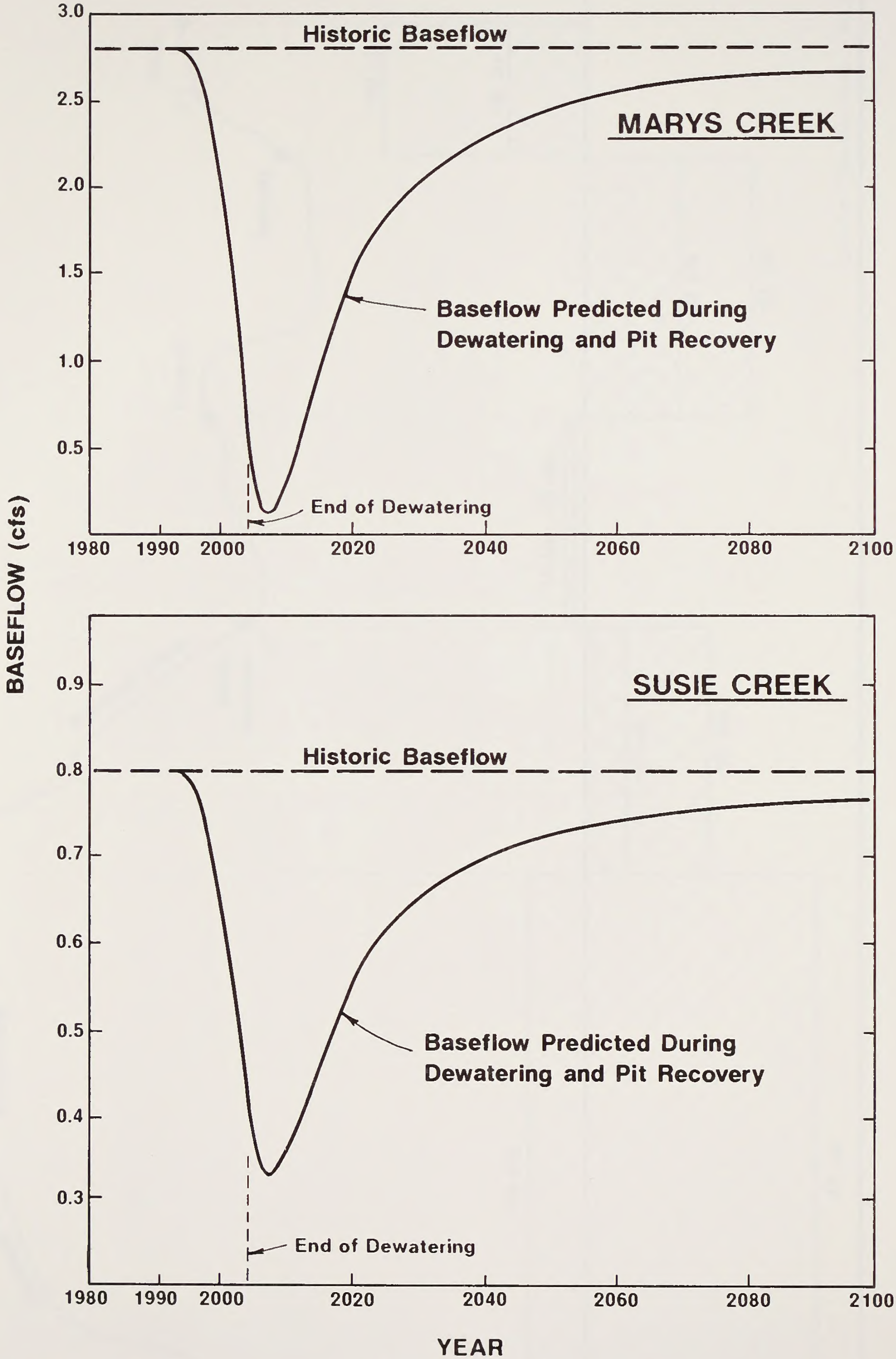
Humboldt River flows after cessation of dewatering are estimated to decrease by a maximum of 19 cfs at the Palisade gage and 9 cfs at the Dunphy gage located approximately 25 miles downstream (HCI 1992a) (Figure 4-6). The rate of 19 cfs is equivalent to the average baseflow gain in the Humboldt River between the Carlin Tunnels and Palisade gages that occurs primarily due to groundwater recharge. A rate of 19 cfs is approximately 40 percent of the average



Source: HCI 1992a

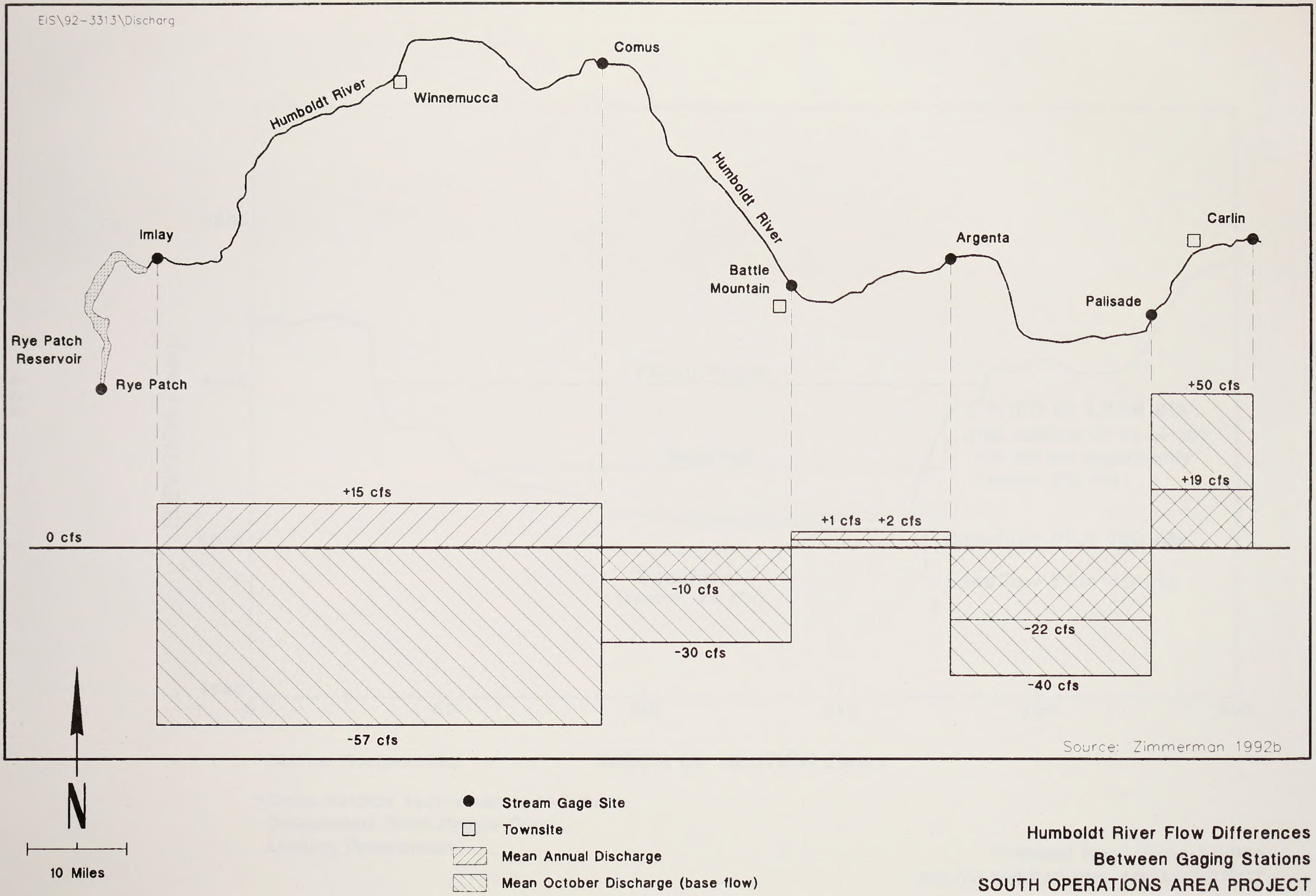
* Dunphy Station on Humboldt River located approximately 25 miles downstream of Palisade.

Predicted Changes in Baseflow
For the Humboldt River and Maggie Creek
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-6

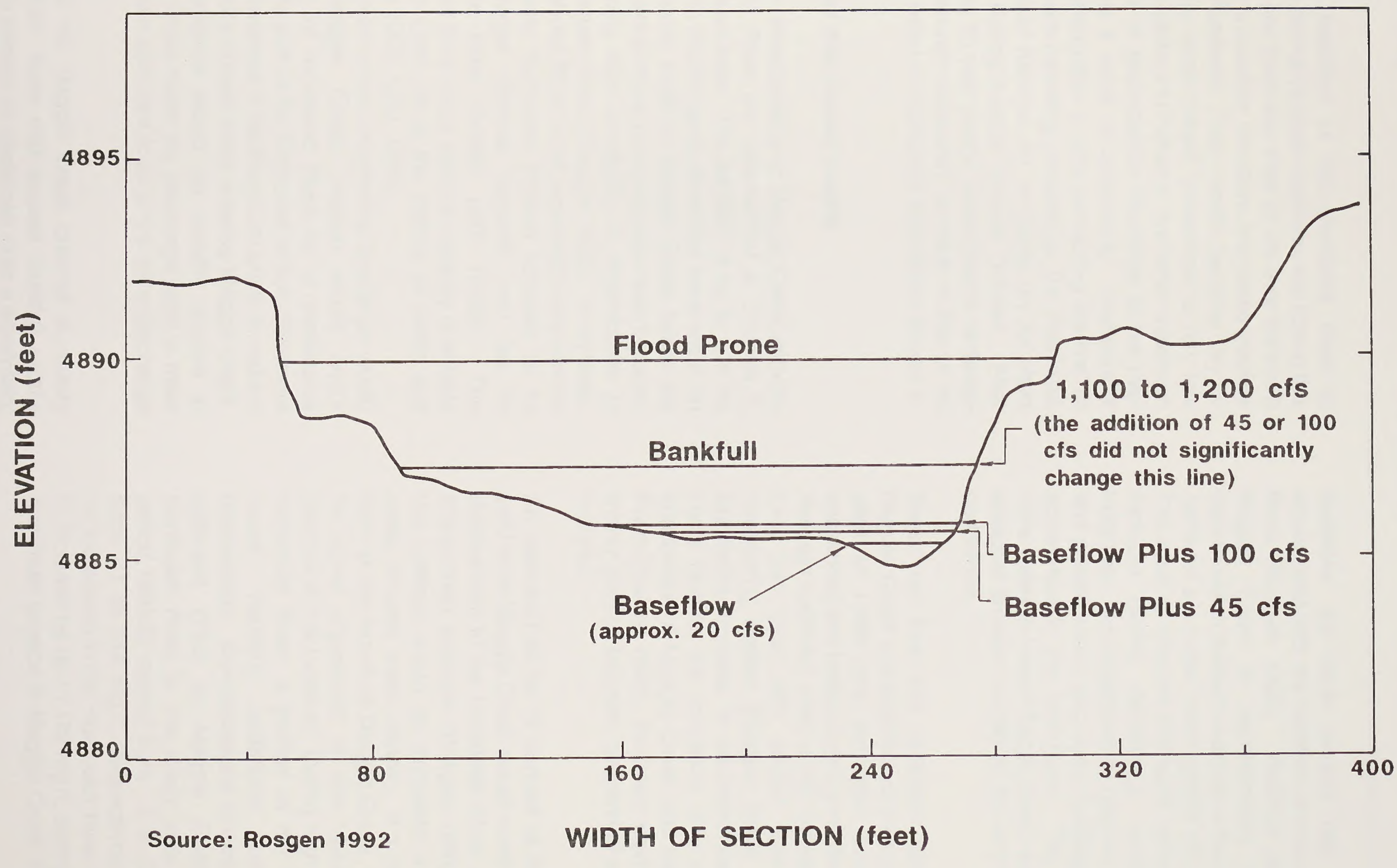


Source: HCI 1992a

Predicted Changes in Baseflow
For Marys Creek and Susie Creek
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-7



Humboldt River Flow Differences
Between Gaging Stations
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-8



Source: Rosgen 1992

*Cross-Section Approximately 100 Yards Downstream From Maggie Creek, Looking Downstream

Humboldt River Cross-Section
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-9

monthly baseflow of the Humboldt River at Palisade during October; however, low flow at this location has been less than 20 cfs over the last 5 years. It is possible, therefore, that some reaches of the Humboldt River would become dry or nearly dry when natural streamflow is very low between Carlin and Palisade, and when maximum reduction in groundwater discharge to the river occurs as a result of dewatering. Therefore, if natural streamflow is very low during the first 10 to 20 years following dewatering, the Humboldt River would become dry or nearly dry for short periods during August through October. After that 10 to 20 year period, groundwater recharge should recover sufficiently to result in little or no adverse effect on Humboldt River flows (Figure 4-6).

Stream and River Channel Stability

Channel characteristics of Maggie Creek and the Humboldt River are summarized in Chapter 3, Water Resources. The addition of up to 104 cfs (25,000 to 46,500 gpm) of excess mine water on a continuous basis to Maggie Creek below the canyon would result in increased erosion because of naturally high erodibility of streambanks in lower Maggie Creek (Rosgen 1992). In contrast, the Humboldt River is not expected to experience significantly increased erosion because of its much larger channel capacity and fair to moderate bank stability (JBR 1992a). The Humboldt River has a channel capacity of at least 1,000 to 1,500 cfs in the vicinity of Carlin and Palisade (COE 1950, 1976).
At the point where dewatering discharge would enter Maggie Creek, erosion would occur because of increased flows on a continuous basis. As part of the Proposed Action, Newmont would construct a discharge structure to reduce the velocity of mine water entering Maggie Creek. Some material would be steadily eroded in Maggie Creek below the discharge point to meet equilibrium sediment load in the mine discharge water.

Because the Maggie Creek channel is deeply entrenched, flows that exceed bankfull widths generally cannot be dispersed onto a floodplain; therefore, the bank erosion rate would be accelerated with the addition of mine dewatering flows (Rosgen 1992). Bankfull discharge in Maggie Creek is approximately 80 cfs as determined in the field and from a flood frequency curve for a 1.5-year return period (Rosgen 1992). The zone of channel and bank saturation would increase during dewatering, contributing to instability. An adjustment in channel dimensions and pattern would also occur in Maggie Creek to accommodate the new flows. The addition of mine water to lower Maggie Creek would reduce seasonal erosion caused by ice and freeze-thaw conditions.

Based on flow and sediment rating curves, Maggie Creek currently has an average sediment yield of 1,980 tons per year, including both suspended and bedload sediment (Rosgen 1992). Average sediment yield would increase to 5,870 tons per year with added flow from the dewatering system (Rosgen 1992). This is a significant increase in sediment transport and could lead to the formation of a delta at the confluence of Maggie Creek and the Humboldt River (Rosgen 1992). Sediment load generally is evenly divided between suspended and bedload material.

An estimated 60 to 70 percent of the sediment yield from Maggie Creek would continue to move downstream in the Humboldt River, primarily as fine-grained sediment (Rosgen 1993). Some of this material would be deposited in pools and areas of lower water velocity. If a delta were to form at the mouth of Maggie Creek, there would be some adjustment to the Humboldt River channel at this location. During high flows in the Humboldt River, a portion of the delta could erode, causing additional sedimentation downstream. Concentrations of total suspended sediment (TSS) in Maggie Creek and the Humboldt River in the study area during the period 1990-92 ranged from <5 to 32 mg/L and from <1 to 344 mg/L, respectively. The TSS concentration in the Humboldt River is projected to increase by up to 132 mg/L during periods of maximum erosion in Maggie Creek for the

Proposed Action (Rosgen 1993). Relative changes in TSS concentrations in the Humboldt River would be higher during naturally low flow conditions when ambient sediment load in the river is low.

Impacts on Water Temperature

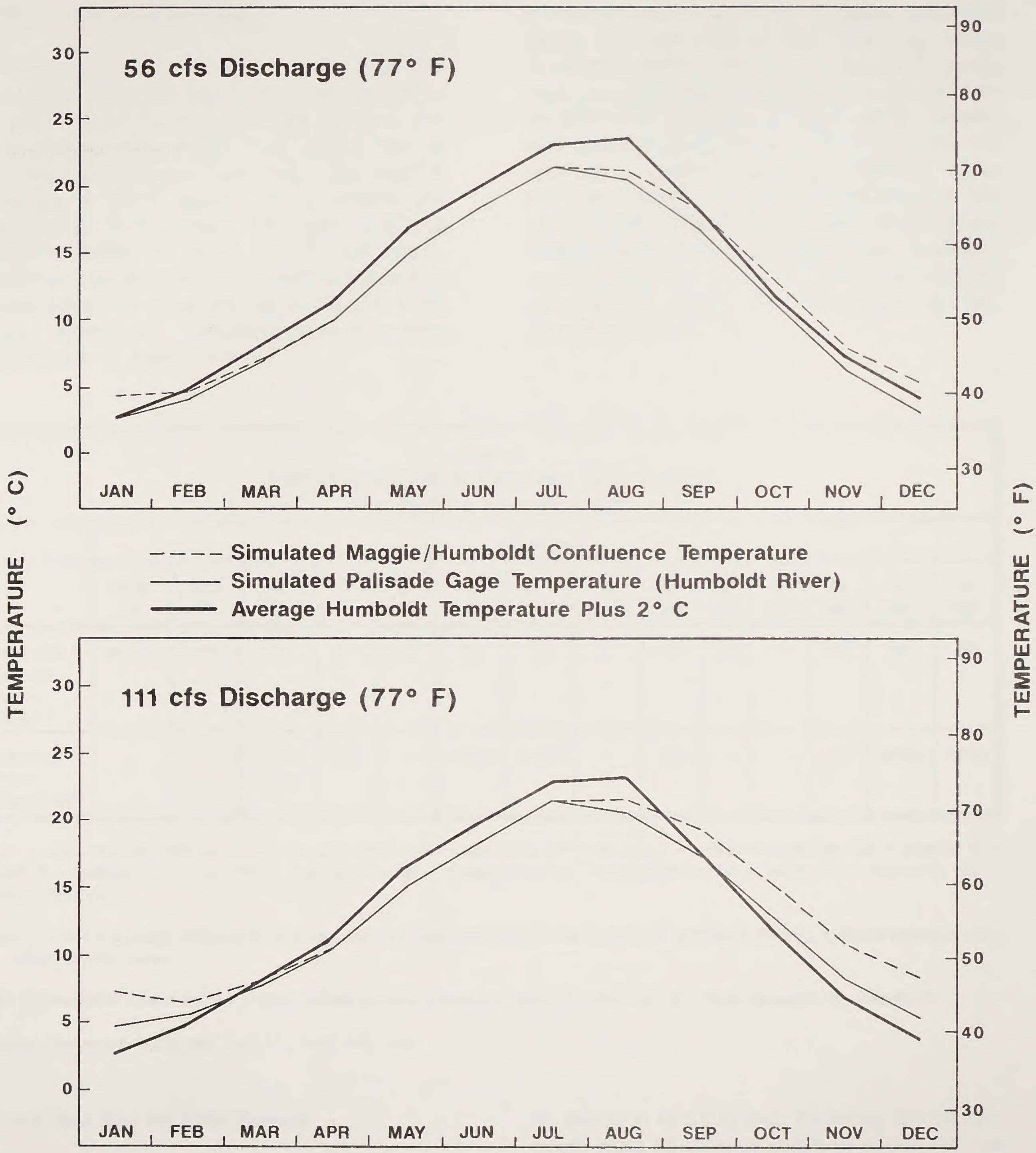
Groundwater from dewatering wells is expected to have an average temperature of about 25°C (77°F); however, maximum groundwater temperatures of up to 29°C (84°F) have been measured from existing deep wells at the mine site. Excess mine water discharged to Maggie Creek would mix with water in Maggie Creek (if present) and finally enter the Humboldt River near the town of Carlin. As stated in Chapter 3, temperature of water in Maggie Creek and the Humboldt River varies considerably between seasons. Water temperatures in Maggie Creek and the Humboldt River are in the range of 0 to 30°C (32 to 86°F) (see Table 3-13). Mine water entering Maggie Creek just below Maggie Creek Canyon generally would experience some cooling as it travels approximately 11 miles to the Humboldt River. Additional cooling would occur in the Humboldt River. Some overall reduction in temperature of water discharged to Maggie Creek could occur from the input of cooler water retained in the Maggie Creek Ranch Reservoir.

Newmont's Proposed Action includes a limitation on increasing water temperature in the Humboldt River at Palisade to within 2°C (3.6°F) of ambient river temperatures. Based on predicted discharge rates and water temperatures, a water cooling system would be required during the later period of dewatering. This cooling system would be constructed adjacent to the water treatment facility so that discharge water would be cooled to a temperature necessary to maintain the Humboldt River at Palisade within the 2°C restriction.

The *QUAL2E* model -- a steady-state, finite-difference, stream water-quality model distributed by the U.S Environmental Protection Agency -- was used by Newmont to provide a generalized prediction of thermal changes for Maggie Creek and the Humboldt River during discharge of excess mine water (Johnson 1991, 1992, 1993a). Water temperature is calculated for each half-mile element established along the channels given a set of steady-state conditions, which include stream/river flow rate, mine water discharge rate, input water temperatures, and atmospheric conditions.

Results of *QUAL2E* model simulations are presented in Figure 4-10 and show that for a mine water discharge rate of 56 cfs (25,000 gpm) and a temperature of 25°C, the resulting temperature of the Humboldt River at Palisade would remain within 2°C of average ambient river temperature throughout the year (1 to 22°C). When the discharge rate increases to 111 cfs (50,000 gpm), which is higher than the predicted maximum discharge rate of 104 cfs (46,500 gpm), the resulting temperature of the Humboldt River at Palisade exceeds 2°C over ambient conditions in the period October through February (Figure 4-10). Maximum exceedence over ambient temperatures is approximately 4 to 5°C. These simulations are based on average monthly flows in Maggie Creek and the Humboldt River and average daily atmospheric temperatures. As mentioned above, Newmont's Proposed Action would provide for temperatures in the Humboldt River that are within 2°C of ambient conditions at Palisade.

Ice development on Maggie Creek and the Humboldt River would be affected by discharge of excess mine water. During winter, flow in lower Maggie Creek is low (<5 cfs) or nonexistent. Therefore, the addition of a continuous flow to Maggie Creek at a temperature of about 25°C would reduce of prevent ice buildup in this stream segment. This lack of ice and freeze-thaw conditions would reduce natural erosion of the Maggie Creek channel. The Humboldt River downstream of Maggie Creek would have areas of open flow where ice development would be limited. This would occur for an unknown distance down-stream as a result of the increased flow and higher water temperature.



Predicted Temperature Changes in the Humboldt River
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-10

Impacts on Surface Water Quality

Groundwater at the South Operations Area that would be discharged has been characterized by samples collected from deep wells (siltstone and carbonate aquifers) in the vicinity of the mine pit (see Chapter 3, Water Resources). This water is generally of good quality with a neutral pH, hardness of approximately 200 mg/L, and total dissolved solids of about 330 to 400 mg/L. Maximum concentrations of arsenic and selenium measured at the mine site are 0.218 and 0.059 mg/L, respectively. Dissolved oxygen in deep groundwater is about 4.8 mg/L.

Newmont would construct a water treatment facility to treat groundwater from the mine dewatering system. Water from this facility would meet all water quality standards established by the NDCNR in a pending NPDES permit. Arsenic and selenium would be of primary concern for removal. Because of the proposed water treatment facility, no water quality impacts are expected from discharge of excess mine water to Maggie Creek and the Humboldt River. Predicted concentrations of selected parameters characteristic of the mine discharge water are presented in Table 4-7.

TABLE 4-7
Predicted Quality of Gold Quarry Mine Discharge Water From the Water Treatment Facility

	Parameters[1]													
	Flow cfs	Temp °C	pH SU	As mg/L	B mg/L	F mg/L	Fe mg/L	Mg mg/L	Mn mg/L	Mo mg/L	Ni mg/L	Se mg/L	SO_4 mg/L	Zn mg/L
Predicted Concentration Range [2]	94-112	31-37	7.7	.04	0.2	0.8	1.0	21	.03	.003	.01	.007	56	.04
Drinking Water Standards[3]	--	--	6.5-8.5(s)	.05	--	1.4-2.4	0.3(s)	--	.05(s)	--	--	.01	250(s)	5.0(s)

[1] cfs = cubic feet per second; ° C = degrees celsius; SU = standard pH units; mg/L = milligrams per liter; As = arsenic; B = boron; F = fluoride; Fe = iron; Mg = magnesium; Mn = manganese; Mo = molybdenum; Ni = nickel; Se = selenium; SO_4 = sulfate; Zn = zinc.

[2] First number is average daily value; second number is maximum daily value; if only one number is present, average and maximum values are the same.

[3] All concentrations reported are primary drinking water standards unless followed by (s) indicating secondary standards.

Source: Newmont 1993f; NAC 445.117; NAC 445.1339.

Impacts from Mine Pit Water Recovery

At completion of dewatering, a mine pit lake would begin to form as groundwater flows back into the pit. The projected bottom of the pit would be at an elevation of 4,275 feet, and the approximate pre-mining water table surface is at an elevation of 5,050 feet; therefore, the pit lake would have an ultimate depth of about 775 feet and cover an area of approximately 190 acres. The pit lake surface would be approximately 350 feet below the eastern mine pit rim. Evaporation from the final Gold Quarry pit lake would be an estimated maximum of 627 acre-feet per year

(390 gpm or 0.9 cfs) based on an evaporation rate of 40 inches per year.

In order to evaluate chemistry of the pit lake, Newmont commissioned a study that utilized existing chemical and hydrogeologic data in conjunction with laboratory tests and computer models (PTI 1992). The geochemistry study and modeling are described in more detail in Appendix E. The Gold Quarry sulfide ore body is bounded by siltstone and limestone (carbonate). Groundwater in both of these formations is alkaline, with a pH of about 8.0. The siltstone contains a higher sulfide-to-carbonate ratio in comparison with the limestone, which buffers the sulfides. After mining is completed, the pit walls would contain a zone of partially oxidized sulfide material.

The pit lake chemistry would evolve as leachate from sulfide-containing wall rock reacts with carbonate rock in the pit walls and the natural groundwater. The majority of leachable constituents in the oxidized wall rock would enter the pit lake within the first 10 years, followed by a decrease toward steady-state as the lake is diluted by through-flowing groundwater (PTI 1992). As the water chemistry approaches equilibrium, principal reactions affecting water quality would include neutralization of acidic inflow by bicarbonate in the groundwater, oxidation of Fe(II) to Fe(III), and subsequent precipitation of amorphous ferric hydroxide, which would settle to the bottom of the pit as a layer of sludge. The geochemical model shows that the interim pit lake would have a minimum pH of 7.9, with pH gradually increasing to 8.4. During the formation and settling of ferric hydroxide, many trace metals would be removed from the lake waters by adsorption onto the ferric hydroxide. The ferric hydroxide and trace metals in the sludge are predicted to remain stable in the pit lake bottom (PTI 1992).

The predicted water quality in the Gold Quarry pit lake 8 years after mining ceases (when maximum metal concentrations would exist) is confirmed by similar water chemistry observed in the Kimbley and Yerington mine pits in Nevada, especially with respect to pH (Table 4-8). These two mines also have limestone formations exposed in the pit walls.

The predicted final Gold Quarry pit lake composition and surrounding groundwater generally would be similar to or lower in dissolved metal concentrations than the pre-mining ore-zone groundwater (Table 4-8). Water quality is predicted for two wall rock porosities (1 and 3 percent) that represent the range of expected conditions after mining using the PTI model. The projected water quality would be a result of several major factors: (1) removal of groundwater associated with the ore zone during dewatering; (2) removal of most of the mineralized zone during mining; and (3) adsorption and deposition of trace metals on ferric hydroxide.

Surface Erosion and Sedimentation

Erosion would occur in areas of increased surface disturbance at the South Operations Area Project. Sediment from these areas would tend to accumulate in drainageways and possibly in streams. Erosion is most likely to occur during heavy precipitation and runoff. Most drainageways and streams in the mine area are ephemeral or intermittent and therefore would not carry increased sediment on a continuous basis. Impacts associated with accelerated erosion at the mine site are not likely to be significant (see Chapter 4, Soils, for additional information on erosion and soil loss). Newmont has developed a monitoring program and best management practices associated with EPA's stormwater regulations.

Mine Processing Impacts

Impacts on water resources could occur in the South Operations Area as a result of: erosion and runoff from disturbed areas; spills of lubricants, fuels, solvents, and cyanide onto the ground surface and into drainageways; acid drainage from waste rock disposal areas; and seepage of cyanide into the subsurface from the leach pads and tailing impoundment.

TABLE 4-8
Comparison of Groundwater and Pit Lake Water Quality[1]

Parameter	Existing Gold Quarry Groundwater[2]	Quality of Two Existing Pit Lakes		Predicted Quality of Gold Quarry Pit Lake[5]	
		Kimbley Pit[3]	Yerington Pit[4]	Gold Quarry Pit Lake (1% Porosity)	Gold Quarry Pit Lake (3% Porosity)
Aluminum	<0.10	NR	NR	0.037	0.017
Arsenic	0.099	<0.180	0.014	0.0[illegible]8	0.043
Barium	0.090	0.003	0.090	0.032	0.033
Cadmium	<0.005	<0.007	0.008	<0.001	<0.001
Chloride	17.0	264	74	[illegible].4	[illegible].8
Chromium	<0.002	<0.010	0.[illegible]2	0.025	0.028
Copper	<0.005	0.172	0.232	0.003	0.001
Fluoride	0.64	2.61	1.4	NR	NR
Iron	0.12	0.059	0.581	<0.001	0.001
Lead	<0.002	<0.0[illegible]	0.012	<0.001	<0.001
Mercury	0.0004	0.[illegible]3	<0.001	0.003	0.002
Magnesium	16.6	NR	22.3	23.3	23.4
Manganese	0.013	0.31	0.076	0.13	0.15
Phosphate	0.03	NR	NR	0.030	0.041
Potassium	7.8	NR	6.9	4.86	4.91
Selenium	0.059	<0.130	<0.002	0.025	0.041
Silver	<0.005	<0.020	<0.0[illegible]5	0.025	0.006
Sodium	90.0	NR	74	7.6	7.8
Sulfate	63	1,607	242	69	99
Thallium	0.014	NR	NR	0.025	0.028
Zinc	0.018	2.43	0.0[illegible]4	0.013	0.041
pH (SU)	7.3	7.59	8.21	8.31	7.96
Alkalinity	224	NR	110	52	24

1 Concentrations are reported in milligrams per liter (mg/L), except pH which is in standard pH units (SU); NR = results not reported.
2 Well GQTW-4, screened in the Gold Quarry siltstone ore zone. Sample collected 7-15-91.
3 Kimbley Pit Lake, Ruth, Nevada. Sampled 9-24-91 (MacDonald 1992).
4 Yerington Pit Lake, Yerington, Nevada. Sampled 10-29-90 (MacDonald 1992).
5 Predicted Gold Quarry pit lake chemistry at equilibrium after 8 years.

Source: PTI 1992.

The South Operations Area Project would produce potentially acid-generating waste rock that would be selectively placed in the Mill 5/6 tailing embankment and the South Waste Rock Disposal Area. Potential impacts from acid rock drainage are expected to be low because of construction techniques, monitoring, arid environment, and depth to groundwater (see Chapter 4, Geology and Minerals, for additional information on potential acid rock generation).

The tailing impoundment is designed to contain a 100-year/24-hour storm. Failure of the tailing embankment would be highly unlikely based on design, operation, and monitoring. Additional information about storage of storm water in the tailing impoundment and potential failure of the tailing embankment is included in the Mill 2/5 Tailing Storage Facility Environmental Assessment (BLM 1991a).

Solutions containing cyanide and metals that are discharged to or utilized at the tailing impoundment and leach pads would be contained in the multiple-lined facilities and eventually would be neutralized during reclamation. Releases during mine operation would be detected by monitoring wells and subsequently corrected. Mine waste and natural soils can attenuate some heavy metals and cyanide (BLM 1991a).

The North Area Haul Road would result in ground disturbance extending from the South Operations Area to the North Operations Area. Effects on water resources from construction of this road would include increased sedimentation in affected drainages. Surface water flow associated with drainageways would be directed through culverts beneath the road surface. No springs are expected to be disturbed by the North Area Haul Road. Minor spills of fuels and lubricants could occur along the road.

Cyanide Fate

Cyanide process solutions are in use throughout the gold recovery process. These solutions are present in the tanks and piping associated with the mill, lined ponds associated with the heap leach facilities, and in the heap leach and tailing disposal facilities. Newmont's reclamation plan includes provisions to neutralize and detoxify all cyanide solutions and ultimately dispose of them through evaporation. These activities would occur in accordance with NDEP regulations.

Cyanide is a highly reactive and relatively unstable compound. Its toxicity is directly related to the amount of cyanide ion (CN^-) and hydrogen cyanide (HCN) present in the solution. Neutralization and detoxification occurs through chemical processes that volatilize hydrogen cyanide, bind the cyanide ion in stable nontoxic compounds, or otherwise degrade the cyanide into nontoxic constituents. Chemical agents may be used to accelerate these processes, but the proposed method consists of adding water to reduce pH and allowing exposure to air and sunlight to accelerate the degradation processes.

Reducing pH of the cyanide-bearing solution is the primary method of neutralization and detoxification. Cyanide remains in solution only under alkaline conditions (pH > 9). As the pH is reduced through introduction of fresh water, the cyanide is converted to hydrogen cyanide gas and released to the atmosphere. Although concentrated hydrogen cyanide gas is highly toxic, the slow release that would accompany neutralization and detoxification is not harmful.

Cyanide neutralization and detoxification at the tailing storage facility and leach pads would begin as soon as the facilities are removed from service. Residual water in the tailing storage facility would evaporate or seep through the tailing material to the underdrain system. Seepage would be collected in the seepage collection pond and treated to meet State of Nevada standards (0.2 mg/L weak acid dissociable cyanide and a pH between 6 and 9 standard units). In the arid environment of the mine site, it is expected that continuous seepage of residual tailing solution would cease approximately 7 years after tailing deposition is halted. It is estimated that approximately 15 gpm of seepage from infiltrating precipitation may continue to discharge from the underdrain system of the tailing impoundment

(Newmont Gold company and Shepherd Miller, Inc. 1992). This water may contain minor amounts of cyanide, but concentrations would be lower than the regulatory limit. Cyanide at these concentrations would not be expected to impact the environment and any residual cyanide would decline over time.

Cyanide solution in the leach pads would be neutralized and detoxified by recirculation and evaporation. Freshwater would be introduced onto the leach pads to rinse residual cyanide from the spent ore. The rinse water would be recycled through the leach pad until it meets the regulatory criterion described above. At that time, all rinse water would be collected and disposed through evaporation. If freshwater rinsing does not meet State of Nevada standards, additional neutralization techniques would be utilized.

Alternatives 1 and 2

Direct and indirect impacts associated with Alternative 1 would be similar to those for the Proposed Action, with the exception of water temperature. When necessary the cooling tower would be used to reduce the temperature of mine discharge water such that the Humboldt River would be maintained within 2° C of ambient conditions measured at a point one-half mile downstream of the confluence with Maggie Creek.

Alternative 2 (backfilling MAC Mine pit) would result in no significant changes to direct and indirect impacts for the Proposed Action. The backfilled MAC Mine pit could slightly reduce groundwater recharge (as opposed to an open pit that collects some precipitation and runoff water).

Alternative 3

Excess water from the South Operations Area would be transported directly to the Humboldt River by pipeline for Alternative 3. No mine water would be discharged to Maggie Creek. The pipeline would be constructed along the east side of Maggie Creek (see Chapter 2, Project Alternatives). Water would be discharged to the Humboldt River near the mouth of Maggie Creek, utilizing an outlet structure consisting of a stilling basin, spillway, and riprapped apron to reduce the velocity of water entering the river. Impacts on water resources associated with Alternative 3 would be similar to those discussed above for the Proposed Action with the following exceptions:

Impacts on Groundwater Levels and Wells

The groundwater cone of depression resulting from dewatering activities at the Gold Quarry Mine would change from the configuration presented for the Proposed Action. Because excess mine water would not be discharged to Maggie Creek, up to 2 cfs of water would not be added to the lower Maggie Creek groundwater system from seepage in the stream channel. Because of this loss of groundwater recharge along lower Maggie Creek, the cone of depression would extend outward approximately 1 to 2 additional miles to the east and north in comparison with the predicted cone of depression for the Proposed Action (Figure 4-2). This modification to the cone of depression would not result in significant water level changes in wells beyond those discussed above for the Proposed Action (Figure 4-3).

Impacts on Springs and Seeps

Flow at the Carlin "Cold" Spring system could be further reduced by implementing Alternative 3. A portion of the recharge area for this spring is in the lower Maggie Creek Basin; therefore, elimination or reduction of water seepage from the Maggie Creek channel could adversely affect the flow rate of the Carlin Spring system. In addition to the 25 springs and seeps predicted to be impacted by the Proposed Action, implementation of Alternative 3 could impact up to five additional springs or seeps to the north of the 10-foot drawdown contour predicted for the Proposed Action. These springs are located between Simon and Jack creeks (Figure 4-5) and are summarized as follows:

(1) Section 7 (SE¼ of SE¼); T35N, R51E; spring in narrow channel tributary to Lynn Creek; flow <1 gpm; not developed; located near mountain spring domain boundary.

(2) Section 10 (SE¼), T35N, R51E; broad floodplain springy area in Jack Creek bottom; flow approximately 10 gpm; not developed.

(3) Section 13 (NW¼ of SW¼), T35N, R51E; spring along Jack Creek; flow <1 gpm; not developed.

(4) Section 13 (SW¼ of SW¼), T35N, R51E; broad wet meadow in fenced pasture near Jack Creek; flow approximately 4-5 gpm; not developed.

(5) Section 18 (NW¼ of NE¼); T35N, R51E; seep near top of hillside; flow <1 gpm; not developed; located near mountain spring domain boundary.

Impacts on these springs would occur near year 2005 when the maximum extent of groundwater drawdown is predicted. At that time, the cone of depression would start reducing in size and affected spring and seep flows would begin to recover.

Impacts on Streamflow

Approximately an additional 2 cfs (900 gpm) of excess mine discharge water would be added to the Humboldt River with Alternative 3 because stream loss in lower Maggie Creek Basin would not occur. Effects on lower Maggie Creek would consist of lowering the baseflow rate by approximately 2 to 4 cfs (HCI 1992a). Therefore, lower Maggie Creek would be dry for periods of the year when baseflow is less than these rates. Upper Maggie Creek above the canyon would also experience a decrease in flow of up to about 2 to 4 cfs; this influence would extend upstream approximately to the confluence with Jack Creek. These changes in streamflow would occur primarily during the dewatering period and for an estimated 10 to 20 additional years beyond cessation of dewatering at the South Operations Area. Complete recovery of some streamflows, however, could take nearly 100 years.

Middle and lower Susie Creek may experience additional decreases in streamflow with Alternative 3 because the groundwater cone of depression would be located closer to this drainage. The cone of depression would prevent some groundwater recharge from entering Susie Creek, thereby reducing baseflow. As with lower Maggie Creek, portions of Susie Creek could become dry during low-flow periods; however, both of these streams typically are intermittent during late summer and fall.

Stream and River Channel Stability

Stability and erosion of the Maggie Creek channel would not be a significant issue with Alternative 3 because excess mine water from the water treatment plant and the Maggie Creek Ranch Reservoir would bypass Maggie Creek and be discharged directly to the Humboldt River. As with the Proposed Action, any flood waters that exceed the capacity of the reservoir would be discharged to the unnamed tributary of Maggie Creek through the spillway. If such a release were to occur, it would cause additional erosion of the Maggie Creek channel during the period of release.

Some additional erosion would occur in the Humboldt River downstream of the discharge point with Alternative 3 because of the mine water added to the river. As shown in Figure 4-9, the additional flows would result in water contact with more river channel bottom during low flows; during high flows, however, there would be little or no change in water contact with the river channel. The mine discharge water would be clear and therefore would attain an equilibrium sediment load. Therefore, the sediment load would increase in the Humboldt River during mine dewatering as a result of implementation of Alternative 3. The TSS concentrations, however, should be similar to ambient levels (up to 344 mg/L TSS) that occur for equivalent natural flow rates. Any changes in sediment load would occur during the dewatering period when excess mine water is discharged to the river. The absence of sediment yield from Maggie Creek and from a delta forming at the mouth would result in a decrease of total sediment production in the Humboldt River when compared with the Proposed Action.

Impacts on Water Temperature

Transporting the mine water in a pipeline directly to the Humboldt River would result in no changes to water temperature over those described in the Proposed Action. As with the Proposed Action, a cooling system would be implemented when necessary such that water temperature of the Humboldt River at Palisade would be maintained within 2° C of ambient water temperature. However, due to little or no cooling of water in the pipeline to the Humboldt River, additional cooling would be required (in comparison to the proposed action) to meet the temperature restriction at Palisade.

Impacts on Surface Water Quality

Only minor changes in surface water quality would be expected from implementation of Alternative 3 when compared with the Proposed Action. Dissolved oxygen concentrations in the mine discharge water would be somewhat lower in the pipeline system than with discharge to the Maggie Creek channel. In addition, sediment load in the Humboldt River would be less for Alternative 3 because of elimination of sediment yield from Maggie Creek resulting from mine water discharge.

Surface Erosion and Sedimentation

Land disturbance associated with construction of a pipeline along the east side of Maggie Creek from the South Operations Area to the Humboldt River would cause some erosion and sedimentation. These impacts would be relatively short-term during the construction period. Ground disturbed during burial of the pipeline would be immediately reclaimed, thus reducing erosion potential.

No Action Alternative

The No Action alternative would result in no adverse impacts on water resources other than those associated with the existing activities at the South Operations Area. Although groundwater pumping is presently occurring at the South Operations Area, all mine water is being consumed and utilized for mining and processing purposes. The existing cone of depression surrounding the Gold Quarry Mine pit may impact flows in lower Maggie Creek and some springs and seeps within the drawdown area. A small pit lake will develop in the bottom of the Gold Quarry Mine pit even if the expansion does not occur. Some adverse impacts on water resources could occur from the existing waste rock disposal areas, leach pad facilities, and tailing impoundment.

POTENTIAL MITIGATION AND MONITORING MEASURES

Groundwater Levels and Wells

The existing groundwater monitoring program would continue for the South Operations Area Project. Water levels would be measured in 47 monitoring wells monthly (see Table 3-20). Water levels would also be monitored quarterly in selected stock, domestic, and public wells in and near the predicted 10-foot drawdown contour. For any private or public wells that are adversely affected by Gold Quarry Mine dewatering with respect to beneficial use, a replacement well or other water source of equivalent yield and quality would be provided during the period of effect.

Springs and Seeps

The existing spring and seep monitoring program would continue for selected sites within the Study Area (see Chapter 3, Water Resources). In addition, some of the 25 springs and seeps within the predicted 10-foot drawdown contour that are most likely to be impacted would be included in the monitoring program (Figure 4-5 and Table 4-6). These springs and seeps would be monitored quarterly or semiannually for flow, temperature, pH, specific conductance, and dissolved oxygen. Individual springs and seeps to be monitored would be specified in the mitigation plan discussed below; selection would be based on a prioritization system utilizing numerous factors, including flow rate, proximity to other springs and seeps, use by wildlife, aquatic habitats, riparian and wetland development, contribution to streamflow, and livestock use.

A detailed mitigation plan would be prepared to address potential adverse impacts at each spring or seep site that could be affected. This plan would contain various mitigation measures that could be effectively utilized to repair or replace the affected water resource. Existing springs and seeps would be prioritized to evaluate importance to land uses and ecological values. This prioritization would assist in determining if and when mitigation would be implemented for each affected spring or seep. Potential mitigation measures include:

- Replacing lost water by truck hauling or pipeline transport from another water source.
- Drilling a vertical well into an underlying aquifer and pumping groundwater using electric, solar, or windmill power.
- Improving existing spring sites to enhance water yield or collection by: (1) constructing protective boxes, storage tanks, troughs, and/or piping; (2) excavating collection basins or ponds; (3) constructing embankments across affected drainages to collect water; (4) constructing horizontal drains into the subsurface; (5) fencing spring/seep areas to prevent physical disturbance and allow riparian vegetation to increase; and (6) constructing guzzlers.
- For springs or seeps that are difficult to repair or enhance, developing or improving other nearby springs to offset the impact would be evaluated.

Stream and River Flows

The existing surface water flow monitoring program would continue for 10 stations on six streams and the Humboldt River (see Figure 3-6). Flow rate would be measured using seven continuous recorders on Maggie Creek, Jack Creek, Marys Creek, Susie Creek, and the Humboldt River. Three existing weirs or flumes also would be utilized on Simon, James, and upper Marys creeks. Some of these sites currently are operated by the USGS. In addition, a weir or flume would be installed on Little Jack Creek to monitor flow because of potential impacts on aquatics and fisheries.

If significant reductions in baseflow conditions are detected in streams such as Susie Creek and upper Maggie Creek during the dewatering period, additional flow could be provided to the affected reaches. During the period just after dewatering ceases, lower Maggie Creek and the Humboldt River also may have significant reductions in baseflow. Water could be supplemented in streams and rivers that have significant flow reductions from the proposed aciton until adequate natural baseflow conditions are restored. Flows in the Humboldt River would not be reduced below 10 cfs at Palisade during the impact period.

Potential sources of supplemental water to streams include mine water transported by pipeline, use of impounded runoff water, and groundwater wells drilled near the affected stream reaches. Transport of water by pipeline from the Gold Quarry Mine dewatering system may not be practical due to long distances, except for lower Maggie Creek and the Humboldt River. Any water discharged to a stream or river would have to be of acceptable quality and approved for discharge by the NDCNR. Improvement of stream conditions, such as limiting livestock use adjacent to channels and methods described below for channel stability, also could enhance of natural streamflow.

Stream and River Channel Stability

Maggie Creek would require mitigation measures to allow excess water from the Gold Quarry Mine dewatering system to flow on a continuous basis without causing significant erosion and stability problems. A detailed mitigation and design plan would be prepared to address necessary modifications to the lower Maggie Creek channel where discharge water would flow. Potential mitigation measures associated with channel modifications include (see Rosgen (1992) for additional mitigation information):

- Modifying the Maggie Creek channel shape to redistribute various flow rates into a stable channel configuration consisting of a baseflow channel, a lower width/depth ratio bankfull channel, and a floodplain to disperse the energy of high flow rates (Rosgen 1992).

- Dispersing initial flow releases onto a terrace in a series of small, interlaced channels prior to discharge into Maggie Creek. This would increase water losses by evapotranspiration and subsurface seepage, and supply a baseline sediment load to the discharge water prior to entering Maggie Creek (Rosgen 1992). Simulations of water temperature changes using the *QUAL2E* model for the terrace channel scenario show that there is little overall decrease in water temperature in the Humboldt River in comparison with direct discharge to Maggie Creek (Johnson 1993b). Use of the terrace channels, however, does significantly reduce lower Maggie Creek water temperatures in comparison with the proposed action. These terrace channels near the Maggie Creek discharge point could only transmit a rate of approximately 20 cfs (Johnson 1993b).

- Sloping channel banks to help establish vegetation and reduce mass wasting, collapse, and other erosional processes.

- Protecting channel and banks using transplanted willows, sod transplants with seeding, and rock wedges or "vanes."

- Constructing vortex rock weirs to reduce degradation of the channel from bed scouring, downcutting, and bank erosion. These rock features also would enhance fish habitat.

The amount of water required for discharge into Maggie Creek and the Humboldt River could be reduced by retaining some of the water within the Maggie Creek Basin by one or more of the following activities (other drainage basins were not evaluated for disposal of excess mine water). Benefits resulting from implementation of one or more of these activities would include retention of some groundwater in the affected basin, and reduction in the magnitude and duration of the groundwater cone of depression.

- Reinjecting one-third of excess mine water into bedrock in the Maggie Creek Basin. A numerical groundwater flow model simulation was performed where one-third of the mine water is injected at a single site (northeast injection site) and two-thirds are discharged to Maggie Creek (HCI 1992b). The simulation indicates that the resulting residual passive inflow to the mine pit would be slightly greater than the baseline value of 3,000 gpm through most of mine dewatering, increasing to a maximum of approximately twice the baseline value (HCI 1992b). The predicted groundwater levels do not exceed the land surface elevation at any time during injection; however, mechanical, hydraulic, or geochemical factors that could increase the groundwater levels were not considered in the model.

- Infiltrating water into shallow alluvium in the Maggie Creek Basin. Limitations to infiltration in Maggie Creek Basin using ponds include relatively low permeability of the alluvium and a high water table. In addition, infiltration water would raise the local water table and could increase the Gold Quarry Mine dewatering rate if the water disposal sites were within the area of influence of groundwater withdrawal.

  Lower Maggie Creek Basin has been evaluated as a potential water disposal site using infiltration. This assessment shows that for a valley floor area of 4 square miles, the alluvium has a storage capacity to hold approximately 180 days of discharge at a rate of 100 cfs, or 45,000 gpm (Stone 1991). A minimum of about 100 acres would be required to allow infiltration of 100 cfs (45,000 gpm) discharge into alluvium in the Maggie Creek Basin (Stone 1991). Evapotranspiration and groundwater flow in the alluvium would disperse less than 3.3 cfs (1,500 gpm) of the infiltration water (Stone 1991). Therefore, infiltration could be used periodically to dispose of some excess mine water. A potential benefit of water infiltration south of the South Operations Area would be a lessening of flow reductions in the Humboldt River.

- Irrigating lands in the Maggie Creek Basin. Newmont currently owns part of the Maggie Creek Ranch and plans to utilize some mine water on existing irrigated lands in the lower Maggie Creek Basin. An additional 1,650 acres could potentially be developed for irrigation in the lower Maggie Creek Basin with a total irrigation diversion of approximately 12.3 cfs (5,500 gpm) for a 6-month irrigation season (Keller-Bliesner Engineering 1991). Upper Maggie Creek Basin also was evaluated and determined that potentially irrigable lands would be limited to about 1,345 acres with a disposal capacity of 7.4 cfs (3,340 gpm) continuous flow during a 6-month period (Keller-Bliesner Engineering 1991). Therefore, total potential irrigation using mine water in the Maggie Creek Basin could be approximately 20 cfs (8,840 gpm) during half the year.

- Expansion of Maggie Creek Ranch Reservoir or construction of an additional storage reservoir. Additional storage capacity for mine water could be created by increasing the proposed Maggie Creek Ranch Reservoir expansion or by construction of an additional storage reservoir. This would allow additional water to be retained within the affected basin and provide recharge to the groundwater systems.

Another option for mitigating impacts on Maggie Creek would be to reduce the mine water discharge rate to the creek by piping a portion of the mine water directly to the Humboldt River while allowing a flow rate in Maggie Creek equal to or less than bankfull (80 cfs). This mitigation could also be a modification of Alternative 3. During the final 2 to 3 years of dewatering, predicted discharge rates would exceed 80 cfs; therefore, a pipeline to the Humboldt River would allow flow in Maggie Creek to be retained below the bankfull level, except when natural runoff conditions exceed this rate. Some modification and protection of Maggie Creek as described above would still be required to prevent significant erosion in the stream channel.

Surface Water Quality

The existing surface water monitoring program for the South Operations Area would continue. Water quality samples would be collected at 14 sites on Maggie Creek (4 sites), Jack Creek (1 site), Simon Creek (1 site), and the Humboldt River (8 sites) (see Figure 3-7). Samples would be collected on a quarterly basis. It is assumed that the NPDES permit would establish water quality standards for the discharge water that would result in no adverse impacts and require compliance monitoring as needed. Any water quality problems identified in the surface water samples would be evaluated for potential source, followed by correction of the problem and remediation of contamination, if necessary.

Groundwater Quality

The existing groundwater monitoring program for the South Operations Area would continue. Water samples would be collected from selected wells on a monthly basis. These wells are listed in Table 3-20. Any water quality problems identified in groundwater samples would be evaluated for potential source, followed by correction of the problem and remediation of contamination, if necessary.

Surface Erosion and Sedimentation

The surface water quality program discussed above would include total suspended sediment sampling and evaluation for indications of erosion and sedimentation problems. If elevated sediment concentrations are observed, the source would be identified and the problem corrected.

Mine Processing Areas

Design and operation of the waste rock disposal facilities, leach pads, and tailing impoundment as described above should prevent impacts on water resources. Spills of cyanide or other chemicals would be immediately addressed according to Newmont's spill response plan. The surface water and groundwater monitoring program described above would detect any problems in the mine facilities area. Water quality problems would be immediately investigated and corrected.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

During life of the South Operations Area Project, approximately 500,000 acre-feet of groundwater would be removed by the dewatering system. A portion of this water would be consumed at the mine site and the remaining water would be discharged into Maggie Creek and/or the Humboldt River. Therefore, most of the water would be removed from the Maggie Creek Basin but would be retained in the Humboldt River Basin. Dewatering would lower the groundwater table and reduce or result in the loss of some stream and spring/seep flows in the vicinity of the mine. However, these water resources would eventually recover and approach pre-mining conditions.

RESIDUAL ADVERSE EFFECTS

Successful implementation of mitigation measures would eliminate most residual adverse effects on water resources. The Gold Quarry Mine pit would continue to be a source of groundwater loss through evaporation at a maximum rate of approximately 627 acre-feet per year (390 gpm); however, this loss is not considered to have a significant impact on the regional water balance. Long-term quality of water in the Gold Quarry Mine pit lake and surrounding groundwater is predicted to be similar to or better than existing groundwater quality. Drawdown of groundwater and reductions in stream and river flows would slow and begin to approach pre-mining conditions after dewatering ceases. Although this period of recovery could extend up to 100 years, most recovery would occur within about 20 years after cessation of dewatering. Successful mitigation of springs and streams generally is unproven technology; should mitigation fail, residual adverse effects would result.

SOILS

SUMMARY

Impacts on soil resources are directly related to acreage of disturbance. Table 4-9 summarizes acreages affected by the Proposed Action and alternatives.

Alternatives 1 and 2 would have the same impact on soils as the Proposed Action, and Alternative 3 could have a greater impact. Comparison of impacts for the Proposed Action and alternatives was conducted assuming Newmont would use the same mitigation and reclamation procedures for all actions.

Primary impacts on soil resources would include soil loss and reduction in productivity as a result of soil salvage, stockpiling, and redistribution during reclamation.

TABLE 4-9 Acreages Affected by Proposed Action and Alternatives			
Action	Disturbed Acreage	Difference in Affected Acreage Relative to Proposed Action	Facilities Responsible for Difference in Acreage or Action
Proposed	1,573	---	---
Alternative 1	1,573	0	Cooling tower added to roaster facility
Alternative 2	1,573	0	Facilities same; 38 acres additional reclamation at MAC pit
Alternative 3	1,629	+56	Water discharge pipeline to Humboldt River

DIRECT AND INDIRECT IMPACTS

Impacts on soils occur in two separate stages during mining operations: (1) soil losses during mining, when salvaged topsoils are stockpiled and stabilized in storage areas, and (2) soil losses between final topsoil redistribution and completion of reclamation. Impacts affecting soils are more numerous during the mining period; however, topsoil erosion during the latter period has greater potential for unacceptable soil losses.

Proposed Action

Direct impacts on soils from the Proposed Action would include modification to soil chemical and physical characteristics, loss of soil to wind and water erosion, and decreased soil biological activity.

Chemical changes would result from mixing of surface soils with subsoils during salvage activities. This mixing would reduce organic matter content of surface soils and increase the probability of undesirable salts in subsoil materials being added to surface soils. These changes would lower the quality of soil.

Impacts on physical characteristics of soils during salvage and stockpiling would include soil compaction, loss of soil structure, increased coarse-fragment content due to mixing, soil pulverization from equipment and traffic, general loss of finer grained soil material due to wind and water erosion, and decreased permeability, available water-holding capacity, and effective rooting depth.

Soil losses from wind erosion are potentially high, especially in Nevada's arid, windy climate. The highest potential for loss of salvaged soils would occur during reclamation after topsoil is redistributed on disturbed areas, while the highest potential for loss of nonsalvaged soils would occur between initial disturbance and redistribution of cover soil. The volume of soil loss would depend on wind velocity, size and condition of exposed area, and soil texture. Coarse, fine, and very fine sands are rated extremely erodible (up to 310 tons/acre/year); fine and very fine loamy sands are rated very highly erodible (up to 134 tons/acre/year); and fine, coarse, and very fine sandy loams are rated highly erodible (up to 86 tons/acre/year) (USDA 1983). Lower soil loss potentials (up to 38 tons/acre/year) could occur on silty, noncalcareous silty loam and fibric, organic soils. These soil loss values are applied to large areas of unprotected soils. The USDA (1983) has set guidelines for soil loss on shallow soils (less than 20 inches to unfavorable substrata) at 1 ton/acre/year. These soil loss guidelines are based on the maximum amount of erosion at which the quality of the soil as a medium for plant growth can be maintained.

Water erosion potential, like wind erosion potential, would be high due to the same considerations of climate, exposed soil, soil texture, soil surface condition, as well as slope. Table 4-10 shows soil loss from water erosion by disturbance area as predicted by the Revised Universal Soil Loss Equation (RUSLE), Version 1.0 (Soil and Water Conservation Society 1992), for three models: models #1 and #2 identify potential soil losses after soil redistribution (assumes no management practices) and model #3 identifies potential soil loss after complete reclamation (assumes 5 years after soil redistribution). A separate soils technical report provides a more detailed discussion of the three models (Westech 1993).

Table 4-10 indicates there could be soil losses to water erosion exceeding maximum tolerable limits during the period between soil redistribution and successful reclamation. The maximum tolerable limit is 5 tons/acre/year (for soils with a rooting depth of 60 inches or more in "favorable substrata that can be renewed by tillage, organic matter, and other management practices") (USDA 1983). The lowest tolerable limit (for soils 20 inches or less to bedrock or unfavorable substrata) is 1 ton/acre/year (USDA 1983). Indications are that redistributed soils on the first five disturbance areas listed in Table 4-10 would be much less than 20 inches deep to unfavorable substrata. Erosion rates under model #3 would be tolerable. Soil losses in Table 4-10 do not include potential losses to wind erosion. Cutbanks formed during expansion of Maggie Creek Ranch Reservoir and releases of water from the reservoir into Maggie Creek would contribute to soil erosion.

Soil biological activity (especially with the mycorrhizae-root association) would be significantly reduced or eliminated during stockpiling as a result of anaerobic conditions created in deeper portions of stockpiles. After soil redistribution, biological activity would slowly increase and eventually reach pre-salvage levels.

Redistribution of soil during reclamation would result in losses from loading, hauling, and placement activities. Soil loss would continue after placement until vegetation is established. Soil compaction would be reduced by Newmont's proposal to rip soils after placement. Soil texture would also be affected during redistribution as a result of mixing surface and subsoil materials. After mixing, soils could have a higher coarse-fragment content in the upper rooting zone.

Redistributed soil would have a lower organic content and could have a higher salt content as a result of salvage and stockpiling. Precipitation migrating through the soil profile could eventually leach salts from the soil surface and improve the general chemical condition of soil over time.

Indirect impacts on other resources caused by soil disturbances from the proposed action include:

- Decreased water quality due to sedimentation from erosion of exposed slopes.
- Decreased vegetative productivity due to soil loss or inadequate cover soil depth.
- Decreased hydric soils supporting wetland and riparian vegetation.
- Decreased land-use utility.

Reclaimed Topography

The Proposed Action would alter pre-mining topography by creating open pits with steep walls and steep-sided hills with flat tops (heap leach pads, waste rock piles, and tailing storage facilities (see Figure 2-9). Roads, process ponds, the seepage collection system, and other miscellaneous disturbances would cause less severe topographic changes. Grading and contouring as proposed in the reclamation plan (Newmont Gold Company and Shepherd Miller, Inc. 1992) would partially mitigate topographic modifications by reducing slope faces to 2.3H:1V (43 percent) or 2.5H:1V (40 percent), rounding sharp edges, and blending disturbances into

TABLE 4-10
Soil Loss to Water Erosion by Disturbance Area

Disturbance Area	Slope %	Maximum Slope Length (ft)	Slope Length & Steepness Factor	Soil Loss (tons per acre per year)		
				Model #1	Model #2	Model #3
Heap Leach Pads	43	189	8.92	23	12	0.42
Tusc Waste Rock Pile	40	189	11.75	30	16	0.55
Tusc Waste Rock Pile	43	187	11.65	30	16	0.56
MAC Waste Rock Pile	40	316	17.84	46	24	0.83
North Waste Rock Pile	40	192	11.90	30	16	0.56
Maggie Creek Reservoir Dam	50	199	14.68	38	20	0.69
Soil Stockpiles[1]	40	130	8.67	23	12	0.41

[1] Data for slope gradient and maximum slope length for all disturbances, except soil stockpiles, are from the South Operations Area Reclamation Plan (Newmont Gold Company and Shepherd Miller, Inc. 1992). For the stockpiles, slope gradient and length were determined from the maximum height of 50 feet and slopes equal to 2.5H : 1V.

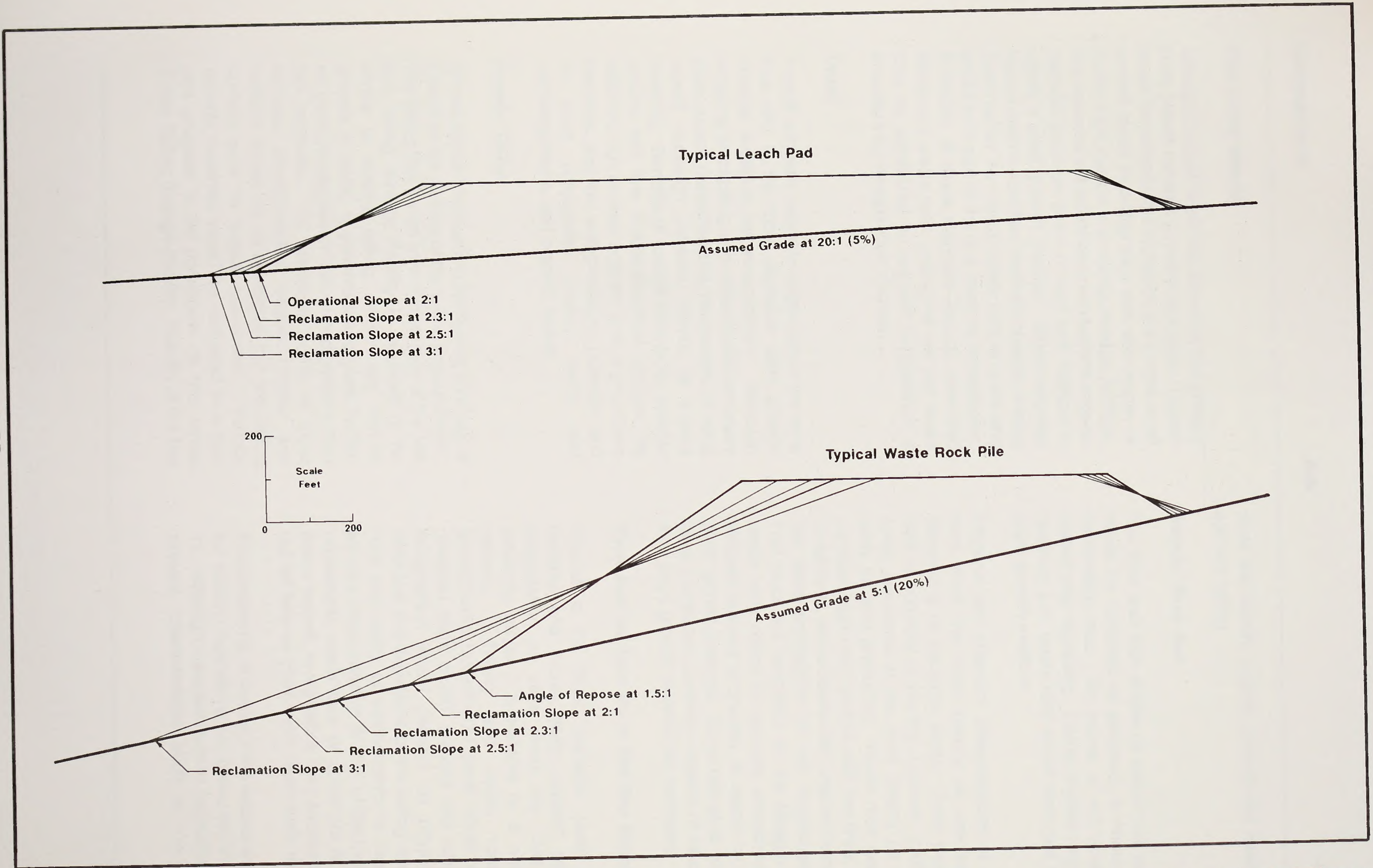
Source: Newmont Gold Company and Shepherd Miller, Inc. 1992.

adjacent undisturbed ground. Backfilling of process ponds and seepage collection structures and grading other mine disturbances would substantially mitigate topographic changes.

Grading the surface of the Mill 2/5 Tailing Storage Facility would create a depression and could result in formation of a shallow pond. Depending on the depth and duration of ponding, seeded species may be unable to survive. Long-term ponding could result in development of hydrophytic species such as sedges, rushes, or cattails.

Newmont has proposed final slopes of 2.3H:1V and 2.5H:1V on the faces of heap leach pads, waste rock piles, and the Mill 2/5 tailing embankment; these slopes reflect geotechnical and erosional stability and can be worked by reclamation equipment. The Mill 2/5 tailing embankment would be constructed at the final reclamation slope; other mine components would be graded to final configuration when they are reclaimed.

Grading slopes from their constructed angle to proposed post-mining angles would result in additional surface disturbance. The amount of additional disturbance would depend on height of the material to be graded, slope of the existing ground surface, and the proposed post-mining slope. Figure 4-11 presents cross-sections showing relative differences in surface disturbance associated with various reclaimed slope angles. In general, flatter reclaimed slopes disturb more land and are more costly to construct because of additional volume of material to be graded. Flatter slopes, however, have less erosion and less topsoil movement downslope; they also allow greater selection of equipment for reclamation. Newmont has proposed constructing benches on steep, regraded slopes to limit slope length (thereby reducing erosion) and to provide access for reclamation.



Conceptual Graded Slopes
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-11

Plant Growth Material

Salvaged topsoil would be utilized as the primary plant growth material on reclaimed areas. Topsoil would be redistributed to depths of 6 inches on all graded areas including tops and side slopes of waste rock dumps and tailing storage facilities. The replaced soil would be amended with organic material (such as straw or hay) and fertilizer to create a plant growth medium. Since respread topsoil depths would be relatively shallow, mining waste below the topsoil (waste rock or spent ore) would form part of the root zone for revegetation. Suitability of these materials (topsoil, amended tailing and waste rock, and spent ore and waste rock as substrates) to support revegetation is important for revegetation success.

Topsoil

Topsoil currently supports vegetation in the mine area and is the most desirable plant growth material available for revegetation. Although stripping, stockpiling, and redistribution adversely affect topsoil characteristics, the benefits of using topsoil outweigh adverse effects of topsoil handling. Benefits of topsoil include its suitable texture and low coarse-fragment content; its relatively high nutrient content, lack of phytotoxic elements, and low acid-producing potential; and its plant propagules (mainly seed), soil microorganisms, and organic matter.

Amended Tailing

Newmont has proposed redistributing 6 inches of topsoil on the surface of the tailing impoundment. The tailing that would form the surface of the Mill 2/5 Tailing Storage Facility is expected to be similar to existing tailing: sandy loam without gravels or rocks. It contains low organic matter, no plant propagules or soil microorganisms, and few nutrients. To overcome some of these adverse characteristics, organic matter and fertilizer would be incorporated into the tailing surface prior to topsoil placement. Various organic materials would be evaluated in a test-plot program to be conducted on the James Creek Tailing Storage Facility. Results of the test plots will identify organic amendment needs for soil and tailing.

Amended Waste Rock

The tops and side slopes of waste rock dumps would be topsoiled as proposed in Newmont's reclamation plan. Six inches of soil would be placed after regrading. Due to shallow depths of replaced soil, waste rock would form part of the plant growth medium.

Physical and chemical characteristics of waste rock from the Gold Quarry pit are variable depending on geologic strata. Rock mined to date is non-acid producing; however, rock from lower elevations in the Gold Quarry pit would likely be acid producing. Waste rock generally contains high rock content with few fines, is low in nutrients, and contains little organic matter and few plant propagules or soil microorganisms. Test plots are proposed on the Maggie Creek waste rock dump to evaluate amendments to mitigate adverse properties of waste rock as a plant growth material. Since test plots have not been completed, potential impacts of waste rock as a plant growth material are unknown.

Waste Rock and Spent Ore as Root Zone Material

Topsoil is the most desirable plant growth material and would likely support adequate revegetation on sites where the mine waste substrate below it is suitable as a root zone material. Tailing and waste rock with amendments, but without topsoil, would be a less desirable plant growth material and success of revegetation would depend on physical and chemical characteristics of the tailing and waste rock and ability of amendments to modify the adverse characteristics (if any) of the material. If undesirable waste rock or spent ore is present below topsoil, revegetation may succeed initially but fail later as plant roots reach toxic materials.

Characteristics of various mine wastes and topsoil for existing operations are presented in Table 4-11. Although materials toxic to vegetation are not present, characteristics such as low organic

TABLE 4-11
Chemical and Physical Characteristics[1] of South Operations Area Mine Materials and Topsoil

Sample Type[2]	pH (SU)	Soluble Salts (μmhos/cm)	Organic Matter (%)	NO_3	NH_4HCO_3- DTPA Extract					
					P	K	Zn	Fe	Mn	Cu
Waste Rock	7.6	1.9	0.2	4	17	306	3	4	2	0.6
Heap Leach	8.3	2.1	0.3	6	19	209	6.1	12	2	3.3
Tailing Impoundment	7.1	1.0	0.4	8	18	69	7.3	39	4	3.9
Dam	8.4	2.5	0.4	6	15	369	0.4	4	4	0.6
Haul Roads	7.7	1.2	0.4	8	17	306	18	26	4	3.2
Topsoil	8.2	1.0	8.3	6	24	686	7.1	8.3	12.3	1.3
Physical Analyses	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Texture**	**Gravel (%)**					
Waste Rock	48	30	27	CL	26					
Heap Leach	48	25	27	SCL	56					
Tailing	60	28	--	SL	--					
Dams	45	28	27	6	27					
Haul Roads	33	28	33	CL	48					
Topsoil	38	44	18	L	7					

1 SU = standard pH units; μmhos/cm = micromhos per centimeter; NO_3 = nitrate; P = phosphorus; K = potassium; Zn = zinc; Fe = iron; Mn = manganese; Cu = copper; CL = clay loam; SCL = sandy clay loam; SL = sandy loam; L = loam.

2 Samples collected February 1992.

Source: Newmont Gold Company and Shepherd Miller, Inc. 1992.

low nutrient content, and high gravel content could limit plant growth. Newmonthas proposed to isolate potentially acid-producing waste rock in the Mill 2/5 tailing embankment and waste rock piles, as well as conduct a monitoring program to evaluate waste rock material and stockpiled refractory ore (Newmont 1993a).

Topsoil Handling

As previously discussed, topsoil would be salvaged prior to disturbance, stockpiled, and then redistributed on all areas except the surface of tailing impoundments and the tops of waste rock dumps. The use of topsoil is a primary mitigation measure to enhance revegetation success. The quantity of topsoil to be salvaged and redistributed appears to be less than the amount available for stripping. Salvage of all identified topsoil would allow increased replacement depths over the disturbance areas. Salvage and replacement of additional topsoil would provide a more suitable plant growth material over a larger area and would enhance probability of revegetation success.

Topsoil and underlying mine waste would be ripped to a target depth of 12 to 18 inches. Deep ripping of shallow layers of topsoil could result in a lower quality plant growth material when matter, subsurface waste materials are mixed with topsoil. Significance of the impact of deep ripping after topsoil redistribution would depend on the physical and chemical attributes of the mine waste. If mine waste is low in coarse fragments and has no other deleterious characteristics, impacts of deep ripping on revegetation would likely be insignificant. If mine waste has high coarse-fragment content or other undesirable characteristics (high salts, high trace element concentrations, or high acidity), impacts on revegetation could be significant.

Reclamation Schedule

No reclamation is scheduled for the expansion project until 2005 (see Table 2-10), although certain mine components may be available for reclamation and reclaimed prior to that time. Delayed reclamation of certain mining components until the end of operations is often necessitated by component design. For example, in most cases, heap leach pads cannot be graded, topsoiled, and revegetated until ore recovery ceases and cyanide is reduced to acceptable levels. Other mine components may, however, be more amenable to concurrent reclamation if construction is modified to accommodate reclamation. Two cases where reclamation could be conducted sooner than currently scheduled are the Mill 2/5 tailing embankment and the waste rock piles for the MAC and Tusc pits. Since the Mill 2/5 tailing embankment would be constructed at final reclaimed slopes (2.5H:1V), reclamation of the embankment face would not have to wait for tailing impoundment decommissioning in 2009.

The MAC and Tusc waste rock piles could be constructed starting with the lowest lifts and proceeding upslope. This would allow for incremental grading and revegetation. Operationally, this type of waste rock dump construction is more costly (primarily related to haul distance). Concurrent reclamation would reduce the amount of unreclaimed area, and allow incremental bond release.

Alternatives 1, 2, and 3

Impacts on the soil resource from Alternatives 1 and 2, would be the same as those identified for the Proposed Action. Total reclaimed area would increase by 40 acres with backfilling and reclamation of the MAC Mine pit as proposed in Alternative 2. Alternative 3, construction of a pipeline to the Humboldt River, would disturb 56 acres more than the Proposed Action, but impacts associated with soil and sediment losses along the Maggie Creek channel would be eliminated. If the pipeline were removed the corridor would be disturbed twice.

Reclamation of major mine disturbances would not vary substantially among alternatives. Alternative 1 is identical to the Proposed Action from a reclamation standpoint. Backfilling of the MAC pit (Alternative 2) would allow reclamation of 40 acres that would have been unreclaimed. Redistribution of topsoil on the MAC pit would result in slightly shallower topsoil depths on other reclaimed areas, but the difference would be less than 1 inch. Backfilling the MAC pit would also result in a 10-foot reduction in the height of the Tusc waste rock dump, slightly decreasing reclaimed slope length and minimally reducing topsoil loss from erosion. Implementation of Alternative 3 would avoid need for repair of damage to the Maggie Creek channel and floodplain resulting from dewatering discharge. The pipeline to the Humboldt River would result in additional surface disturbance and require reclamation.

No Action Alternative

Under the No Action Alternative, additional soil impacts would not occur. Newmont would continue with the soil mitigation and monitoring measures required in existing permits. The No Action Alternative would result in reclamation of permitted disturbances as approved in the current South Operations Plan of Operations.

POTENTIAL MITIGATION AND MONITORING MEASURES

Mitigation and monitoring measures for soils would include those outlined in the BLM Solid Minerals Reclamation Handbook H-3042-1 (BLM 1992a). In addition, Newmont would be required to:

- Plan landscaping to create variable irregular edges and undulating surfaces.
- Slope the top of the South Waste Rock Disposal Area away from steep faces toward natural topography (as is proposed for the North Waste Rock Disposal Area). This would reduce runoff, soil loss, and gullying on waste rock pile faces.
- Slope tops of heap leach pads toward the lowest (uphill) side of pads. For pads 3, 4, 5, and 6, this would generally be the west side. Grade the short side of the pad to 3H:1V and/or install benches at a greater frequency than for the other three sides. A flatter west-facing slope would increase chances for revegetation stabilization.
- Design toes of heap leach pads, waste rock dumps, and tailing storage facility embankments to withstand surface water flows (assuming ultimate failure of diversion channels).
- Vary slope gradient on waste rock disposal and heap leach areas (between 3H:1V and 2.3H:1V) to create more diversity and naturally appearing slopes.
- Round edges of heap leach pads and create topographic diversity by grading on slopes visible from highway.
- Leave evidence of existing benches.
- Selectively place coarse waste rock on sideslopes and tops of reclaimed areas to break up topography and provide variable wildlife habitat.
- Rip compacted areas prior to spreading topsoil.
- Mulch with straw or hay to create a plant growth material out of tailing and waste rock prior to topsoil placement. Mulching is desirable for enhancing revegetation and reducing soil loss.
- Salvage and stockpile all available and suitable topsoil. Soils data in the JBR report (JBR 1992c), the Mill 2/5 Environmental Assessment (BLM 1991a), and SCS Soil Survey report (USDA 1980) were used in determining topsoil salvage depths for each disturbance in the proposed and alternative actions. Table 4-12 shows volumes of topsoil and inches of topsoil available for redistribution over each disturbance. More detail regarding salvageable soil depth, volume, and acreage is contained in a separate soils technical report (Westech 1993).
- Monitor salvage operations to ensure equipment operators are salvaging all suitable topsoil materials.
- Monitor topsoil redistribution to ensure soil mixing with underlying materials is minimized.
- Redistribute cover soil in patches on bench remnants, especially on north and east slopes, to promote establishment of shrub communities.
- Vary soil depth on reclaimed surfaces to provide vegetation diversity (species diversity as well as community and structural diversity).
- Direct-haul topsoil from salvage operations, when possible, to areas designated for immediate reclamation.
- Provide yearly reports that include status of topsoil stockpiles (locations, volumes, where and when used, and volumes redistributed)

TABLE 4-12 Acreage, Volume of Salvaged Soil Available, and Average Depth of Cover Soil by Action - South Operations Area									
	Action	Facility Acres[1]	Acreage[2] Contributing Soil to Stockpiles S1-S7 Soil Pool	Scheduled in Reclamation Plan to Receive Cover Soil	Acreage that will Receive Cover Soil as per Reclamation Plan[3]	Acreage[4] that would benefit from Cover Soil	Cover Soil Volume (Millions of Cubic Yards) Available From S1-S7 Soil Stockpile Pool	Average[5] Inches Cover Soil Applied to Column E Acres	Average[5] Inches Cover Soil Applied to Column F Acres
COLUMN	A	B	C	D	E	F			
PROPOSED ACTION	Facility								
	Gold Quarry pit expansion	45	29.8	N	0	0			
	Maggie Creek Ranch Reservoir	50	50.0	Y	50	50			
	MAC/Tusc ancillary facilities	264	256.1	Y	264	264			
	MAC Mine	40	40.0	N	0	0			
	Tusc Mine	112	112.0	N	0	0			
	South Waste Rock Disposal Area	50	48.1	EO	50	50			
	Tusc Waste Rock Disposal Area	268	268.0	EO	132	268			
	MAC Waste Rock Disposal Area	47	28.0	EO	28	47			
	Water treatment plant	35	26.1	Y	35	35			
	Pipelines and access roads	7	0.0	N	7	7			
	Refractory ore leach pads	378	348.3	Y	378	378			
	Roaster	50	0.0	Y	50	50			
	Oxygen plant	15	0.0	Y	15	15			
	Process solution ponds	14	12.3	Y	14	14			
	Underdrain collection ponds	6	6.0	Y	6	6			
	Schroeder Mtn. Substation	3	0.0	Y	3	3			
	North Area Haul Road	189	0.0	N	184	184			
	Total Acres or Cubic Yards	**1,573**	1,224.7		**1,216**	**1,371**	2.3 - 3.4	16.7-24.7	14.5-21.4
Alternative 1		1,573	1,224.7		1,216	1,371	2.3 - 3.4	16.7-24.7	14.5-21.4
Alternative 2		1,573	1,224.7		1,256	1,411	2.3 - 3.4	16.1-23.7	14.0-20.7
Alternative 3		1,629	1,224.7		1,216	1,371	2.3 - 3.4	16.7-24.7	14.5-21.4

[1] Y = yes; N = no; EO = embankment only.
[2] Linear disturbances (North Area Haul Road, miscellaneous access roads, and pipelines) and facilities on ML-EA soil map unit (mine-related disturbance lands) do not contribute to the S1 through S7 soil stockpile volume. Linear disturbances will be reclaimed from sidecast soil stockpiles adjacent to each disturbance.
[3] Newmont Gold Company and Shepherd Miller, Inc. 1992.
[4] Assume pits not reclaimed.
[5] Based on salvaged soil volume ranging from 2,302,695 to 3,398,236 cubic yards.

and expected increases or decreases in stockpiled soil volumes.

- Test all material (tailing, waste rock, and spent leach pad ore) and develop a material handling plan before end of operations so that desirable material can be stored or operations can be modified to ensure desirable material ends up in root zone. If special material handling is not feasible, develop a plan for treating or amending undesirable materials.
- Place a coarse waste rock capillary break on top of tailing that proves to be deleterious to plant growth, and add several feet of less coarse waste rock over it to provide adequate rooting depth under redistributed topsoil.
- Inspect final root zone materials prior to topsoil redistribution to ensure suitability to support revegetation.
- Reclaim Mill 2/5 tailing embankment face at end of construction unless there are sound reasons for delaying reclamation until the tailing storage facility is decommissioned.
- Develop a plan for concurrent reclamation of waste rock piles unless concurrent reclamation is unfeasible.
- Conduct periodic monitoring and documentation of topsoil stockpiles, especially after storms, to ensure continuing stability, and evaluate potential for future soil losses.
- Conduct periodic monitoring and documentation of erosion control and sedimentation structures.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Soil losses due to erosional or man-caused forces are irretrievable and irreversible.

RESIDUAL ADVERSE EFFECTS

Loss of soil or discontinuation of natural soil development, decrease in infiltration and percolation rates, decrease in available water-holding capacity, breakdown of soil structure, and loss of organic matter content would be reversed by natural soil development over an unknown amount of time. Reclamation steps such as grading, resoiling, and revegetating would expedite the process.

Loss of soil fertility and soil microorganisms, loss of vegetative productivity, and loss of land-use potential could be reversed within 5 to 15 years after successful reclamation. If reclamation is not successful, these impacts could have long-term adverse effects.

VEGETATION

SUMMARY

The Proposed Action would disturb 1,573 acres of vegetation, primarily lower elevation sagebrush-bunchgrass community types in deteriorated range condition. . The existing reclamation plan would not result in revegetation of the entire area. While reclamation (including the mitigation and monitoring measures outlined below) would restore much of the disturbed area, some features (e.g., mine pits) could not be reclaimed. Reclamation would not restore pre-mining topography or plant diversity and cover. However, comparable plant diversity and cover may develop over time with invasion of species from adjacent, undisturbed land.

There would be an irretrievable commitment of resources in the loss of plant productivity in the area disturbed by mining until reclamation is completed, and in areas that cannot be reclaimed.

DIRECT AND INDIRECT IMPACTS

Proposed Action

The Proposed Action would effect vegetation at mine facilities and within transportation and water pipeline corridors. Hydrologic changes within the groundwater cone-of-depression are not expected to impact upland vegetation. Acreages of range sites that would be impacted by the Proposed Action and Alternatives 1 and 2 are presented in Table 4-13. Acreages of range sites that would be impacted by Alternative 3 are shown in Table 4-14. !mpacts to riparian areas and vegetation are discussed in the following section.

Reclamation would entail establishing self-perpetuating plant communities on most disturbed land; however, these communities would differ from native plant communities in species composition and, species diversity. These components may return to pre-mining levels on most sites over time with the invasion of species from adjacent, undisturbed areas.

Reclamation problems may be encountered where: soils are deeply compacted; soils contain or are shallowly underlain by acid-producing materials unfavorable to plant growth; slopes fail; and soils erode before vegetation becomes established.

Potential indirect impacts would include invasion of disturbed areas by weeds that may spread to undisturbed areas; sedimentation of downslope vegetation due to erosion of slopes on mine facilities; and dust from haul roads inactive, tailing ponds, and other mine facilities. Dust and eroded soils may inhibit photosynthesis and predispose some plants to attack by insects or other pathogens (Elliott 1992). Exclusion of livestock in the fenced operations area would improve range condition on undisturbed rangeland.

TABLE 4-13 Acres of Disturbance by Dominant Range Site for the Proposed Action and Alternatives 1 and 2							
	Range Site						
Proposed Disturbance	**Dry Floodplain**	**Loamy 10-12" p.z.**	**South Slope 8-12" p.z.**	**Claypan 10-12" p.z.**	**Loamy 8-10" p.z.**	**Chalky Knoll**	**Acreage Total**
Gold Quarry Mine Expansion		3			42		45
Water Treatment Facility					35		35
South Waste Rock Disposal Area Expansion		25		25			50
Refractory Leach Pads					361	17	378
Tusc Pit			7		84	20	112
Tusc Waste Rock Facility		56	16		110	86	268
MAC Pit		7	21		12		45
MAC Waste Rock Facility		11	36				47
Tusc/MAC Ancillary Facilities		180			84		264
Roaster					50		50
Oxygen Plant					15		45
Haul Road		34		36	119		189
Expansion of Maggie Creek Ranch Reservoir	16				15	20	50
Inlet Pipeline and Discharge Channel from Maggie Creek Ranch Reservoir					7		7
Collection and Process Ponds					20		20
Schroeder Substation		3					3
TOTAL ACREAGE	**16**	**319**	**80**	**61**	**945**	**152**	**1,573**

TABLE 4-14 Acres of Disturbance by Dominant Range Site for Alternative 3							
	Range Site						
Proposed Disturbance	Dry Floodplain	Loamy 10-12" p.z.	South Slope 8-12" p.z.	Claypan 10-12" p.z.	Loamy 8-10" p.z.	Chalky Knoll	Acreage Total
Gold Quarry Mine Expansion		3			42		15
Water Treatment Facility					35		35
South Waste Rock Disposal Area Expansion		25		25			56
Refractory Leach Pads					361	17	378
Tusc Pit			7		80	25	112
Tusc Waste Rock Facility		56	16		110	86	268
MAC Pit		7	21		12		40
MAC Waste Rock Facility		11	36				47
Tusc/MAC Ancillary Facilities		180			80		264
Roaster					50		56
Oxygen Plant					15		15
Haul Road		34		36	119		189
Expansion of Maggie Creek Ranch Reservoir	16				80	24	50
Discharge Pipeline					56		56
Inlet Pipeline and Discharge Channel from Maggie Creek Ranch Reservoir					7		7
Collection and Process Ponds					20		20
Schroeder Substation		3					3
TOTAL ACREAGE	**16**	**319**	**80**	**61**	**1001**	**152**	**1,629**

Alternatives 1, 2, and 3

Acreage associated with Alternative 1 would be the same as for the Proposed Action. Alternative 2 would allow reclamation of an additional 40 acres associated with backfilling the MAC Mine pit. Discharge of mine water directly to the Humboldt River by pipeline (Alternative 3) would result in additional disturbance of 56 acres of range site Loamy 8-10 inch p.z. (Table 4-14).

No Action Alternative

The No Action Alternative would have no impact on vegetation. No disturbances beyond those presently permitted would occur.

POTENTIAL MITIGATION AND MONITORING MEASURES

Potential mitigation measures could include:

- Use of seed mixes that take advantage of slope and aspect, soil depth, and landscaped features of post-mining reclamation. These mixes should be determined on the basis of test plots and site- specific goals.
- Seeding or planting shrubs in patches, rather than uniformily over the area, taking into account soil redistribution depths. Shrubs should not be included in every seed mix; their use should depend on specific management goals and the ability of the growth medium to support them.
- Deleting crested and pubescent wheatgrass from dry-site mix and add native species or adjust rates.
- Allowing option of spring seeding.
- Preventing livestock grazing of revegetation for a minimum of two growing seasons.
- Developing and implementation of an integrated pest management plan for weeds.

Mitigation and monitoring for Alternatives 1 through 3 would be the same as for the Proposed Action. Additional monitoring along the water pipeline to the Humboldt River (Alternative 3) would be necessary to verify vegetation establishment and to ensure detection and control or eradication of weed infestations.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There would be an irreversible commitment of resources in the loss of 197 acres of vegetation in the Gold Quarry, MAC, and Tusc mine pits. There would be an irretrievable loss of vegetative productivity from the area disturbed by mining until reclamation is complete.

There would be no additional loss of vegetation beyond that in the Proposed Action for Alternatives 1 and 2. Construction of a pipeline to the Humboldt River (Alternative 3) would result in an irretrievable loss of vegetative production on 56 acres until reclamation is completed and vegetation established. Reclamation would begin immediately after burial of the pipeline.

RESIDUAL ADVERSE EFFECTS

Residual adverse effects of the Proposed Action and alternatives would be determined by the success of reclamation. Long-term perpetuation of non-native vegetation species may not support land use objectives.

RIPARIAN AREAS AND WETLANDS

SUMMARY

Riparian areas and wetlands along some stream reaches would be indirectly affected by mine dewatering or discharge of excess water. Potentially impacted streams include Maggie Creek, James Creek, Soap Creek, Marys Creek, Susie Creek, Simon Creek, Lynn Creek, East Cottonwood Creek, and the Humboldt River. There are 1,342 riparian acres potentially impacted on tributaries to the Humboldt River. Impacts on riparian areas and wetlands along these drainages would vary from minimal to major depending on magnitude of drawdown, discharge rate, water source, and effective mitigation. Stream-laid deposits along the Humboldt River would be partially inundated by increased flows during dewatering. The cone of depression associated with pit dewatering could cause flow losses in the Humboldt River resulting in increased exposure of stream-laid deposits and a decrease in acreages and production of wetter riparian types.

Wetlands and riparian areas associated with springs would be directly affected by the South Operations Area Project. Impacts from dewatering would affect up to 25 spring and seep sites with about 14 acres of associated wetlands, although some of these springs are located in mountain spring domains and thus may not be affected by mine dewatering.

Alternatives 1, 2, and 3 would have impacts on wetlands and riparian areas similar to those of the Proposed Action. Alternative 3 would reduce potential development of wetland and riparian vegetation along Maggie Creek associated with discharging water to this stream. Appropriate mitigation and monitoring plans would detect and minimize irretrievable impacts.

DIRECT AND INDIRECT IMPACTS

Proposed Action

No wetlands would be directly impacted by placement of dredge or fill material in wetlands as defined and regulated by the U.S. Army Corps of Engineers. Wetland and nonwetland riparian zones associated with the Humboldt River and tributary streams would be directly affected by pit dewatering and discharge of excess water (Figure 4-12). Decreases or increases in streamflow (see Chapter 4, Water Resources) would modify streamside vegetation. A total of 1,342 acres of riparian vegetation on tributaries to the Humboldt River would be potentially impacted by dewatering. Table 4-15 lists potentially affected acreage by vegetation type on Humboldt River tributaries.

Dominant riparian communities along streams that would be most impacted include streamside, B1-bench and B2-bench, coyote willow thicket, upland meadow, and wet meadows (sedge meadow, Baltic rush meadow, and grassy wet meadow). With reduction or loss of flows, species composition would be modified and acreage of riparian types diminished. Wetter site species, including few-flowered spikesedge, bulrushes, Nebraska sedge, Baltic rush, and fowl bluegrass, would be replaced by species typical of the remnant riparian vegetation type. These vegetation types include cheatgrass, Kentucky bluegrass, squirreltail, and drier site forbs. Site productivity would be decreased, resulting in lower value for livestock grazing and wildlife habitat. Streams potentially impacted include:

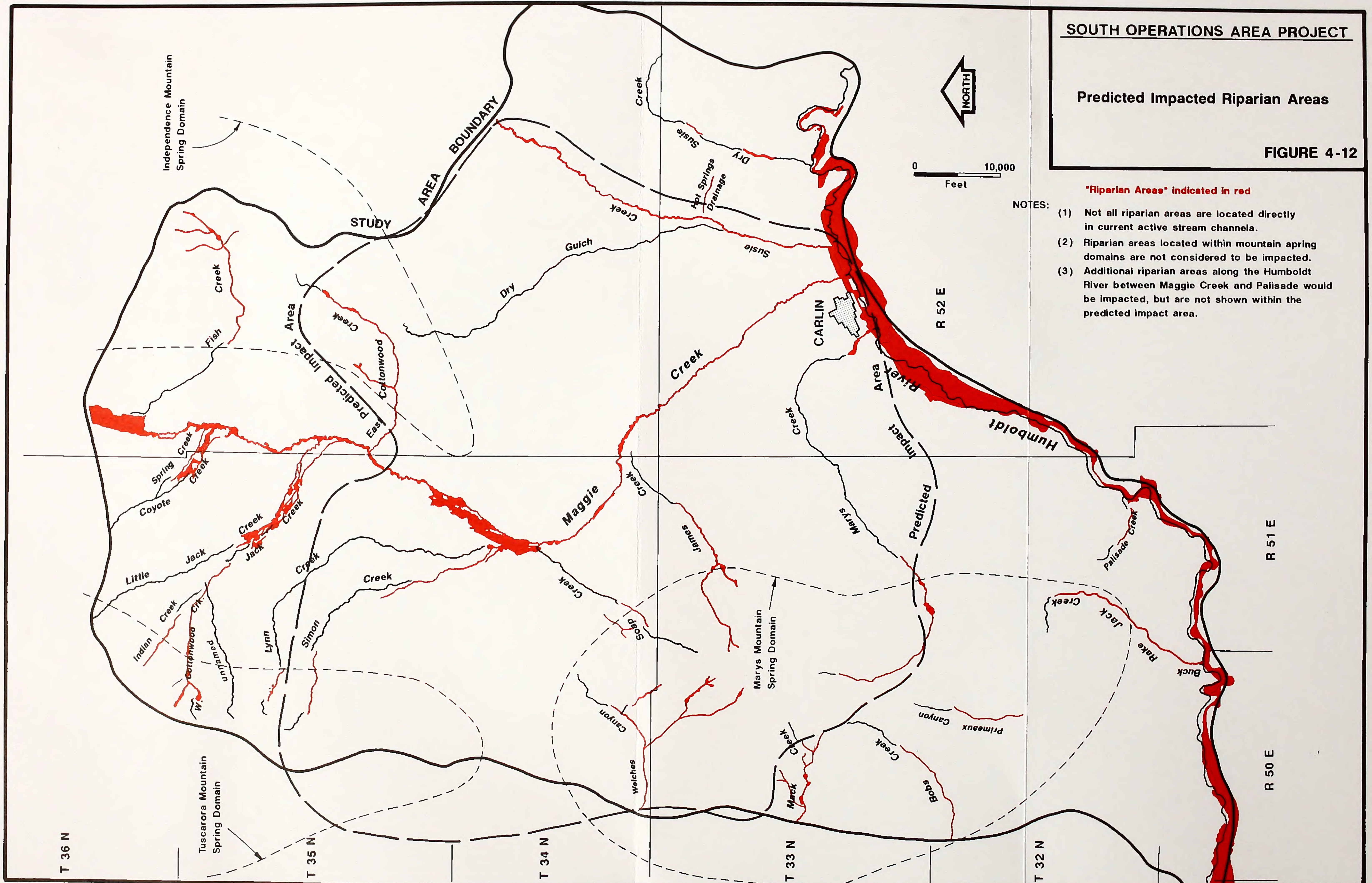
<u>Maggie Creek</u>. During dewatering and discharge, flow in lower Maggie Creek between the discharge point and the Humboldt River would be higher than normal and more consistent throughout the year, providing water when this reach is normally dry. This portion of the drainage currently supports a narrow zone of non-wetland riparian vegetation. Discharging to Maggie Creek would allow encroachment of wetland vegetation in narrow zones along the creek (depending on channel characteristics) and would provide growing-season subirrigation on stream terraces. Subirrigation would support additional riparian vegetation. Following cessation of dewatering, any hydrophytic vegetation established during dewatering would be replaced with drier site species now present along the stream.

Increased temperature of discharged water would cause herbaceous vegetation to green-up earlier in the spring and maintain growth longer into the growing season. The increase in water temperature would not be high enough to significantly affect species composition in riparian types. Increased flow would cause bank instability and sloghing and existing riparian communities would be lost where banks failed.

SOUTH OPERATIONS AREA PROJECT

Predicted Impacted Riparian Areas

FIGURE 4-12



"Riparian Areas" indicated in red

NOTES:

(1) Not all riparian areas are located directly in current active stream channels.

(2) Riparian areas located within mountain spring domains are not considered to be impacted.

(3) Additional riparian areas along the Humboldt River between Maggie Creek and Palisade would be impacted, but are not shown within the predicted impact area.

TABLE 4-15
Potentially Affected Acres of Riparian Vegetation by Vegetation Type Associated With Tributaries to the Humboldt River[1]

STREAM	RIPARIAN VEGETATION TYPE[2]													Streamside, Gravel Bar, B1 and B2 Benches, and Remnant Riparian[4]	Riparian Wetland and Nonwetland Waters of the U.S.[3]	Non-wetland Riparian	Total Riparian
	Stream-side	B1 Bench	B2 Bench	Gravel Bar	Yellow Willow Thicket	Coyote Willow Thicket	Cattail Pond or Pond	Sedge Meadow	Baltic Rush Meadow	Grassy Wet Meadow/ Grassy Meadow	Upland Meadow	Remnant Riparian	Poplar (aspen)				
Maggie Creek	123.6	90.2	141.0	1.2	-	80.0	0.7	146.6	-	190.6	264.0	-	-	-	632.9	405.0	1,037.9
James Creek	-	-	-	-	1.9	-	-	-	-	-	-	-	9.9	3.5	5.4	9.9	15.3
Soap Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	1.7	0.7	1.0	1.7
Marys Creek	-	-	-	-	-	2.4	-	-	-	-	-	-	-	1.7	4.1	-	4.1
Lower Susie Creek	71.0	121.0	68.9	2.0	-	-	-	-	-	-	-	-	-	-	194.0	68.9	262.9
Lynn/Simon Creeks	1.0	-	-	-	-	-	-	4.0	12.7	2.4	-	-	-	-	20.1	-	20.1
East Cotton-wood Creek	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	0.1
TOTAL	**195.7**	**211.2**	**209.9**	**3.2**	**1.9**	**82.4**	**0.7**	**150.6**	**12.7**	**193.0**	**264.0**		**9.9**	**6.9**	**857.3**	**484.8**	**1,342.1**

1 See Figure 4-12 for location of affected riparian areas.

2 See Table 3-22 for vegetation type descriptions.

3 Nonwetland Waters of the U.S. include streambeds and low benches along streams which fail to meet either of three wetland criteria (wetland hydrology, hydric soils, or hydrophytic vegetation), but are subject to Section 404 of the Clean Water Act since they meet criteria for Waters of the United States.

4 Complex of riparian vegetation types mapped where drainages were small or narrow.

Source: Adapted from JBR 1993.

Riparian wetland and nonwetland vegetation is present along Maggie Creek above the discharge point. The reach from the mouth of Maggie Creek Canyon to about East Cottonwood Creek could have reduced flow due to dewatering. With reduced flow, plant composition would be shifted toward species less dependent on water. Specific changes in wetland and riparian vegetation would depend on the magnitude and duration of flow reduction and the degree to which flows depend on unaffected water sources. During groundwater drawdown, up to 1,038 acres of riparian vegetation would be potentially affected on Maggie Creek (Table 4-15).

James Creek. The James Creek drainage contains about 28 acres of riparian and wetland vegetation of which about 15 would potentially be affected by dewatering. Eleven springs support riparian and wetland vegetation and contribute to streamflow in James Creek. Five of the 11 springs could be affected by dewatering and two are adjacent to the Marys Mountain spring domain and may be unaffected. The five potentially impacted springs provide about 60 percent of the streamflow originating in the drainage. However, the majority of this flow is provided by one spring (Section 10, T33N, R51E) just inside the Marys Mountain spring domain. The lower reach of James Creek has been impacted by prior disturbances in the South Operations Area.

Soap Creek. The Soap Creek drainage contains about 4 acres of riparian and wetland vegetation dependent upon one identified spring. This spring would be impacted by dewatering. Since most flow in Soap Creek originates from the headwaters in the Marys Mountain spring domain, impacts on riparian/wetland vegetation should be minimal, however, about 2 acres could be affected by dewatering.

Marys Creek. Marys Creek supports about 28 acres of riparian and wetland vegetation. The upper reaches are not expected to be impacted because flows are related to perched springs in the Marys Mountain spring domain. Wetland vegetation and riparian zones from the Carlin "Cold" Springs to the Humboldt River would, however, be impacted by predicted flow reductions at Carlin Springs. About 4 acres of riparian and wetland vegetation occur in the area potentially impacted.

Susie Creek. Lower Susie Creek supports about 263 riparian and wetland acres that would be impacted by dewatering. Reduction in baseflow would favor development of upland plant species instead of riparian species and preclude successful implementation of the ongoing riparian habitat restoration project.

Simon and Lynn Creeks. Simon and Lynn Creeks support about 39 acres of riparian vegetation, of which 28 acres would potentially be affected. This area is within the predicted 10-foot groundwater drawdown contour line. Some springs in the upper reaches and tributaries of these two drainages also may be impacted by dewatering.

East Cottonwood Creek. East Cottonwood Creek supports less than 7 acres of riparian vegetation and would not be substantially affected by dewatering since it is primarily within the Independence Mountain spring domain.

Humboldt River. Riparian communities along the Humboldt River would be affected by: (1) increased flows resulting from mine pit dewatering and discharge to Maggie Creek from 1993 through 2001, and (2) decreased flows resulting from groundwater drawdown after year 2001. Although groundwater drawdown would occur prior to year 2002, decreased river flows from drawdown would be offset by increased flows from discharge. Beginning in 2002, decreased flows would affect riparian vegetation. Maximum effect of decreased or lost flows would occur in about 2005; this condition would continue for 20 years or more as flows recover and approach pre-mining conditions.

Increased flows in the Humboldt River would be most noticeable during the low-flow periods from August through December when monthly flows at

Palisade are generally less than 100 cfs. Increased flows during this period would partially inundate normally exposed stream-laid deposits within and immediately adjacent to the channel. These seasonally exposed stream-laid deposits range from unvegetated gravels, sands, or silts to communities of weedy annual species or young willow.

The areal extent of inundation would vary depending on river flow rate, discharge rate, and channel and stream deposit configuration. Baseline data collected during November 1991 and April 1992 at 14 sites along the Humboldt River suggest that a 100-percent increase in flow results in a 30-percent increase in river width (JBR 1992a). Table 4-16 presents flow data related to river width. The 21.8 feet of increased river width caused by a doubling of flow rates would result in a net loss of 15 to 20 percent of in-channel and adjacent stream-laid deposits (based on a mean water plus stream-laid deposit width of about 210 feet). For the 10-mile reach between Maggie Creek and Palisade, a 15- to 20-percent loss would be 24 to 73 acres of the 163 acres of stream deposits.

During the maximum discharge period late in the growing season, a reasonably stable flow of 130 to 160 cfs would allow development of riparian vegetation along the river's edge. Current land use practices along the river, including seasonal grazing and willow control, would likely retard development of bank-stabilizing riparian vegetation (Bradley 1993).

Increased flows and water elevations during the growing season would provide more surface water and subirrigation for lower terraces, oxbows, and abandoned meanders. Currently, these features support riparian types ranging from relatively wet cattail and bulrush types to relatively dry inland saltgrass, depending on moisture conditions. Projected changes in communities are shown in Figure 4-13 and include: (1) drier types tending to become more moist (such as an inland saltgrass type in an abandoned meander becoming dominated by wetter site grasses, sedges, or rushes), and (2) increased production with increased available water. Acreage changed in lowland riparian types (other than stream deposits) are not quantified because of the lack of specific information on site conditions and variables associated with increased or decreased flow.

TABLE 4-16
Increase in Humboldt River Width Related to Increased Flow

	Flow (cfs)[1]		River Width (feet)	
Date	**Range**	**Mean**	**Range**	**Mean**
November 1991	60-104	82.4	41-124	73.6
April 1992	123-211	164.7	60-104	95.4
Difference	63-107	82.3	17-20	21.8
Percent Difference	103-105	100	16-41	30

[1] cfs = cubic feet per second.

Source: JBR 1992a.

Increased water temperatures associated with the discharge may cause herbaceous vegetation to initiate growth slightly earlier in the spring for a few miles downstream of Maggie Creek. Changes in species composition related to increased water temperature are not expected since the projected increases are within tolerances of established vegetation.

After dewatering ceases, the groundwater cone of depression would reduce flows in the Humboldt River in the study area. Potential impacts of reduced flows on riparian vegetation would be opposite those discussed previously for increased flows. During low flows, more stream-laid deposits within and adjacent to the channel would be exposed and available for colonization by weedy annuals or willows. Approximately 89 acres of additional stream deposits would be exposed if the Humboldt River became dry in the 10-mile reach between Maggie Creek and Palisade. With a decrease in groundwater elevations, existing mesic or wet types in oxbows or abandoned meanders could become dominated by drier site species and production on these sites would decrease. Flow reductions of up to 19 cfs during moderate to high flow periods (greater than 100 cfs) would not significantly affect riparian vegetation. Humboldt River flow reduction would occur primarily within about 20 years of dewatering cessation; therefore, changes in vegetation probably would be temporary.

Impacts on wetlands associated with springs and seeps would occur as a result of pit dewatering and groundwater drawdown. Of the 193 acres of wetlands associated with springs and seeps in the study area, approximately 14 acres (7 percent) would be impacted by dewatering (Table 4-17). However, some of these are adjacent to the mountain spring domains and may not be affected by dewatering.

Alternatives 1, 2, and 3

Alternatives 1 and 2 would result in impacts on riparian acres and wetlands similar to those of the Proposed Action (Table 4-15). Implementation of Alternative 1 would reduce discharge-water temperature such that potential earlier green-up of vegetation under the Proposed Action would not occur.

Alternative 3 would eliminate discharge to Maggie Creek and prevent development of expanded riparian acres or wetlands associated with the discharge. Bank sloughing and related loss of streambank vegetation would not occur. The effects of the cone of depression would impact existing riparian vegetation earlier in the dewatering schedule. Without increased flow from discharge, existing riparian communities in the stream reach below the proposed discharge point would be affected by flow loss.

No Action Alternative

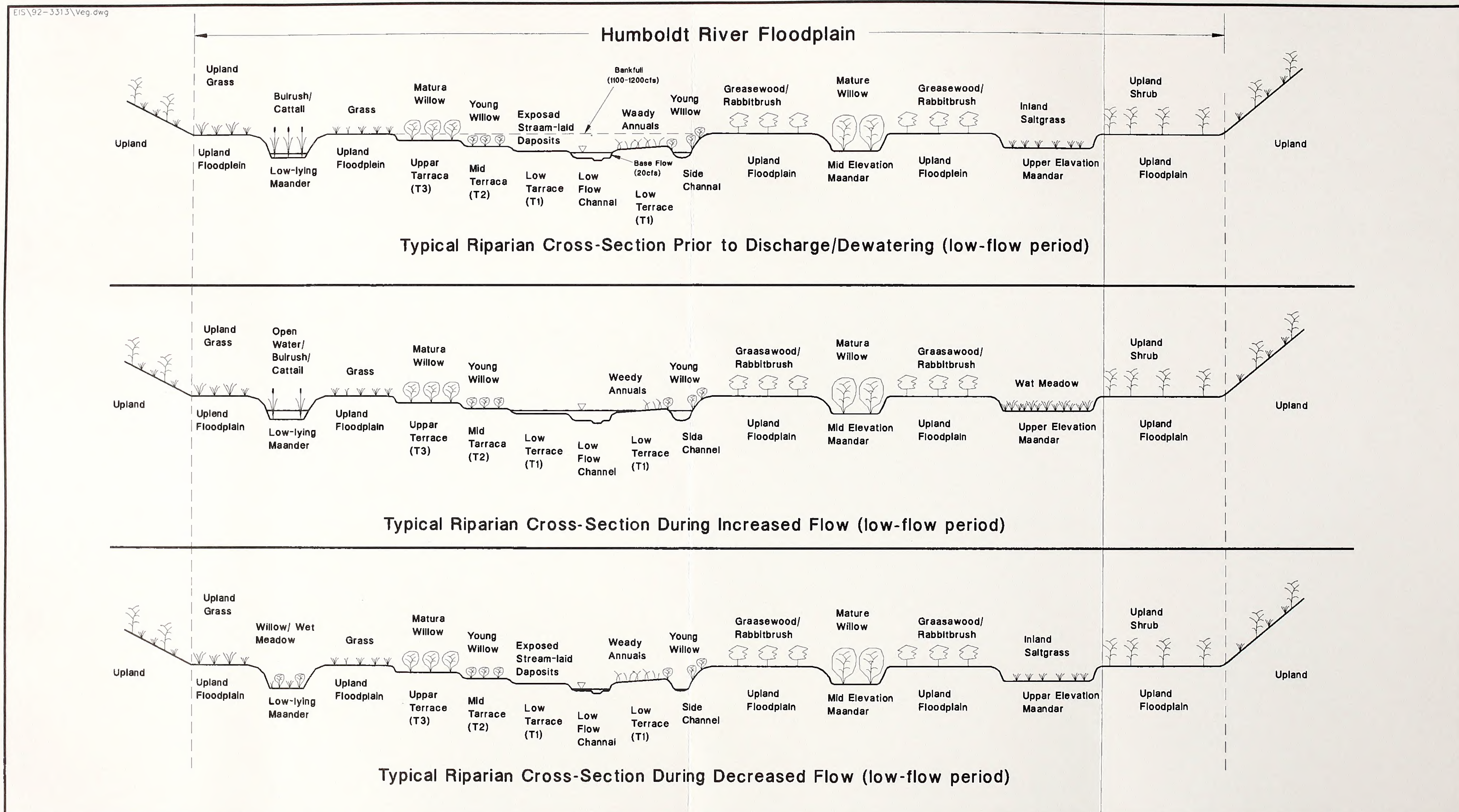
Although groundwater pumping associated with existing operations would directly affect wetlands and riparian areas within the drawdown zone, impacts would be substantially less than with the Proposed Action.

POTENTIAL MITIGATION AND MONITORING MEASURES

Measures to mitigate potential impacts on wetlands and riparian areas include:

- Development of a comprehensive plan for expanding wetlands and riparian areas along Maggie Creek, including a stream mitigation plan to prevent adverse changes in channel configuration and stability.

- Development of a spring and stream mitigation plan to maintain or enhance existing wetlands and riparian zones, or create replacement wetlands or riparian areas on the basis of their importance to existing land uses and ecological values. Mitigation should emphasize springs or stream reaches with high value and should be designed to replace or enhance wetlands or riparian zones on an acre-for-acre basis.



Potential Changes to
Humboldt River Floodplain Vegetation
Resulting From Flow Modifications
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-13

TABLE 4-17
Wetland Acreage and Dominant Vegetation
Associated with Springs Potentially Impacted by Gold Quarry Mine Dewatering

Spring/Seep Location[1] TN/RE-Section-¼,¼	Wetland Area[2] (acres)	Dominant Vegetation[2]
Springs Within 10-ft Drawdown Contour and Not Adjacent to Spring Domains		
35/51-18-SE,SE	0.01	Kentucky bluegrass, bur buttercup
35/51-30-SE,SE	0.04	Redtop bentgrass, Baltic rush
35/51-32-NW,NW	0.20	Baltic rush, fewflowered spikerush
34/51-10-NW,SE	9.61	Silverweed cinquefoil, Baltic rush
TOTAL	**10.08**	

Spring/Seep Location[1] TN/RE-Section-¼,¼	Wetland Area[2] (acres)	Dominant Vegetation[2]
Springs Adjacent to Spring Domain Boundaries		
35/51-18-SE,NW	0.31	Algae
35/51-30-NE,SE	not inventoried	not inventoried
34/52-6-NW,SW	not inventoried	not inventoried
34/52-6-SW,NW	0.28	Baltic rush, fewflowered spikerush
34/51-29-SW,SE	1.56	Nebraska sedge, Baltic rush
34/51-33-NW,NW	0.03	Baltic rush, American speedwell, moss
33/51-9-NE,NE	not available	Fowl bluegrass, Woods rose, watercress
33/51-10-NW,SW	0.20	Woods rose, quaking aspen, watercress
33/51-10-SE,NW	<0.1	Fowl bluegrass, American speedwell
33/51-10-NE,NW	0.20	Fewflowered spikerush, fowl bluegrass, American speedwell
33/51-10-SW,NW	0.20	Nebraska sedge, watercress
33/51-15-SW,NW	0.06	Coyote willow, fowl bluegrass
33/51-21-NW,NE	not inventoried	not inventoried
33/51-21-SE,NE	not inventoried	not inventoried
33/51-21-SW,SE	0.01	Fowl bluegrass, redtop bentgrass, Nebraska sedge
33/51-28-SE,NW	0.01	Fowl bluegrass, redtop bentgrass
33/51-33-NE,NW	0.01	Baltic rush
33/51-33-NE,NW	not inventoried	not inventoried
33/51-33-SE,NW	0.01	Nebraska sedge, Baltic rush
33/51-33-SW,NE	0.48	Nebraska sedge, Baltic rush
33/51-33-NW,SE	0.20	Baltic rush, watercress
TOTAL	**3.73**	

[1] TN = township north; RE = range east; ¼ section of ¼ section.
[2] From JBR 1992b.

- Assessment of the feasibility of creating shoreline wetlands for the Maggie Creek Ranch Reservoir.

- Establishment of riparian or wetland vegetation in blocked drainages, depressions in post-mining topography, and permanent diversion ditches.

- Monitoring of: (1) changes to significant vegetation adjacent to the Humboldt River as a result of discharging and dewatering; (2) selected springs that could be affected by dewatering to determine changes in wetland species or productivity; and (3) stream reaches that could be affected by dewatering to assess potential changes in acreage of riparian or wetland vegetation, species composition, and productivity.

- Potential mitigation of springs and seeps outlined in Chapter 4, Water Resources.

- Utilize proven methodologies including precipitation- supported wetlands created for the interval between cessation of dewatering and recovery of the cone of depression.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Successful mitigation and reestablishment of the hydrologic system would reverse wetland and riparian area diminishment or loss. Losses would be irreversible only if the hydrologic conditions do not return to pre-mining conditions. Wetlands and riparian areas would be irretrievably lost at spring sites or stream reaches where mitigative development of adequate water sources is not feasible. Magnitude of irretrievable loss of wetlands and riparian areas would depend on the impacted sites selected for mitigation.

RESIDUAL ADVERSE EFFECTS

Wetlands and riparian zones associated with springs and streams would return to approximate pre-mining conditions. Natural invasion of hydrophytic or riparian species could take several years, depending on seed sources. Proposed mitigation, if successful, would minimize adverse effects.

TERRESTRIAL WILDLIFE

SUMMARY

The primary impact on terrestrial wildlife would be direct loss of habitat (primarily sagebrush/grassland) and the loss or displacement of wildlife from affected habitat. Depending on the alternative selected, some of this loss would be crucial pronghorn winter range and/or mule deer transitional range. The North Area Haul Road and the MAC and Tusc mine pits and associated facilities would impede seasonal migration of several thousand mule deer. Loss or reduction of some springs, seeps and small streams due to groundwater drawdown would impact terrestrial wildlife dependent on these sites (e.g., amphibians, chukar, songbirds, waterbirds, small mammals, sage grouse, and predators) and may affect distribution of other species (e.g., bats, raptors, and mule deer) that use these sites as part of a larger habitat complex.

DIRECT AND INDIRECT IMPACTS

Proposed Action

The Proposed Action would result in direct loss of at least 1,573 acres (about 2.5 square miles) of terrestrial wildlife habitat, until such habitat is reclaimed. About 603 acres of this loss would occur within or immediately adjacent to the current South Operations Area. Another 731 acres would be associated with the MAC and Tusc operations. The remaining loss of 239 acres would be associated with the Maggie Creek Ranch Reservoir about 2 miles northeast of the Gold Quarry Mine, and the North Area Haul Road (which would extend about 9 miles northwest of the MAC and Tusc mine pits).

Direct loss of habitat would eliminate forage, hiding cover, breeding sites, nesting cover, and thermal cover. All terrestrial wildlife species dependent on these disturbed sites would be killed or displaced. Displaced animals may be incorporated into adjacent populations, or may die. Depending on variables such as species, behavior, density, and habitat, adjacent populations may experience increased mortality, decreased reproductive rates, or other compensatory or additive responses. The species impacted most severely would be those that rely primarily on big sagebrush/bunchgrass habitat, including: reptiles and amphibians; small mammals such as deer mice, voles, pygmy cottontails, black-tailed jackrabbits, and Richardson's ground squirrels; birds such as vesper sparrows, rock wrens, sage thrashers, and horned larks; and associated predators such as coyotes, golden eagles, and ferruginous hawks. A small number of mule deer that live year-round in the vicinity would be temporarily displaced.

Upon cessation of dewatering of the Gold Quarry Mine and recovery of the groundwater table, a lake of approximately 190 acres would form in the of the pit. Surface of the lake would be 920 feet below the pre-mining surface of the pit. Steep pit walls and an 8-foot-tall chain link perimeter fence would preclude access by larger animals. Some birds, amphibians, reptiles, and small mammals could use the pit lake; however, lack of vegetation in the mine pit would limit significant use by wildlife, except perhaps by waterfowl as a resting area.

Construction of the MAC and Tusc mine pits, associated waste rock dumps, ancillary facilities, and the primary haul road would remove about 1,428 acres of mule deer year-round range including 850 acres of transitional range. This transitional range produces forage and provides cover that are important to migrating mule deer in both autumn and spring. In fall, mule deer are largely restricted to the migration route depicted in Figure 3-12.

Construction of the North Area Haul Road would create a potential barrier to autumn migration of 2,000 to 4,000 mule deer between summer and winter ranges. Some mule deer probably would be killed by vehicles on the haul road, but a greater potential impact would be delay in crossing the road experienced by an indeterminate number of deer; they would suffer further physiological stress and become more susceptible to predators and vehicle collisions on the Simon Creek Road. Some mule deer may not cross the haul road at all. Mule deer that do not cross the road would have no other route to take in reaching their winter ranges in the Dunphy Hills and Palisade complex; some of these deer may attempt to winter in the Sheep Creek and Izzenhood ranges. Mule deer cannot remain in the mountainous area north of the haul road because annual snow depths are too great to allow movement and access to forage.

Expansion of the Maggie Creek Ranch Reservoir would result in loss of 50 acres of crucial pronghorn winter range. The construction of the water pipeline would impact an additional 7 acres of crucial winter range.

No known sage grouse display sites (leks) would be impacted by the proposed action. The vegetation associated with the MAC and Tusc operations, portions of the Gold Quarry Mine expansion, and the Haul Road are considered potential year-round habitat for sage grouse.

Approximately 1,169 acres of this habitat would be lost under the Proposed Action. The groundwater drawdown would impact up to 14 acres of wetland habitat at several springs and seeps (Figure 4-5 and Table 4-17) and 1,342 acres of riparian habitat along streams (Table 4-15). The loss of these vegetation types would effectively eliminate brood-rearing habitat at these sites, reducing the total sage grouse population and potentially altering sage grouse distribution during summer and autumn.

Some chukar upland habitat (steep, rocky slopes) in the vicinity of the Tusc Pit and Tusc Waste Rock Disposal areas would be lost, but this loss would be minor compared with habitat availability in the study area. The groundwater drawdown would result in loss of free water and riparian habitat at several seeps and springs along Soap Creek, near Simon Creek, and possibly along the east pediment of Marys Mountain. Dewatering would also impact available water in Lynn Creek, Simon Creek, and James Creek. Since chukar are dependent on available water, the loss of this component of the habitat would render the adjacent uplands uninhabitable. This loss would reduce the total chukar population and alter chukar distribution in the study area.

Hungarian partridge are widely distributed at low numbers throughout the study area. Loss of upland habitat as a result of the proposed action would be minor compared with habitat availability in the study area. Loss of riparian habitat as a result of groundwater drawdown at several springs and seeps (Figure 4-5 and Table 4-17) and streams (Table 4-15) could potentially alter Hungarian partridge distribution at least seasonally.

Mourning doves would not likely be affected by the loss of upland habitat associated with the proposed action. Loss of free water and riparian habitat as a result of groundwater drawdown at several springs and seeps could reduce the total population of mourning doves in the study area, and alter mourning dove distribution. Mourning doves were found almost exclusively in or near riparian habitats during the baseline surveys (JBR 1992d).

One prairie falcon nest site would be disturbed by the development of the Tusc mine. Five other nests (2 prairie falcons, 2 golden eagles, and 1 ferruginous hawk) would be within 1 mile of the proposed action. These nests have been active during the existing operations, and may remain active in spite of the increased disturbance as proposed. Topographic features, vegetative barriers, and distance from disturbance are factors that determine the magnitude of impacts. In some cases, nest sites may be abandoned. In other situations, where individual raptors habituate to human activity or the activity is far enough away or hidden by topographic or vegetative barriers, nest sites may not be affected.

Raptors would also be affected by the loss of prey base as a result of disturbance of 1,573 acres of upland habitat. Because most raptors usually range over a large area, this loss is not quantifiable but is probably minor and would not result in a change in raptor diversity. Some raptors would be able to take advantage of prey availability in reclaimed habitats.

Some raptor nesting and foraging habitat could be lost as a result of groundwater drawdown at springs, seeps, and streams. If warm discharge water from the water treatment facility results in more open water in Maggie Creek and the Humboldt River, raptors including the bald eagle may be able to take advantage of increased prey (e.g., fish, waterfowl, and shorebirds) availability. Conversely, flow in some streams may be impacted at least seasonally (see Chapter 4, Water Resources), resulting in a decrease in availability of some prey species.

Springs, seeps, and small streams provide habitat components not otherwise available in the study area, and therefore, support a high diversity of wildlife and contribute to the diversity of wildlife found in adjacent upland habitats areas. Because of their function in supporting wildlife diversity, water sources and associated riparian/wetland vegetation are important wildlife habitat components in the study area.

Alteration of riparian and wetland habitats by reduction of stream or spring flow (Figure 4-12, Table 4-15, Table 4-17) would directly affect at least 12 to 13 species of mammals, 18 nongame birds, 4 to 5 raptors, 31 species of waterfowl and shorebirds, and 5 amphibians that are dependent on these habitats. Many other species of wildlife that may be found in these habitats at least occasionally would be affected to a lesser degree. Habitat components that would be lost or reduced by groundwater drawdown at springs, seeps, and streams include nesting and foraging habitat for birds such as the mourning dove, yellow warbler, western tanager; foraging habitat for birds such as the great blue heron and sage grouse; drinking water for many species such as chukar and, Hungarian partridge, coyote, Townsend's big-eared bat, mule deer, and pronghorn; foraging, breeding, nesting, and security habitat for several raptors, waterfowl and shorebirds such as short-eared owl, mallard, gadwall, green-winged teal, greater yellowlegs, and whimbrel; and year-around habitat for furbearing mammals like beaver, muskrat, and mink.

Alteration of riparian habitats may benefit some certain wildlife species. For example, if aspen on James Creek die as a result of groundwater drawdown, these trees would eventually attract several species of woodpeckers to feed on insect adults and larvae in the decomposing wood. Other birds, such as mountain bluebirds and American kestrels, would be able to nest in cavities excavated by woodpeckers.

Individual springs and seeps may also support populations of animals such as amphibians or invertebrates (see Chapter 3, Aquatic Habitat and Fisheries) that are effectively isolated genetically from populations at other sites. Loss of these sites through groundwater drawdown could result in loss of genetic diversity and elimination of some local populations.

Eventually most water sources would approach their pre-mining condition (see Chapter 4, Water Resources). However, restored springs and seeps may be far enough away from undisturbed springs that some relatively immobile species, such as amphibians or invertebrates, would not repopulate these sites for many years, if ever. It could also be many years before mature trees, willows or mesic shrubs are available in riparian areas for raptors, non-game birds, and other wildlife.

Noise levels associated with the proposed expansion are not expected to increase above existing levels, although location of noise sources (e.g., development of the MAC and Tusc pits) would have a short-term effect on animals near those areas. Some animals would be displaced an unknown distance from the noise source, but many would become habituated to regular noise and resume their use of otherwise unaffected habitat.

Impacts of dust, exhaust fumes, and other air pollutants on wildlife may include effects such as temporary or permanent displacement due to reduced palatability of vegetation. Any impacts would primarily occur downwind from construction and mining activities.

Some wildlife (mostly bats and birds) consuming water from the leach heaps or tailings ponds would be killed. Existing monitoring programs indicate that 17 mallards, 2 teal, 11 unidentified ducks, 2 blackbirds, 1 sparrow, 1 unidentified bird, and 1 mule deer have been found dead due to exposure to water from tailings and heap leach facilities in the last 6 years. The number of such mortailities is expected to increase with the addition of process solution collection ponds associated with the refractory ore leach pads. Impacts on wildlife from toxic materials at other sites would be minimal. Water discharged from the mine would be treated to reduce levels of arsenic, iron, and selenium to meet NDEP standards.

Water from the water treatment plan and/or storage reservoir would be discharged into Maggie Creek and eventually the Humboldt River (see Chapter 4, Water Resources). Discharge flows would vary, but would eventually peak at approximately 104 cfs, or 46,500 gpm. Some wildlife would have difficulty crossing Maggie

Creek at higher flows. Pronghorn antelope are especially susceptible to barriers, and the portion of Maggie Creek that would receive the discharge dissects pronghorn antelope winter range. Approximately 15 percent of the crucial winter range may be made unavailable during the period of discharge. A similar situation would occur for mule deer attempting to move from crucial winter range east of Carlin to crucial winter range west of Carlin, although the magnitude of the impact would be less than for antelope.

The Humboldt River could experience minor channel modifications and addition of sediment (Rosgen 1992; see Chapter 4, Water Resources). Impacts on wildlife would result from a temporary loss of riparian vegetation along the river, potential flooding of denning and nesting sites for small mammals and birds, and possible changes in community structure that favor non-native species and species insensitive to higher sediment loads.

The human population of Carlin and vicinity would increase as a result of the construction force associated with the proposed action. Indirect impacts on wildlife from an expanded human population would include: (1) loss of habitat due to development or expansion of subdivisions, work camps, and other housing; (2) wildlife losses through predation or harassment by dogs and cats; (3) increase in legal harvest by hunters; (4) increase in illegal killing of wildlife; and (5) losses associated with off-road vehicle use.

Alternatives 1, 2, and 3

Alternative 1 would reduce the temperature of discharge water to Maggie Creek and the Humboldt River. This temperature change would not be expected to affect terrestrial wildlife. Alternative 1 would result in no change in flows in Maggie Creek and the Humboldt River compared with the Proposed Action.

Alternative 2 (backfilling the MAC Mine pit) would prolong disturbance to wildlife in the area, as mining of the pits would be sequential rather than concurrent. The same amount of habitat would be disturbed under this alternative as with the Proposed Action, but backfilling the MAC Mine pit would reduce the amount of habitat irretrievably lost by 40 acres.

Construction of a water discharge pipeline to the Humboldt River (Alternative 3) would impact wildlife along Maggie Creek by the temporary displacement of some species during construction and disturbance of 56 acres of habitat. Alternative 3 would result in an expansion of the groundwater cone of depression. The result would be a decrease or elimination of flows in lower Maggie Creek, potential dewatering of additional springs and seeps north of the mine area, (Figure 4-5), and loss of associated riparian vegetation. Impacts on wildlife at the discharge point and along the Humboldt River would depend upon how the water from the pipeline is cooled, oxygenated, and dispersed after discharge.

No Action Alternative

The No Action Alternative would have no impacts on wildlife other than those already occurring at the South Operations Area.

POTENTIAL MITIGATION AND MONITORING MEASURES

The Proposed Action would result in direct loss of a minimum of 1,573 acres of sagebrush-bunchgrass habitat, including more than 50 acres of crucial pronghorn winter range and 850 acres of mule deer transition range. Mitigation measures include the acquisition of replacement lands equivalent to the impacted public lands and/or the enhancement of suitable areas identified through consultation with BLM and NDOW.

Direct impacts associated with the Proposed Action or selected alternatives would be mitigated by excluding the months of November, March, and April from North Area Haul Road construction, and minimizing construction activities for expansion of the Maggie Creek Ranch Reservoir during November through March to reduce impacts on wintering pronghorns.

Construction of the North Area Haul Road could include the following provisions to minimize impacts on migrating mule deer:

- The segment of the haul road passing through Section 13, T35N, R50E and Section 19, T35N, R51E would be built either on a ridgetop or in a valley bottom. Cut and fill slopes generally would be less than 50 percent. Where this slope cannot be achieved, diagonal ramps at least 5 feet wide would be constructed on the cut or fill slopes. The slope of these ramps would be less than 50 percent. A ramp on one side of the road would have a ramp on the opposite side of the road. Ramps would be placed no more than 100 yards apart and maintained annually.

- Road berms through this area would be constructed to have less than 50 percent slopes. Gaps 3 to 5 feet wide would be placed in the berms at intervals of 50 yards.

- There would be no fence between the North Area Haul Road and the Carlin Mine access road. A southern fence would be constructed on a ridgetop south of the haul road and a northern fence on a ridgetop north of the Carlin Mine access road. These fences would be intended to control livestock and would be three-strand, with the bottom wire 16 inches above the ground and the top wire smooth and no more than 38 inches above ground.

- Traffic would be prohibited on the haul road from one-half hour before sunset to one-half hour after sunrise between November and March unless preceded by a lookout vehicle; speed would be restricted to less than 30 miles per hour at all times of day or night for a 2-mile segment through the major deer crossing area.

- Impacts of the North Area Haul Road on mule deer migrations would be monitored by BLM personnel during peak migration periods for the first 5 years of the project. If the haul road is implicated in major disruption of the mule deer migrations, immediate steps would be taken to correct the situation.

Existing monitoring programs would be expanded to determine mortalities of wildlife, particularly birds and bats. Leach pads and tailing facilities would be monitored weekly (i.e., all such facilities would be thoroughly searched once each week and all dead wildlife would be identified). All animals smaller than a coyote would be collected and stored pending examination by appropriate authorities and reported to BLM (numbers and species of animals collected at each site each week). If a given site contributes substantially to wildlife mortalities, BLM and NDOW would be consulted and appropriate mitigation measures (e.g., detoxification of affected water, netting, fencing, or hazing) would be employed to reduce or eliminate the problem.

All pipelines would be constructed to allow free passage of wildlife. Accepted reclamation practices would be implemented on all disturbed sites after cessation of mining.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Wildlife resources are generally considered renewable. If wildlife habitats lost through implementation of the Proposed Action or alternatives are reclaimed to pre-mining condition after project completion, no wildlife resources would be irreversibly or irretrievably lost. However, open pits of the Gold Quarry Mine, Tusc Mine, and possibly the MAC Mine, would result in lands irretrievably lost to wildlife use.

Degree of land surface recovery after mining ceases would depend on success of reclamation. It is highly unlikely that reclamation would create habitat similar in quality to pre-mining conditions. It is probable that diversity and density of many species of wildlife would not recover to pre-mining levels within the foreseeable future.

There is a possibility that small, isolated populations of some species of small mammals, reptiles, amphibians, or invertebrates associated with springs could be irretrievably lost if springs dry up. Repopulation through dispersal would likely be slow or nonexistent if affected springs are isolated from unaffected wildlife populations by areas of unsuitable habitat or relatively large distances.

RESIDUAL ADVERSE EFFECTS

The Gold Quarry, MAC, and Tusc mine pits (unless Alternative 2 is chosen and the MAC pit is backfilled) would remain potential hazards to wildlife for the foreseeable future. The Gold Quarry pit would partially fill with water and all pits would have steep, unvegetated sidewalls. Even though pits would be fenced, some mammals would probably enter them and possibly drown. Water in the Gold Quarry pit may pose a hazard to birds and bats drinking it for about 10 years or until water quality stabilizes.

When lands disturbed by construction of the North Area Haul Road, the Maggie Creek Ranch Reservoir, and the tailing and leach pad facilities are successfully revegetated following reclamation, habitat on these sites would be less diverse, contain more introduced species, and have up to 26 percent open ground. This vegetative cover would not support the same numbers and diversity of wildlife as the habitat that existed prior to mining disturbance. Alteration or loss of springs, seeps, and small streams due to groundwater drawdown would potentially affect wetland sites for some time during and after mining and would reduce the diversity of small mammals, birds, and other organisms dependent upon them.

AQUATIC HABITAT AND FISHERIES

SUMMARY

Large reductions in streamflow from drawdown within the cone of depression during the South Operations Area Project would decrease habitat quality for fish and other aquatic organisms in the Humboldt River, Maggie Creek, and Susie Creek. Periodic cessation or significant decreases of flows in these streams from mine dewatering would occur during periods of natural lowflow. Intermittent streamflows created by groundwater drawdown would eliminate or severely restrict fish and many aquatic invertebrates in dewatered portions of streams. Increases in suspended sediment would adversely affect aquatic life. Discharge of warm water into the Humboldt River would alter growth rates of fish and metabolic activities of aquatic invertebrates and algae. Timing of spawning, interspecific competition for food and habitat, and susceptibility to disease would be affected by increased water temperatures.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Potential impacts on fish, aquatic habitats, and aquatic insects in the Humboldt River and lower Maggie Creek would result from increased streamflow from mine-water discharge, altered water temperatures, elevated sediment levels, and reductions in dissolved oxygen. Potential impacts on aquatic organisms and aquatic habitat in Maggie Creek and Susie Creek would result from decreased streamflows within or near the groundwater cone of depression. After mine dewatering ceases, portions of the Humboldt River downstream from Carlin would experience reduction or loss of flow during low-flow periods from reduced groundwater recharge (see Chapter 4, Water Resources).

During the low-flow period of an average year, a baseflow rate of 0.8 cfs in middle and lower Susie Creek would be reduced to 0.3 cfs. Flows in lower Maggie Creek also would be reduced by an estimated 2 to 4 cfs after dewatering ceases. Middle Maggie Creek (between Maggie Creek Canyon and Jack Creek) also could have a reduction in flow of up to 2 to 4 cfs during and for approximately 10 to 20 years after dewatering. After this time period, natural baseflow in these streams would approach pre-mining conditions.

Reductions or loss of flow in Maggie and Susie creeks would reduce aquatic habitat, wetlands, and riparian habitat, resulting in fewer fish. During drought years or low-flow periods, groundwater drawdown from mine dewatering would result in an increase in the duration and length of no-flow reaches of Maggie Creek and Susie Creek, eliminating fish and many aquatic insects from affected reaches. Baseline flow data show that the lower reaches of Maggie and Susie creeks are intermittent, with dry portions during low-flow periods. Groundwater drawdown would exacerbate this condition. Dewatering impacts on lower Susie Creek would preclude successful implementation of the ongoing fisheries habitat restoration project.

As discussed in Chapter 4, Water Resources, some reaches of the Humboldt River between the Carlin Tunnels and Palisade gages may become dry or nearly dry during the period after dewatering ceases, when very low natural streamflows coincide with the period of maximum reductions in groundwater recharge to the river due to dewatering. Cessation or significant reduction of flow in portions of the Humboldt River would reduce habitat and consequently fish numbers. Fish would move to deeper pools or would die in dewatered sections of the river. As fish become concentrated in pools, competition for food and oxygen would increase as would mortality from predation and disease. It is likely that native fish would experience greater mortality than introduced species such as carp, bullheads, and catfish. Significant flow reductions in the Humboldt River would occur during extreme low baseflow conditions that typically occur in August, September, and/or October, for about 10 to 20 years after dewatering ceases.

Discharge of mine water at approximately 25°C (77°F) into Maggie Creek would increase temperatures in the Humboldt River during winter and spring, and slightly decrease temperature of the river during the warmest part of the summer. Under the proposed action, Newmont would maintain temperature changes in the Humboldt River at Palisade within 2°C of ambient conditions. Temperature increases would increase productivity of aquatic organisms (e.g., bacteria, algae, invertebrates, and fish) due to increased metabolism (Kaeding and Kaya 1978; Lamberti and Resh 1983). During the warmest part of the summer, mine water discharge would reduce maximum temperatures in the Humboldt River. Temperature reductions in summer would benefit fish because warmer-than-optimum water increases the spread of disease and reduces feeding activity for some fish species (Reeves et al. 1987).

Discharge of water from the South Operations Area to Maggie Creek and the Humboldt River probably would induce most species to spawn earlier because optimum water temperatures for spawning would be reached earlier in the spring. Potential impacts on fish populations from altered timing of spawning are not known. According to Reeves et al. (1987), water temperatures may also influence the composition of fish communities by affecting species survival and outcomes of competitive interactions for habitat and food.

If water discharged to the Humboldt River were to have low levels of dissolved oxygen (less than 5 parts per million), fish probably would become stressed, particularly during summer months when dissolved oxygen levels drop during the night. Low oxygen levels would reduce numbers of fish most sensitive to oxygen depletion. Oxygen reduction would have the greatest impact on native species (e.g., speckled dace, Lahontan redside, redside shiners, and mountain sucker) during the summer low-flow period.

Water temperatures in Maggie Creek downstream from the discharge point would be elevated in winter due to mine water discharge. Water discharged to Maggie Creek at a temperature of about 25°C or cooler would enhance aquatic habitat for invertebrates and warm-water fish if the water contains sufficient concentrations of dissolved oxygen (5 parts per million or greater). Currently, lower Maggie Creek is dry or nearly dry from August through December. Consequently, aquatic insects are unproductive and low in species diversity. Few, if any, fish inhabit lower Maggie Creek for most of the year. With discharge of mine water near 25°C, it is likely that fish would migrate upstream from the Humboldt River during the spring runoff period and recolonize the portion of Maggie Creek that receives mine dewatering flows.

Discharge of dewatering flows to the channel of Maggie Creek would accelerate bank erosion, increase sediment transport, and increase lateral channel migration (Rosgen 1992). Increased amounts of sediment in the Humboldt River would adversely affect fish and aquatic invertebrates. Fine sediments deposited in stream gravels affect incubating eggs and developing fry by inhibiting dissipation of metabolic wastes of developing embryos in the intergravel spaces (Phillips 1971). These sediments also abrade emerging fry (Weaver and White 1985), delay the rate of egg hatching, and reduce survival rates during incubation (Martin et al. 1987). Movement of suspended and bedload sediments abrades aquatic insects and reduces insect numbers and diversity. Sediment load that would be delivered to the Humboldt River as a result of discharge of excess mine water to Maggie Creek is estimated to be approximately 5,810 tons per year. Maggie Creek currently discharges about 1,980 tons per year of suspended and bedload sediment (Rosgen 1992). Existing concentrations of total suspended sediment (TSS) in the Humboldt River range from <1 to 344 mg/L. With the proposed action, TSS loads in the Humboldt River would increase up to 132 mg/L above current conditions at maximum discharge (Rosgen 1993).

Impacts from increased sediment from Maggie Creek on the biota of the Humboldt River would be greatest during low-flow periods. Typically, during low flows the Humboldt River carries relatively little sediment. Increased sediment contributions from Maggie Creek as a result of the proposed action would elevate sediment levels throughout the year and result in chronic exposure of aquatic organisms to higher concentrations of sediment. Although fish species in the Humboldt River are adapted to periodically high sediment levels, chronic exposure to elevated sediment levels would cause moderate losses in productivity of species most sensitive to sediment. Native fish such as speckled dace, Lahontan redside, and mountain sucker would probably experience the greatest impacts. Adverse impacts on some fish from increased sediment levels would occur downstream from Carlin.

High sediment loads in Maggie Creek would cause a delta to form at the confluence of Maggie Creek and the Humboldt River. This delta would reduce habitat quality for fish by covering rocks and gravel that provide hiding cover, spawning areas, and food sources. During periods of high flow in the Humboldt River, some of the deposited sediments would be resuspended and carried downstream where they would be distributed in pools and areas with lower water velocities. Habitat for fish and aquatic invertebrates would be affected.

Groundwater dewatering at the Gold Quarry Mine would affect up to 25 spring or seep sites in the study area (see Chapter 4, Water Resources). Reduced or lost flow would affect the composition and distribution of aquatic plants, periphyton (algae and diatoms), and invertebrates associated with each spring. Of particular concern would be the potential impacts on two species of springsnails (one of which is known to occur only in a warm spring approximately 8 miles south of the Gold Quarry Mine) that may have very limited distribution in the Great Basin. Since little is known about the ecology, distribution, and environmental requirements of these two species, the impact of flow reductions on springs cannot be predicted; however, if springs dry up, the snails would die. The warm spring (spring no. 52; Section 5, T32N, R52E, Figure 4-4) harboring one species of springsnail (*Fluminicola nevadensis*) could be affected by drawdown from mine dewatering; however, this spring is not located within the predicted 10-foot groundwater drawdown contour. The other species of springsnail has been found at two springs located approximately 13 miles south of the Gold Quarry Mine (Willy Billy Spring, Section 32, T32N, R51E and Rattlesnake Spring, Section 2, T31N, R50E). These two springs probably would experience little if any change as a result of mine dewatering.

Alternatives 1, 2, and 3

Alternative 1 would reduce or eliminate impacts on aquatic life resulting from discharge of warm water to the Humboldt River. Under Alternative 1, mine water would be discharged at a temperature such that the Humboldt River would be within 2°C of ambient conditions at a point one-half mile downstream of the Maggie Creek confluence. Impacts on aquatic resources associated with Alternative 2 would be the same as with the Proposed Action.

Alternative 3 (direct discharge of mine water to the Humboldt river) would be similar to the Proposed Action by increasing productivity of aquatic organisms due to warming of water in the Humboldt River during winter and spring. Sediment-related impacts would be reduced with Alternative 3. With the exception of natural spring runoff in Maggie Creek, little or no sediment would be discharged directly into the Humboldt River under this alternative. Flows in lower Maggie Creek and Susie Creek would be further reduced or eliminated by implementation of Alternative 3.

No Action Alternative

Selection of the No Action Alternative would result in elimination of adverse and beneficial impacts on fish, aquatic habitat, or other aquatic organisms.

POTENTIAL MITIGATION AND MONITORING MEASURES

Mitigation measures could be implemented to reduce impacts on aquatic life in the Humboldt River associated with elevated water temperatures, decreased oxygen levels, and elevated sediment levels. Adverse temperature effects could be reduced by discharging water near ambient water temperatures, with dissolved oxygen levels of at least 5 parts per million. Elevated sediment levels would be reduced by implementing mitigations discussed in Chapter 4, Water Resources.

Impacts from dewatering in Maggie Creek and Susie Creek could be mitigated by providing supplemental streamflows to these creeks by methods, such as pumping water from wells to affected streams using wind or solar power. The water would be discharged at temperatures near ambient conditions and at dissolved oxygen levels of at least 5 parts per million. Water would be released at rates simulating the natural flow regimes expected in a year of average precipitation and runoff. Monitoring would be ongoing through the groundwater recovery period.

Impacts from dewatering portions of the Humboldt River could be mitigated by continuing discharge from groundwater sources at the South Operations Area. The rate of pumping would be commensurate with maintaining a minimum flow of 10 cfs at Palisade. Typically, baseflows in the Humboldt River during low-flow periods average between 10 and 50 cfs.

Because of the possible rarity of the two springsnails species identified in the area, a mitigation plan should be developed with the U.S. Fish and Wildlife Service. This mitigation plan should address the following: searching over a broader geographic area for other occurrences of these species; studying the ecology of the two species more intensively; and surveying a broader geographic area for springs that closely replicate the environments of springs to be potentially impacted. The plan should consider the possibility of supplementing flows at impacted springs to maintain the existing environment; transplanting springsnails to other suitable sites, and artificially propagating springsnails until the pre-disturbance environments of the impacted springs are naturally restored. The mitigation plan should be developed within a year of project authorization.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There would be no irreversible or irretrievable commitment of resources that would affect aquatic life with successful implementation of mitigation measures. With exception of loss of aquatic life in dewatered reaches of streams there would be no irreversible irretrievable effects.

RESIDUAL ADVERSE EFFECTS

Aquatic habitats associated with smaller tributaries to Maggie Creek would have temporary losses during the period of dewatering effects.

THREATENED, ENDANGERED, AND CANDIDATE SPECIES

SUMMARY

Bald eagles wintering along the Humboldt River would experience minor positive benefits from discharge of dewatering flows to the Humboldt River. Greater expanses of ice-free water in winter would make waterfowl more accessible prey. Lahontan cutthroat habitat in middle Maggie Creek would be degraded from flow reductions caused by groundwater drawdown from the cone of depression. Potential Lahontan cutthroat habitat would be similarly degraded in middle and lower Susie Creek.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Bald Eagles

Bald eagles wintering along the Humboldt River would experience minor positive impacts due to greater expanses of ice-free water in winter. Discharge of water at temperatures of 25°C or less would increase the amount of ice-free water and attract migrating and wintering waterfowl, a potential food source for eagles. After discharge from Gold Quarry dewatering ceases, some reaches of the Humboldt River below Carlin may become dry or nearly dry due to the cone of depression. Periodic cessation of flow probably would reduce fish populations. This impact would be minor because bald eagles within the Study Area primarily rely on jackrabbits and carrion for winter food.

Peregrine Falcons

Impacts on peregrine falcons resulting from the Proposed Action would be negligible. Migrating peregrine falcons would not be adversely affected by loss of upland habitat or altered distribution of waterfowl during winter along the Humboldt River.

Lahontan Cutthroat Trout

Flows in middle Maggie Creek from Maggie Creek Canyon upstream to near the confluence with Jack Creek (see Figure 3-13) could be reduced by up to 2 to 4 cfs. Predicted groundwater drawdown would extend upstream to approximately the confluence of Maggie and Jack creeks. No Lahontan cutthroat trout were observed in 1992 in middle Maggie Creek; however, one Lahontan cutthroat trout was electroshocked during a fishery survey in 1980 near the confluence of Simon and Maggie creeks (see Figure 3-13). Since habitat elements for this species are present, potential impacts on Lahontan cutthroat trout could occur if dewatering reduces flows in middle Maggie Creek sufficiently to render it unsuitable for this species. In compliance with Section 7 of the Endangered Species Act, consultation with the U.S. Fish and Wildlife Service would be carried out. Populations of Lahontan cutthroat trout inhabiting Maggie Creek about 3 miles above the predicted drawdown area and Jack Creek would not be significantly affected by dewatering at the Gold Quarry Mine pit.

Flows in Susie Creek, potential habitat for cutthroat trout, would be decreased as a result of groundwater drawdown, from 0.8 cfs to 0.3 cfs during low-flow periods (see Chapter 4, Water Resources). Although Susie Creek is not currently inhabitated by Lahontan cutthroat trout, it has been identified as a potential stream for re-introduction in the Draft Lahontan Cutthroat Trout Recovery Plan (U.S. Fish and Wildlife Service 1992).

The proposed South Operations Area Project probably would degrade 10 to 12 miles of potential Lahontan cutthroat trout habitat in middle Maggie Creek and Susie Creek as a result of the groundwater cone of depression, until groundwater levels approach pre-mining conditions.

Candidate Species

Potential direct impacts on some candidate species from dewatering would result from habitat destruction and degradation, displacement from habitat, and reduction of wetlands and riparian zones. Direct loss of sagebrush-grassland habitat would have minor impacts on the loggerhead shrike, pygmy rabbit, and ferruginous hawk. Ferruginous hawks and loggerhead shrikes forage for prey in upland habitats that would be disturbed by mining and construction of ancillary facilities. Impacts on these species would be minor because sagebrush-grassland habitat is abundant and widespread in the study area and in north-central Nevada.

Displacement from habitat adjacent to mining as a result of noise and human activity would have minor impacts on loggerhead shrikes and ferruginous hawks because both species have become accustomed to noise and human activity and currently forage close to mining activities in the South Operations Area.

Impacts on pygmy rabbits would be minor. No known occupied habitat for this species would be affected by the proposed mine expansion, but potential habitat (i.e., sagebrush-grassland) would be lost. Mattoni's blue butterfly, and northern goshawk would be negligible. Townsend's big-eared bat could be adversely affected if the ponds formed by springs in the Lynn Creek drainage dry up as a result of drawdown from mine de-watering. Townsend's big-eared bats drink from open bodies of water of sufficient size to allow them to drink while in flight. If the Lynn Creek ponds dry up, big-eared bats inhabiting this area would need to acquire drinking water from another more distant source. Increased energy expenditures and alteration in behavior patterns as a result of having to travel longer distances for water could cause big-eared bats to abandon their habitat in the Lynn Creek drainage.

Loss of riparian vegetation from mine de-watering drawdown could potentially affect nesting habitat for white-faced ibis; however, because white faced ibis are not known to nest in the study area the probability for impacts to this species from loss of riparian vegetation would be low.

Loss or degradation of wetlands or riparian areas as a result of groundwater drawdown from dewatering would adversely affect potential habitat of the Nevada viceroy, spotted frog, and Preble's shrew. Habitat for these species would likely be degraded along Maggie Creek from Maggie Creek Canyon upstream to the confluence with Jack Creek. If willow density or distribution is reduced, habitat for the larval stage of Nevada viceroy would be affected. Willows are essential host plants for this butterfly. It is not known whether willow habitat for the Nevada viceroy is limiting its population size or distribution in the area.

The California floater, a freshwater mussel, was reported to be abundant in the Humboldt River in 1912 (Walker 1916). No recent studies have been conducted to determine whether this species is present in the portion of the Humboldt River that would be affected by the proposed action. Like fish and other aquatic organisms, California floaters could be adversely affected by increased sediment, elevated water temperatures, and reduced dissolved oxygen (see Chapter 4, Aquatic Habitat and Fisheries). Increased water temperatures could affect the species directly through mortality or indirectly by altering stages of the life cycle. Because larval stages in the life cycle of this mussel are attached to various fish, loss of fish in the Humboldt River could affect its reproductive success. Reduction of flows in the river would affect California floaters if they are present in affected portions of the river (see Chapter 4, Water Resources).

Impacts on the Tui chub would be negligible because its primary population center is upstream from the reach of the Humboldt River that would be affected by sedimentation, increased flows, and possible dewatering.

Alternatives 1, 2, and 3

Alternative 1 would reduce or eliminate potential impacts associated with discharge of warmer-than-ambient water to Maggie Creek and the Humboldt River. Implementation of Alternative 2 would result in restoration of 40 acres of mine pit lands to productive uses, including supporting wildlife.

Alternative 3 would be similar to the Proposed Action in affecting bald eagles. Discharge of water at about 25°C or less directly to the Humboldt River would increase the amount of ice-free water from Carlin for an unknown distance downstream. This open water would be attractive to waterfowl, a potential food source for bald eagles.

No Action Alternative

Selection of the No Action Alternative would result in elimination of adverse impacts on threatened, endangered, and candidate species.

POTENTIAL MITIGATION AND MONITORING MEASURES

Because of uncertainties in predicting the magnitude of impacts on Lahontan cutthroat trout habitat, monitoring and surveys would be conducted beginning in the spring of 1993. Field surveys would consist of:

- Mapping suitable Lahontan cutthroat trout habitat in middle Maggie Creek.
- Surveying for the presence of Lahontan cutthroat trout in middle Maggie Creek during late spring and early summer following the high-flow period.

Specific mitigation elements would be determined during Section 7 consultation with the U.S. Fish and Wildlife Service and may include the following:

- Supplemental water provided by groundwater pumping (e.g., by wind or solar power or other approved methods).
- Exclusion of cattle from the riparian area of middle Maggie Creek.
- Physical improvement of the stream channel.
- Revegetation of streamsides in middle Maggie Creek or elsewhere with suitable species, including willows, cottonwoods, and other riparian-area shrubs.

Uncertainties concerning impacts on California floaters and meadow pussytoes also exist; therefore, field surveys would be conducted to determine if these species are present in portions of the study area that could be affected. If these species are found, appropriate mitigation measures would be developed to address potential impacts.

Potential impacts to townsend's big-eared bats could be mitigated by monitoring water levels in the Lynn Creek ponds. If water levels in the ponds decrease from mine dewatering, supplemental water could be provided to the ponds to maintain adequate surface water for bats to access while in flight.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There would be no irreversible and irretrievable commitment of resources that would affect threatened, endangered, and candidate species if mitigation measures were successful. Loss of aquatic life in dewatered reaches of stream would be an irreversible commitment of resources.

RESIDUAL ADVERSE EFFECTS

Successful mitigation measures would eliminate residual adverse effects on threatened, endangered, or candidate species. Monitoring a minimum flow of 10 cfs in the Humboldt River would minimize impacts to California floaters.

LIVESTOCK GRAZING

SUMMARY

The Proposed Action would result in elimination of 8,092 AUMs on public and private lands for the period of groundwater drawdown and recovery. Some springs, seeps, wells, and streams within the study area would be affected by groundwater drawdown. Twenty-five springs and seeps would be affected through reduction or loss of flow.

Livestock grazing in the study area would be affected by impacts on stockwater availability associated with groundwater drawdown. Stocking rates would likely be reduced on some grazing allotments during the drawdown and recovery period for the groundwater cone of depression. Some areas would be permanently lost to livestock grazing because they are not reclaimable (e.g., mine pits). Some steep slopes remaining after reclamation would experience limited grazing. Losses in animal unit months (AUMs) coupled with uncertainty regarding stockwater availability may result in permanent reductions in stocking rates on some grazing allotments. Stockwater losses can be mitigated by replacing the water source. There will be an irretrievable commitment of forage lost during and following mining, and an irreversible loss of forage due to mine pits and reclaimed areas too steep for livestock grazing.

DIRECT AND INDIRECT IMPACTS

Proposed Action

The proposed action would result in temporary elimination of 8,092 AUMs on public and private lands, resulting from surface disturbance, reclamation or loss of flows in springs, and relocation of fences. Decreased acreage would result in fewer available AUMs and reduced livestock numbers on impacted allotments. Disturbance of 1,573 acres of land would result in loss of 222 AUMs, 173 on the T Lazy S allotment and 49 on the Hadley allotment. The proposed disturbance on the Marys Mountain allotment would be within the mine area that is already fenced to preclude livestock grazing; thus there would be no stocking rate adjustment on this allotment.

Dewatering of the Gold Quarry pit would affect both surface water and groundwater resources, and therefore stockwater sources. There are 10 known stock wells within the maximum 10-foot drawdown contour (see Figure 4-3). Impacts on these wells would depend on their depth and location within the groundwater cone of depression. Based on the assessment presented in the Water Resources section of Chapter 4, only one stock or irrigation well (Hadley stock well; Section 17, T34N, R52E) with a known total depth is likely to be entirely dewatered.

Dewatering of the Gold Quarry pit would result in reduced flow or complete cessation of flow in several springs and seeps within the predicted groundwater drawdown area (Table 4-6). A total of 25 spring and seep sites are predicted to be impacted, of which five have been developed for livestock use. Although many springs have not been developed for livestock use, they may provide water for livestock. Loss of these springs would displace livestock from forage that is too far from water to be usable.

Four springs that would be impacted by dewatering are in the T Lazy S allotment. Two springs are in the Marys Mountain allotment, and one is in the Hadley allotment. If other springs in these allotments keep flowing at some level, they may supply enough water to compensate for springs that could dry up. However, additional pressure on the remaining springs from livestock may damage surrounding vegetation and reduce the springs' functionality due to trampling.

The north-central portion of the T Lazy S allotment could be without water, making forage in this area unusable by livestock if: the 25 springs discussed above are dewatered; Simon Creek, Welches Canyon, and Soap Creek are affected; and wells of unknown depth are dewatered.

Similarly, if springs along the boundary of the spring domain in the Marys Mountain allotment are dewatered, and James Creek and Marys Creek are affected, availability of water in the central portion of the Marys Mountain allotment could be impacted. The south-central portion of the Hadley allotment may be without stockwater if springs and wells discussed previously are impacted by pit dewatering. Reductions in active preference AUMs for allotments potentially impacted by dewatering and surface disturbance range from 17 to 58 percent (Table 4-18).

Range improvements potentially impacted by the proposed action include spring developments mentioned previously and a boundary fence between Marys Mountain and T Lazy S allotments in Section 34 (T34N, R51W). The North Area Haul Road may produce some livestock mortality due to collisions between livestock and haul trucks in the T Lazy S allotment.

Reductions in available forage would negatively impact permittees by forcing them to find additional pasture for livestock or reduce their herd size. Some permittees would likely try to find additional pasture, whereas others would reduce livestock numbers. Reduced flows of springs and seeps would occur primarily during the dewatering period (through year 2001) and for about 10 to 20 years after dewatering. Complete recovery of some springs, however, could take nearly 100 years.

Alternatives 1, 2, and 3

Alternative 1 would not result in impacts beyond those described for the Proposed Action. Backfilling the MAC pit with waste rock from the Tusc Mine (Al-ternative 2) would allow reclamation of 40 acres that would have been irretrievably lost

TABLE 4-18 Changes in AUMs[1] (Active Preference) by Allotment in the South Operations Area - 1993									
		AUMs Lost due to Implementation of the Proposed Action and Alternatives 1 and 2				AUMs Lost due to Implementation of Alternative 3			
Allotment/ Permittee	Existing AUMs[2]	Surface Disturbance[3]	Dewatering	Total	Percent Reduction in AUMs	Surface Disturbance[3]	Dewatering	Total	Percent Reduction in AUMs
Hadley/ Maggie Creek Ranch	8,335	49[4]	1,651	1,700	20	47	1,999	2,046	25
Marys Mountain/ Melvin Jones Ranch	2,748	--	1,589	1,589	58	--	1,589	1,589	58
T Lazy S/Elko Land and Livestock	27,963	173[5]	4,630	4,803	17	173	4,630	4,803	17
TOTAL	**39,046**	**222**	**7,870**	**8,092**		**220**	**8,218**	**8,438**	

1 AUMs = animal unit months.

2 Public, private and leased land combined.

3 The proposed disturbance on the Marys Mountain allotment falls within the mine area that is already fenced. Loss of AUMs in the proposed disturbance area has already been included in existing active preference.

4 Surface disturbance includes the Maggie Creek Ranch Reservoir and associated pipelines.

5 Surface disturbance includes the Tusc/MAC operations area.

Source: BLM 1993.

had the pit not been backfilled. Depending on reclamation success, this area could be available for livestock grazing.

Alternative 3 would result in reduced flows in lower Maggie Creek and Susie Creek through portions of the Hadley allotment. Maggie Creek is the stockwater supply for the southern portion of this allotment. Complete elimination of streamflow during lowflow periods would leave this portion of the allotment without water, making forage in the area unusable by livestock. Reduced flows in lower Maggie and Susie creeks would occur primarily during the dewatering period and for about 10 to 20 years thereafter.

No Action Alternative

The No Action Alternative would have no impact on livestock grazing. No disturbances beyond those already permitted would occur. Existing grazing levels would be maintained on study area allotments.

POTENTIAL MITIGATION AND MONITORING MEASURES

Selected springs, seeps, and streams would be monitored during and following mine pit dewatering to determine effects on flows. Significant reduction in flows or loss of important springs and seeps would be compensated for by providing water in the same vicinity by methods described in Chapter 4, Water Resources. Forage could be replaced by rangeland seedings in areas outside of the cone of depression that have existing low carrying capacities.

Livestock displaced from areas where springs have been dewatered would be concentrated on rangeland with viable water sources. The effects of increased grazing pressure on vegetation in these areas would be monitored.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

If the Proposed Action is implemented, 197 acres of vegetation in the Gold Quarry, MAC, and Tusc mine pits would be irreversibly lost. There would also be an irretrievable loss of livestock grazing potential for the disturbed area until reclamation is sufficient to allow grazing to resume.

Backfilling the MAC pit with waste rock from the Tusc Mine (Alternative 2) would allow reclamation of 40 acres that would have been irreversibly lost. Depending on reclamation success, this area could be available for livestock grazing.

Constructing a pipeline to the Humboldt River (Alternative 3) would result in an irretrievable loss of forage production on 56 acres until reclamation is completed and vegetation established.

RESIDUAL ADVERSE EFFECTS

There may be a reduction in livestock numbers due to permanent unreclaimed features (Tusc, MAC, and Gold Quarry mine pits) and steep slopes (leach pads, waste rock dumps). Eventual recovery of groundwater levels at the mine site is expected to restore flow to springs and seeps affected by dewatering; the total recovery period, however, could be nearly 100 years.

RECREATION AND WILDERNESS

SUMMARY

The South Operations Area Project would result in fewer acres being available for recreational use during and after mining. New temporary workers associated with construction of new facilities could impact existing campgrounds and displace other recreationists in the area. Impacts on wilderness areas from the Proposed Mine Action would be negligible.

DIRECT AND INDIRECT IMPACTS

Proposed Action

Recreation

The Proposed Action would increase the amount of disturbed land associated with the South Operations Area by 1,573 acres (810 public and 761 private). Disturbed areas would not be available for recreation during mining and reclamation; however, these areas are not intensively used for recreational activity and do not offer unique recreational opportunities. Presently, much of the area adjacent to mining activity is utilized for mineral exploration. Public access to the mining area has been restricted for safety and security reasons; however, large areas of open land are available for dispersed recreation in the Elko area.

During construction, the projected increase in temporary employees due to the proposed action would peak at 758 in the fourth quarter of 1993. The majority of these employees would be located in Elko or in Carlin at the workers camp. Some construction workers may attempt to live in area campgrounds, affecting their potential use by recreationists. In addition, temporary employees living in Carlin or Elko could impact recreational use of the area through increased hunting, fishing, camping, ORV travel, and related activities. Recreational resources in the towns of Elko, Carlin and Spring Creek also would be stressed with the additional construction population. Baseball fields, tennis courts, school gymnasiums, and golf courses are currently at capacity and would be adversely affected by the increased population occurring during the construciton period. Impacts by temporary employees would be short term as the construction period would last less than 1.5 years, and most temporary workers would be employed during the last half of 1993 and the first half of 1994. No permanent employees are scheduled to be hired for the operation.

Wilderness

The proposed South Operations Area Project would have no direct impact on wilderness areas and wilderness study areas, although there would be increased visitation by temporary employees. High-intensity lighting associated with mining activity could affect wilderness visitors' sense of solitude when glow from the lights is visible; however, the glow would not be significantly different from existing operations nor necessarily discernable from other light sources in the area.

Alternatives 1, 2, and 3

There would be no significant change to recreation associated with Alternative 1. Alternative 2 would result in an additional 40 acres being available for recreation after reclamation. The wilderness areas and wilderness study areas would not be affected by any of the alternatives.

No Action Alternative

With the No Action Alternative, no additional private or public land would be dedicated for mining activities. Therefore, 807 acres of public land would not be removed from recreational use and there would be no additional impact on recreation in the area. The No Action Alternative would not impact wilderness areas or wilderness study areas.

POTENTIAL MITIGATION AND MONITORING MEASURES

No mitigation or monitoring for recreation or wilderness would be required.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Recreation and wilderness would not be irreversibly or irretrievably affected by the proposed mine expansion.

RESIDUAL ADVERSE EFFECTS

The only residual adverse effect on recreation would be loss of future use of lands associated with mine pits. There would be no residual adverse effects on wilderness.

VISUAL RESOURCES

SUMMARY

Visual impacts of the Proposed Action and alternatives were analyzed using procedures set forth in the Visual Contrast Rating Handbook (BLM 1986b). Changes in the landscape from the proposed action and alternatives are compared with the characteristic landscape to determine the resulting degree of contrast in form, line, color, and texture. If the degree of contrast does not meet the Visual Resource Management (VRM) System objectives, the project should be redesigned or mitigation measures proposed. As noted in Chapter 3, most of the project site is located on VRM Class IV land. A small portion of the Tusc and MAC mine developments and the northern and southern ends of the North Area Haul Road would be located within a strip of VRM Class III land that includes the Tuscarora Mountains.

Contrast rating worksheets were completed from five key observation points (KOPs); these worksheets are included in Appendix C. The KOPs were selected to represent typical views of project features from within

the affected area. Visual simulations of appearance of the Proposed Action were prepared to aid in this process. The five KOPs are described in Chapter 3 and shown in Figure 3-16.

DIRECT AND INDIRECT IMPACTS

Proposed Action

The primary impact of the Proposed Action would be large-scale modification of landforms. Angular, blocky forms and horizontal lines would create moderate contrasts with the natural rounded, rolling hills and ridges of the characteristic landscape. These contrasts would be weaker where existing facilities are expanded.

Land clearing and construction of waste rock disposal facilities would expose soil and rock material in a variety of colors ranging from light grayish tan to reddish tan to very dark gray. Contrast between these colors and those existing in the landscape would range from moderate in bright sunlight and when front- lighted to weak in overcast conditions and when back-lighted.

Clearing of vegetation in mine expansion areas would create weak to moderate color contrasts with the existing landscape. New lines would be introduced delineating the edges of cleared areas and some change in texture would be seen, but overall contrast would be weak. Visual impacts from new structures would be small when compared with the visually dominant waste rock disposal areas.

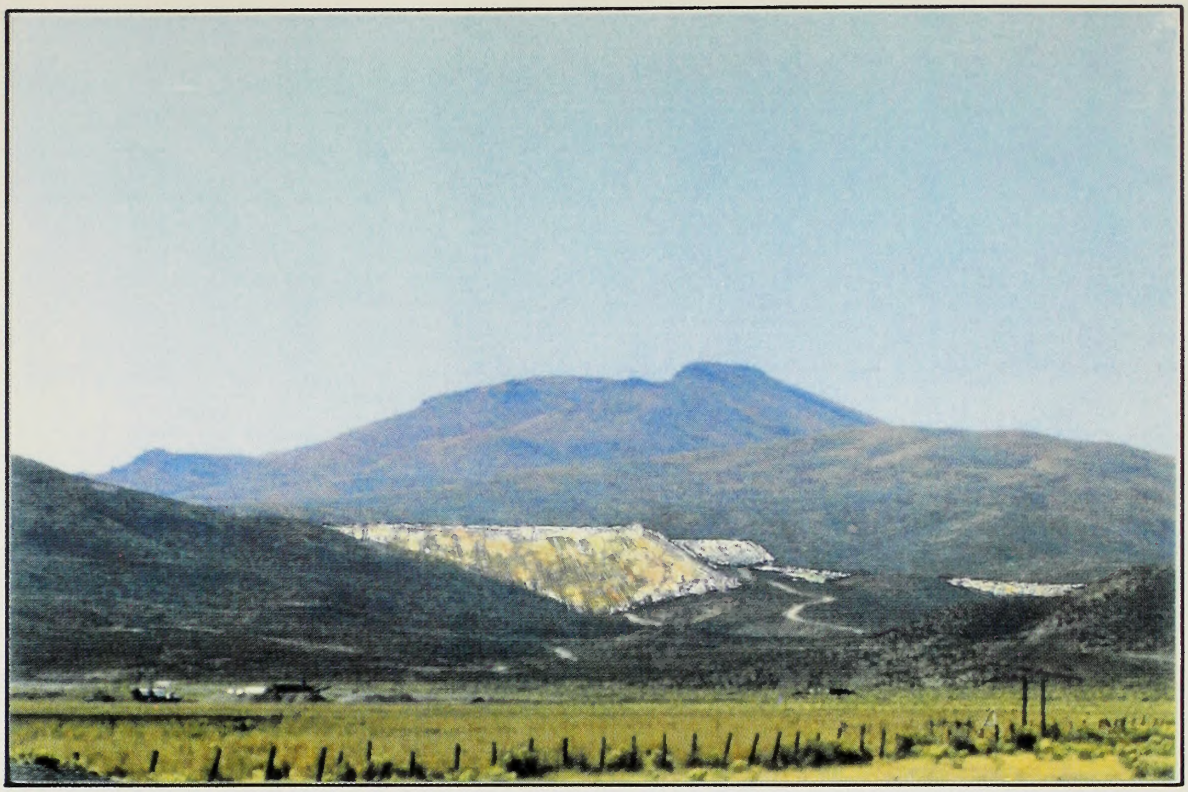
When viewed from KOP 1, the Proposed Action would contrast weakly with the existing landscape. While some of the existing mining facilities would appear more dominant, contrasts in form and color would not be appreciably increased over existing conditions. In addition, existing visual impacts in the foreground reduce the visual dominance of mining activities from this KOP. The Proposed Action would not introduce new types of landforms, lines, colors, or textures. View of the mine by motorists on Interstate 80 would be increased from approximately 70 to 75 seconds.

From KOP 2, development of the Tusc Waste Rock Disposal Area would introduce moderate to strong contrasts in form, line, and color with the existing landscape. Currently, no South Operations Area mining operations are visible from this point. The Tusc Waste Rock Disposal Area would be visible from the north along Eureka County Road 117 (Maggie Creek Road) for a distance of over 10 miles. The likely appearance of this facility as viewed from KOP 2 is depicted in Figures 4-14 and 4-15. Portions of the North Area Haul Road would be visible from this KOP. The nearly horizontal line and straight alignment of the road, along with angular cut and fill slopes, would create moderate to strong contrasts in form and line with the flat to rolling terrain and rounded landforms. Exposure of unweathered soil and rock in cuts and fills would create moderate contrasts in color with the characteristic landscape.

Existing mining operations are visually dominant from KOP 3 due to the superior vantage point. Expansion of facilities south of Schroeder Mountain would increase the apparent size of the facilities, but would not introduce any new forms, lines, colors, or textures. Contrasts with the existing landscape would be moderate to weak.

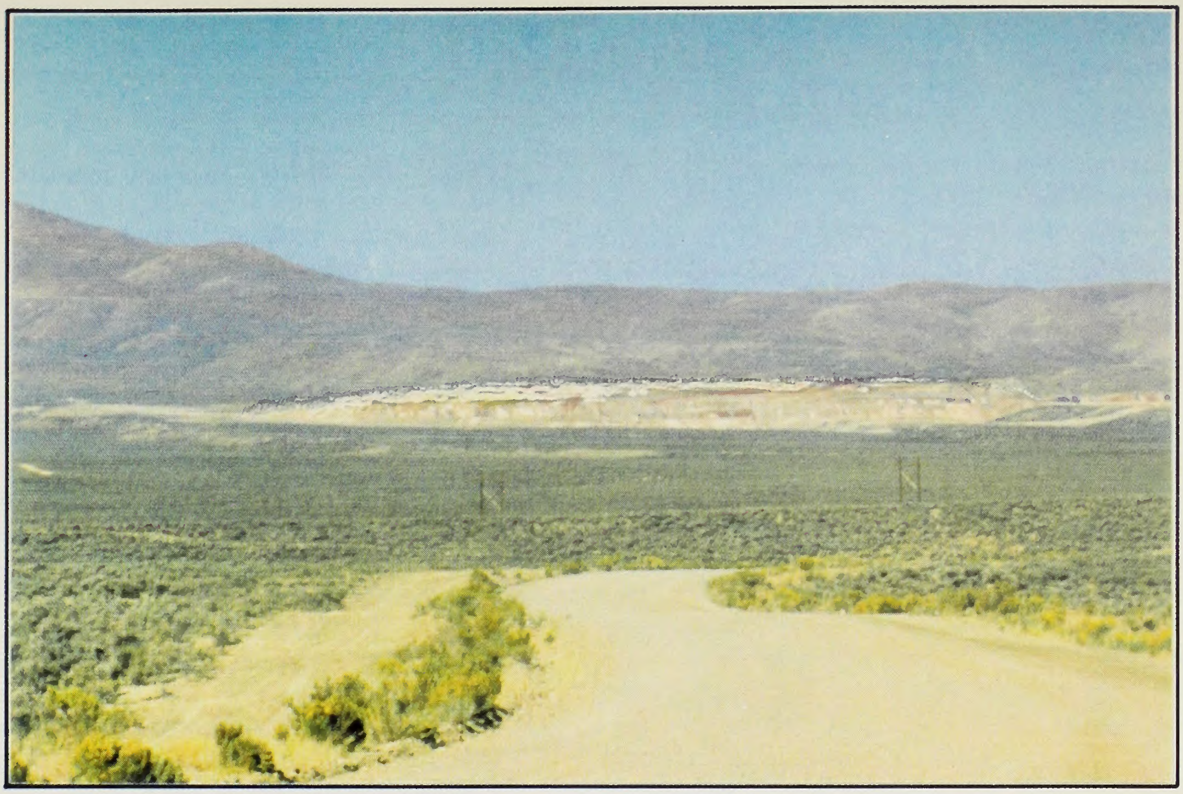
Expansion of the Mill 2/5 Tailing Storage Facility would be readily apparent from KOP 4 (Figures 4-16 and 4-17). This would be overshadowed by the much higher and more visually dominant mountain backdrop. As at other KOPs where existing mining operations are visible, no new landscape elements would be introduced; visual contrasts in form would remain moderate, while contrasts in line, color, and texture would remain weak.

From KOP 5, most of the North Area Haul Road corridor would be visible. Portions of the Tusc and MAC mine developments would be visible in the background. The straight alignment and



Post-Mining From KOP 2
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-14

Post-Reclamation From KOP 2
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-15



Post-Mining From KOP 4
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-16

Post-Reclamation From KOP 4
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-17

nearly horizontal grade of the haul road would create moderate contrasts in form and line with the flat to rolling terrain. Moderate contrasts in color would also occur. Large fill slopes of up to 35 feet would be visible at the point where the haul road enters a canyon in the Tuscarora Mountains (Figures 4-18 and 4-19). This would create moderate contrasts in form, line, and color with the existing landscape.

A cooling tower on the ore roasting facility would lose approximately 300 gallons per minute of water in the form of steam. A steam plume would be generated, that would be visible from all five KOPs. The plume would be largest during cool, wet weather. A fog bank would develop in the vicinity of the mine, and would be accompanied by enhanced cloud cover during cloudy or rainy weather. Moderate contrasts in form, line and color would result under all weather conditions.

Night-lighting required by the Proposed Action activities would result in a visible glow from all KOPs.

Alternatives 1, 2, and 3

Alternative 1 would not increase the visual impact of structures in the proposed action. Under certain weather conditions, visibility of the steam plume associated with the water treatment plant cooling tower would be enhanced. This would attract attention due to contrast in color, as well as from motion. During cooler and wetter weather, the plume could be visible from all five KOPs.

Backfilling the MAC pit with waste rock from the Tusc pit (Alternative 2) would result in a 10-foot reduction in the height of the Tusc Waste Rock Disposal Area. Impacts on visual resources would remain essentially the same as those resulting from the Proposed Action.

The proposed water pipeline to the Humboldt River (Alternative 3) would be visible in the foreground-middleground from KOPs 1 and 4, and in the background from KOP 3. Contrasts in form and line with the existing landscape would be weak to moderate. Weak color contrasts would result from the exposure of unweathered soil.

No Action Alternative

Under this alternative, only those actions currently permitted would continue. As mining operations cease, the project area would be reclaimed according to the current reclamation plan. This would result in reduction of the visual impacts of existing disturbance. Visual impacts from the Proposed Action and alternatives would not occur.

POTENTIAL MITIGATION AND MONITORING MEASURES

Mitigation measures have been developed to minimize visual impacts. The objective is to reduce visual contrasts and is based on three concepts: (1) siting facilities in less visible areas; (2) minimizing disturbance; and (3) repeating the basic elements of form, line, color, and texture. In addition to measures included in the proposed action, the following measures could be applied to minimize visual impacts of the proposed action and alternatives:

- Slope gradients on embankments (between 3H:1V and 2.3H:1V) could be varied to create diversity of form and reflect the naturally rolling, rounded forms of the existing topography.
- Edges of embankments could be rounded to reduce the angular appearance and soften edges.
- Contrasts in color of disturbed soil or rock could be minimized by using commercially available chemical staining agents.

- Clearly defined construction limits should be established. Construction limits should use irregular shapes that reflect existing forms and patterns.

- Revegetation should be planned so that colors and textures blend with undisturbed lands.

- The visual contrast of structures with natural forms could be minimized by using colors that blend with the land rather than the sky and by using finishes with low levels of reflectivity.

- Painting structures a slightly darker color than the surrounding landscape could compensate for the effects of shade and shadow.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irretrievable commitment of visual resources would occur during the active mining period (approximately 10 years). Impacts on visual resources could be reduced through implementation of the proposed mitigation measures.

RESIDUAL ADVERSE EFFECTS

Following successful implementation of reclamation measures, the most noticeable residual adverse effect of the Poposed Action and alternatives would be the Gold Quarry, Tusc, and MAC mine pits. Small portions of the upper slopes of the Tusc pit could be visible from KOP 2 and small areas of the upper slopes of the Gold Quarry pit could be visible from KOP-4 (Figure 4-16). Contrasts in form, line, and color would remain. Weak contrasts would result from the prismoidal forms and straight lines of the reclaimed waste rock storage embankments, tailing impoundments, and leach pads. Finer and more uniform soils in these areas would also create weak contrasts in texture with the existing landscape.

NOISE

SUMMARY

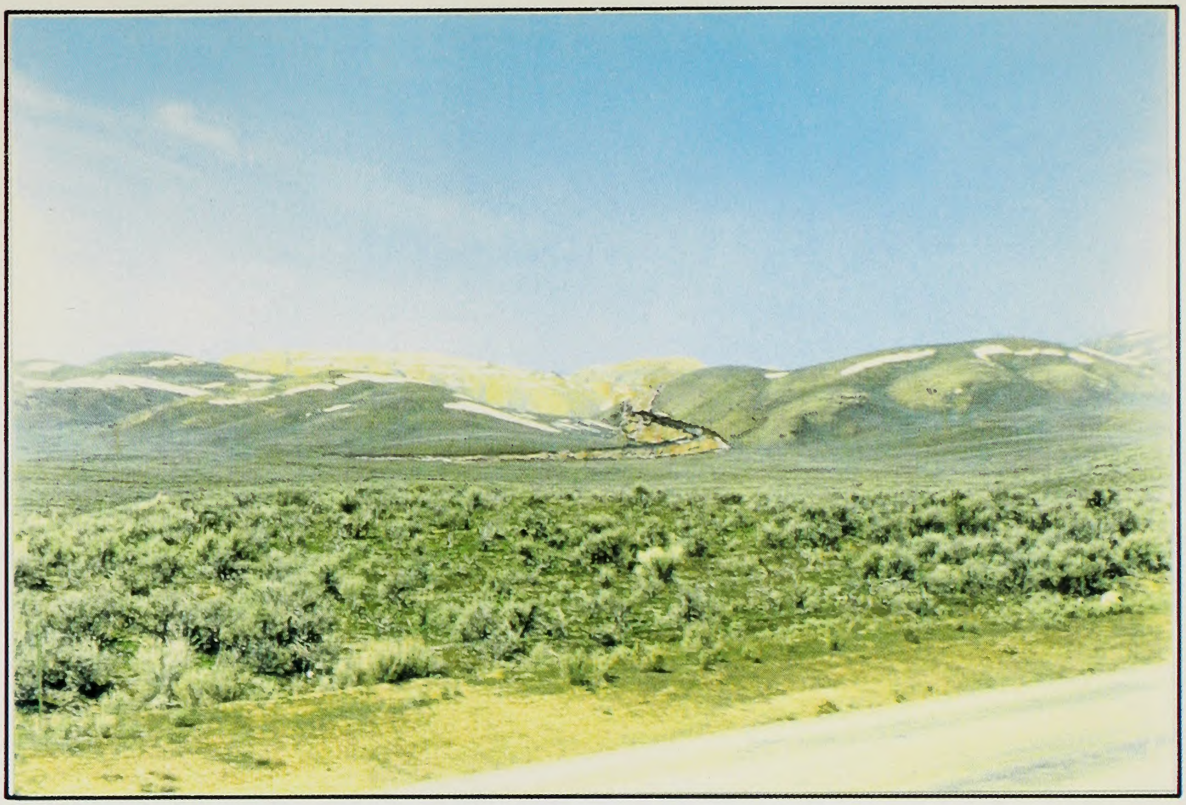
Continuation and expansion of the South Operations Area would result in a continuation of noise generated by mining and ore-processing activities. The noise generated would not impact the town of Carlin, the closest sensitive receptor to the South Operations Area Project.

DIRECT AND INDIRECT IMPACTS

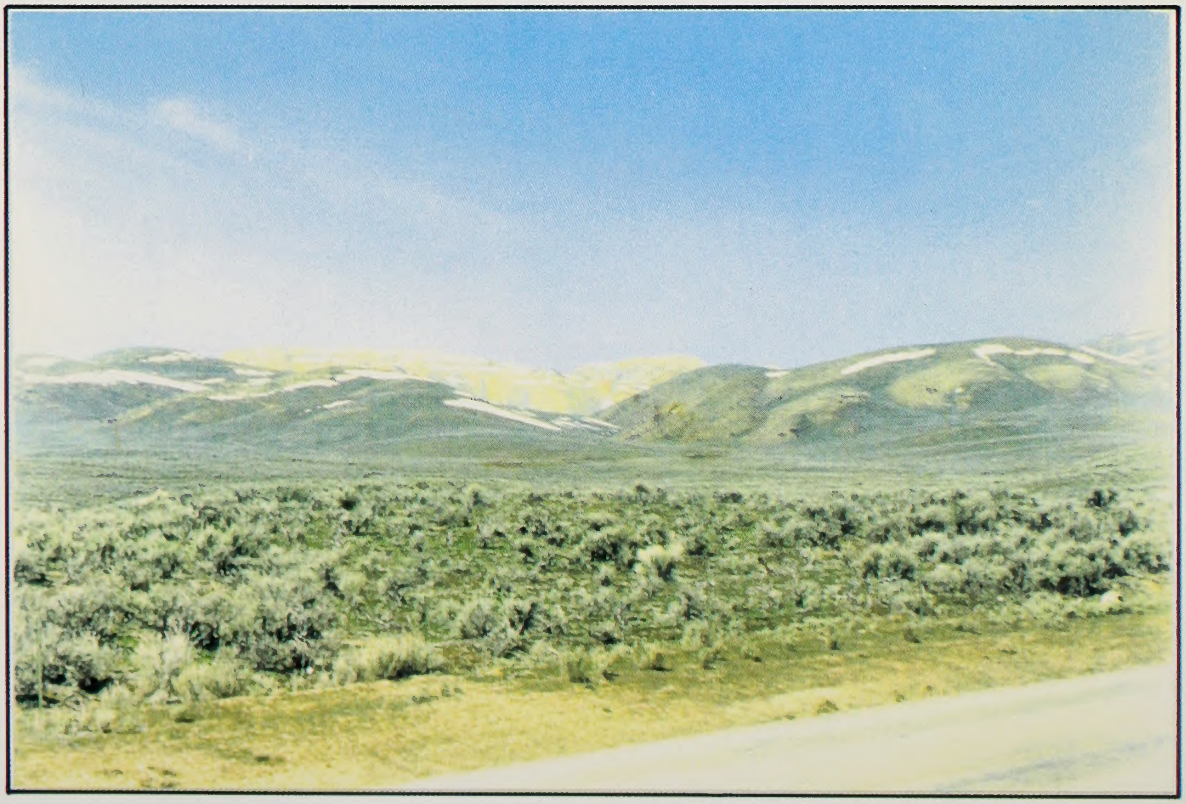
Proposed Action

Major sources of noise from the South Operations Area Project would be the same as those from the existing mining and processing operations: rock drilling, blasting, loading of waste rock and ore, truck hauling, and ore crushing and milling. The same types of equipment currently in use would continue to be used for the mine expansion. Blasting in the pits would be concurrent and occur once a day.

Development of the MAC and Tusc Mine pits, the waste rock disposal areas, and expansion of the South Waste Rock Disposal Area would result in increased nolse if done concurrently with the Gold Quarry Mine expansion. Large haul truck and dozer activity in the new waste rock disposal areas would increase noise. Blasting in the Gold Quarry pit would continue, but noise levels would



Post-Mining From KOP 5
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-18



Post-Reclamation From KOP 5
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-19

decrease as pit depth increases. Similarly, blasting noise at the new Tusc and MAC pits would diminish as the pits develop in depth. The Tusc and MAC pits would be in the northwest area of the expansion and thus farthest from the town of Carlin.

Alternatives 1, 2, and 3

Alternatives 1 and 3 would not result in an increase in noise over current levels. Alternative 2 (backfilling the MAC pit) would result in a reduction of noise, since the MAC and Tusc pits would not be developed concurrently.

No Action Alternative

Under the No Action Alternative, impacts from noise would remain at current levels.

POTENTIAL MITIGATION AND MONITORING MEASURES

No mitigation or monitoring for noise would be required.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There would be no irreversible or irretrievable commitment of resources from noise generated by the proposed mine expansion.

RESIDUAL ADVERSE EFFECTS

There would be no residual adverse effects on the environment from noise generated during mining and ore-processing operations. Once mining operations cease, noise would be reduced to relatively low levels associated with reclamation activities.

LAND USE AND ACCESS

SUMMARY

Land use in the proposed South Operations Area would shift from wildlife use, ranching, and grazing to mining and associated activities. Some restriction of access to the South Operations Area would occur. Impacts on surface water and groundwater use would result from lowered water levels in wells, reduced or eliminated flows in springs and seeps, and reducing or eliminated flows in some streams and the Humboldt River.

DIRECT AND INDIRECT IMPACTS

Proposed Action

The proposed South Operations Area Project would be almost evenly divided between private land (763 acres) and public land (810 acres). The portion on public land would not be available for grazing or recreational activities during the mining operation. Land ownership in the area would remain the same.

The North Area Haul Road from the North Operations Area would cross BLM Roads 1237 and 1391 (see Figure 2-7). Access on roads 1237 and 1391 may need to be controlled for safety. Continued expansion of mining would restrict access to the area; however, access would still be possible by alternate routes.

The existing powerline and natural gas pipeline corridors would continue to be used. Portions of three federal oil and gas leases in the project area

(N-35626, N-51688, and N-53873) could be impacted by proposed mine facilities (see Figure 2-2).

Surface water and groundwater use in portions of the study area would be impacted by Gold Quarry pit dewatering. Such impacts would include lowered water levels in wells, reduced or eliminated flows in springs and seeps, and reduced or eliminated flows in some streams and the Humboldt River (see Chapter 4, Water Resources, for more detailed information on water impacts). Potential impacts on specific water rights in the project area would be evaluated by the Nevada State Engineer's Office. Maximum impacts on water use would occur in about year 2005, followed by a gradual recovery of flows. Most recovery would occur within the first 10 to 20 years following cessation of dewatering; however, complete recovery could take nearly 100 years.

Alternatives 1, 2, and 3

The impacts of these alternatives on existing land use and access would be the same as those identified for the Proposed Action.

No Action Alternative

The No Action Alternative would result in 810 acres of public land remaining available for grazing and recreation.

POTENTIAL MITIGATION AND MONITORING MEASURES

No mitigation or monitoring for land use or access would be required. (See Chapter 4, Water Resources, for corresponding mitigation and monitoring measures).

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Land affected by excavation of open pits would be irreversibly and irretrievably lost in terms of pre-mining land use.

RESIDUAL ADVERSE EFFECTS

With the exception of the mine pits, there would be no residual adverse effects on land use and access following cessation of mining and reclamation. Reclamation of surface disturbances would restore lands to post-mining land uses, including wildlife habitat and grazing.

CULTURAL RESOURCES AND ETHNOGRAPHY

SUMMARY

Thirty-seven cultural resources have been recorded in the area of direct effects. Three of these sites, located in the North Area Haul Road corridor, are eligible for inclusion in the National Register of Historic Places (NRHP). It is not known how many cultural resources exist in areas of Proposed Action where there has been no Class III cultural resource inventory. Where no cultural resource inventory has been conducted, projections about the existence of sites eligible for inclusion in the NRHP are based on distribution of such sites throughout the Study Area.

Through a detailed review of historic and ethnographic literature and formal interviews with Newe/Western Shoshone individuals knowledgeable about traditional and spiritual ways, an ethnographic report was prepared assessing the impacts of the proposed South Operations Area Project on Newe/Western Shoshone traditional values, practices, properties and human remains, and cultural items.

While ethnographic inquiry did document four general issues of concern (see Chapter 3, Ethnography), it was determined that:

1. *Current use of the area of direct effects for spiritual or ceremonial purposes appears to be nonexistent (Deaver 1993).*

2. *No cultural properties within the area proposed for mine expansion appear to fit the formal definition of traditional cultural properties (Deaver 1993).*

3. *While human skeletal material (a mandible and 10 isolated teeth) was recovered in 1984 during the archaeological excavation of a rockshelter in the area, surveys in the area of direct effects have yielded no further evidence of graves (Deaver 1993). Likewise, surveys in the area of direct effects have identified no associated funerary objects, unassociated funerary objects, sacred objects, or objects of cultural patrimony.*

DIRECT AND INDIRECT IMPACTS

Proposed Action

Table 4-19, column 1 lists the Proposed Action and alternatives in the area of direct effects, column 2 lists the number of cultural resources within the impact zone of each action and alternative, and column 3 lists the number of these cultural resources that are NRHP-eligible.

Altogether there are 22 sites and 15 isolates in the area of direct effects. As shown in Table 4-19, only the North Area Haul Road corridor would affect sites eligible for the NRHP; they are CrNv-12-11421, 11422, and 11428. All are lithic scatters.

There would be no direct or indirect impacts on Newe/Western Shoshone traditional values, practices, properties or human remains and cultural items as a result of the Proposed Action.

Alternatives 1, 2, and 3

There would be no direct or indirect impacts to NRHP-eligible sites resulting from the implementation of Alternative 1 or Alternative 2.

The proposed location of the pipeline corridor for discharge of water into the Humboldt River (Alternative 3) is generally along the east side of Maggie Creek and it is anticipated that its construction would result in 56 acres of surface disturbance. No cultural resource inventories have been performed for this alternative; however, based upon what is currently known about the density of cultural resources in the Study Area, it would be expected that two sites would be found along the pipeline route. No more than one of these would be expected to be NRHP-eligible[1].

There would be no direct or indirect impacts on Newe/Western Shoshone traditional values, practices, properties or human remains and cultural items resulting from implementation of the alternatives.

No Action Alternative

Selection of the No Action Alternative would result in no direct or indirect impacts on NRHP-eligible cultural resource properties or on Newe/Western Shoshone traditional values, practices, properties, and human remains and cultural items.

POTENTIAL MITIGATION AND MONITORING MEASURES

Proposed Actions and/or selected alternatives affecting areas that have not been inventoried

[1]See the Cumulative Effects Section of this chapter and Table 4-21 for discussion of average site density and percentage of NRHP-eligible sites.

TABLE 4-19
Cultural Resources in Areas of Proposed Action and Alternatives

Proposed Action	Number of Cultural Resources Impacted by Activity	Number of NRHP-Eligible Sites Impacted by Acitvity
Gold Quarry Pit Expansion	0	0
Refractory leach pads	3	0
Roaster	3	0
Water treatment facility/ water pipelines	1	0
South Waste Rock Disposal Area expansion	0	0
Powerlines and substations	1	0
MAC Mine	1	0
MAC Waste Rock Disposal Area, and other potential disturbance areas	6[1]	0
Tusc Mine	0	0
Tusc Waste Rock Disposal and Stockpile Area	1	0
Tusc road corridor and North Area Haul Road	23[1]	[illegible]
Proposed fence	3	0
Maggie Creek Ranch Reservoir expansion and discharge into Maggie Creek	2	0
Alternative 1 - water treatment plant cooling towers	0	0
Alternative 2 - backfill of MAC Mine	0[2]	0
Alternative 3 - discharge pipeline route into Humboldt River	2[3]	1[3]

[1] One large site is counted in both of these actions.

[2] One isolate is located within the proposed MAC Mine.

[3] This number is based upon site density projections and is not part of the 37 cultural resources recorded in the area of direct effects. See the Cumulative Effects Section of this Chapter and Table 4-21 for the discussion of average site density and percentage of NRHP-eligible sites.

would be subject to compliance with the National Historic Preservation Act prior to initiation of surface disturbance.

Three sites within the area of direct effects are considered eligible for NRHP listing. These sites are located on private lands; consequently, any mitigation measures or monitoring would be developed cooperatively by the BLM and Newmont.

Since no direct or indirect effects on Newe/Western Shoshone traditional cultural values, practices, properties, or human remains and cultural items is anticipated as a result of the Proposed Action, no mitigation or monitoring measures are required.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Cultural resources represent a finite resource which cannot be replaced. Therefore, any disturbance that results in their destruction would constitute an irreversible and irretrievable commitment of resources.

Since no direct or indirect impacts on Newe/Western Shoshone traditional values, practices, properties, or human remains and cultural items are anticipated as a result of the Proposed Action, no irreversible or irretrievable commitment of resources is anticipated.

RESIDUAL ADVERSE EFFECTS

Construction of new access roads would have residual adverse effects, since roads provide unauthorized artifact collectors access to cultural resources that might otherwise remain inaccessible. Road networks are major contributing factors in the vandalism of cultural resources (Nickens et al. 1981).

No residual adverse effects to Newe/Western Shoshone traditional values, practices, properties, or human remains and cultural items are expected as a result of the Proposed Action.

SOCIAL AND ECONOMIC RESOURCES

SUMMARY

Primary socioeconomic impacts from the South Operations Area Project would be construction-period impacts within local communities and fiscal impacts within local jurisdictions. Newmont projects that no additional permanent employees would be hired during the operational phase of the project.

Influxes of construction workers and their families would have both positive and negative impacts on communities in Elko County. Potential adverse impacts would include stressing existing retail facilities (e.g., motels, restaurants), community services (e.g., law enforcement, roads), and housing. The South Operations Area Project also would benefit local communities by increasing retail sales and generating short-term employment.

Positive economic impacts during operational phases of the project would include continued employment in the mining industry and secondary jobs in retail and service industries. Income would continue to be produced, primarily in Elko County, from wages paid in mining and secondary jobs created by the Proposed Action.

Most property taxes and net proceeds of mining taxes would be paid to Eureka County, whereas most sales tax revenues would accrue to Elko County. Commercial and residential development induced by mine *expansion in Elko County would increase revenues from property and sales taxes. The increase in revenues from property and sales taxes in Elko County is unlikely to be adequate to mitigate impacts on existing social services or improve services stressed by the influx of construction workers and their families.*

DIRECT AND INDIRECT IMPACTS

Proposed Action

Social Life

The influx of construction workers and their families would strain some community resources (e.g., law enforcement and housing) and as a result would diminish social well-being of some segments of the population. Perceptions that law enforcement is inadequate or that affordable housing is not available would cause anxiety for some people. Housing shortages would increase selling prices and rent for housing. People on fixed incomes or with low incomes would be most affected by housing shortages because housing shortages would induce higher prices.

The Proposed Action would attract job seekers and their families to Elko County hoping to obtain employment at the South Operations Area. Some in-migrants would not have adequate financial resources to obtain housing and would seek public assistance. Public assistance programs provided through the Elko County Human Services are currently understaffed and transient workers seeking jobs would place additional demands on them, particularly during construction. In addition, transient job seekers are generally perceived by Elko residents as negatively affecting quality of life in the area.

During the scoping process, many residents expressed the opinion that dewatering flows from the South Operations Area Project should be used to establish water-based recreation or enhance existing water-based recreation (i.e., add flows to South Fork Reservoir). Because Maggie Creek Ranch Reservoir is proposed to have extreme fluctuations in water levels, it would not be suitable for development of fisheries or other water-based recreation. Providing supplementary water to South Fork Reservoir or developing other end-uses of excess waters is beyond the scope of this EIS (see Chapter 2, Project Alternatives).

Many residents favoring expanded water-based recreation would oppose water being discharged to the Humboldt River rather than being stored for recreation. They would be disappointed that the opportunity to enhance the local quality of life through expanded recreation would not be realized.

Community Service Providers

Continuation and expansion of the South Operations Area would have negligible impacts on government in Elko and Eureka counties. Over the last decade, city and county governments have functioned in an environment of rapid growth with stresses caused by increased population and demands for community services. Demands on government would not appreciably change with the proposed action.

Assuming that each in-migrating family would have one school-aged child, 83 new students would be enrolled in local schools. Of this total, 66 (80 percent) would likely be primary school students and 17 (20 percent) would be high school students. Impacts on existing schools would be negligible if students were evenly distributed throughout the grades. The Elko School District typically uses modular units that could be purchased or leased over the short term to accommodate increases in school enrollment during construction activities.

Currently there is no licensed ambulance at the South Operations Area. Continuation of the mine could place demands on the Carlin Ambulance Service and could stress the capacity of the service during construction.

Mental health services are currently understaffed and cannot meet demands of area residents.

Newcomers to the area during construction would further stress the ability of local mental health service providers to furnish necessary services.

Housing

The influx of workers and their families would further stress temporary housing (rentals, motels, apartments, and mobile home/RV spaces) and displace tourists and other visitors to the area. At least 83 dwellings of sufficient capacity for families or mobile home/RV spaces would be needed in the study area to meet this temporary housing demand. Assuming two single workers per housing unit, approximately 417 units would be needed to meet the single-worker housing demand during the peak construction period. Newmont's workers camp near Carlin could absorb some of the demand for housing for single workers or workers without families present.

Government and Public Finance

Revenues paid to Eureka County from net proceeds of mining taxes would amount to approximately $2.58 million per year.[1] With the proposed expansion, sales and use taxes paid would average about $1.45 million, assuming $25.3 million per year would be spent on materials for expansion. Property taxes after construction are not known because assessed valuation is not known; however, property taxes would exceed the $2.4 million paid to Eureka and Elko counties in 1992.

Sales taxes from construction workers spending their salaries would be an estimated $444,000 per year.[2] Sales taxes would be divided primarily among Elko County (Nevada), Salt Lake City (Utah), and Twin Falls (Idaho), the areas where local residents most often purchase major items.

[1]This figure is calculated based on an estimated cost of gold production of $230 per ounce and a gold value of $328 per ounce. Total yearly production is estimated at 1.7 million ounces per year. The tax rate of Eureka County is $1.55 per $100 of net proceeds.

[2]Sales taxes are estimated assuming that workers would spend 35 percent of their salaries on taxable items.

Sales taxes generated by workers spending their salaries would be about $1.044 million. If it is assumed that wages paid in the mining industry would induce additional jobs and salaries in other economic sectors (Dobra 1988), additional salaries generated by the South Operations Area expansion would be about $17.9 million during construction and $42.2 million during operations.[3] These salaries also would generate additional sales and use taxes.

After construction, the cost of producing an ounce of gold would increase from $203 per ounce to $230 per ounce (Newmont 1992k). This increase in production costs would reduce the amount of taxes paid for net proceeds of mining per ounce of gold produced.

Employment

Newmont projects a maximum of 758 temporary construction workers would be hired through contract during peak construction activities. It is estimated that during peak construction 136 employees (17.9 percent) would be hired from the local labor force and 622 (82.1 percent) would be hired from outside the study area. Construction employment during 1993 would fluctuate from a low of 51 employees to a maximum of 758.

During peak construction, an estimated 931 people would move into the area.[4] Of this total, 672 (560 directly employed in construction and 112 indirectly employed) are projected to be single workers or workers without families present. Seventy-four (62 direct and 12 indirect) married workers with families present are anticipated to move into the area during the peak construction period.

[3]Induced wages are estimated assuming that each dollar paid in mining would generate an additional $0.92 in other economic sectors.

[4]The total of 931 includes 622 direct workers (560 single or married workers without families present, 62 married workers with families present, and 155 family members) and 124 indirect workers (112 single or married workers without families present, 12 married workers with families present, and 30 family members). It is assumed that 74 families (10 percent of the non-local work force), each with 3.5 family members, would move into the study area. Indirect workers were estimated assuming that for every construction job, 0.2 indirect job was created in other segments of the economy (ENSR 1991).

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DIRECT AND INDIRECT IMPACTS

Proposed Action

Social Life

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Income

Total payroll for construction workers would average $19.5 million per year for the 3-year construction period. In 1992, Newmont paid approximately $45.9 million in salaries at the South Operations Area. At least this amount would be paid in salaries for the operational phase after construction.

Reduction of the operational work force would increase unemployment rates, reduce wages, decrease taxes paid to Eureka and Elko counties, and stress public assistance programs. Many workers would likely remain in the Elko area and seek work at other mines, while others would move from the area.

Alternatives 1, 2, and 3

Impacts on social well-being, community services, and housing in the study area with these alternatives would be the same as under the Proposed Action. Impacts on economic resources in the study area with these alternatives would also be the same as under the Proposed Action.

No Action Alternative

With the No Action Alternative, existing mining would continue until December 30, 1994. After that date, the majority of the operational work force would be laid off. A limited number of employees would likely be retained to decommission the operation.

With cessation of mining at the South Operations Area, the population of Elko County would eventually decline. More housing would become available and prices for buying or renting would decrease. Traffic also would decrease.

Crime and other indicators of decreased social well-being (e.g., divorce, domestic abuse, suicide, alcohol and other drug abuse, and welfare rates) would increase in the short term after mining ceases. Eventually, the community would adjust to the loss of population and economic benefits. As previously discussed, boom-and-bust cycles have been part of the social history of the Elko area.

POTENTIAL MITIGATION AND MONITORING MEASURES

No specific mitigation measures are required by NEPA; however, local, county, and state governments, the BLM, and Newmont could work together in planning and implementing measures to mitigate social and economic impacts resulting from the South Operations Area Project.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

There would be no irreversible and irretrievable commitment of socioeconomic resources associated with the Proposed Action and alternatives.

RESIDUAL ADVERSE EFFECTS

Residual adverse impacts would be as described under direct and indirect impacts.

CUMULATIVE EFFECTS

INTRODUCTION

As stated in 40 CFR 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 reasonable 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... ." For purposes of this rule, impacts and effects are synonymous.

Cumulative effects discussed in this section address resource areas for which direct and indirect impacts have been described earlier in this chapter. Cumulative effects analyses do not take into account mitigations that may reduce or minimize adverse effects and that may be required by BLM or other agencies.

The cumulative effects area referred to in this section varies depending on the resource being addressed. With the exception of social/economic and recreation/wilderness resources, Figure 4-20 depicts the general area for which cumulative effects have been evaluated. The area of mine development shown in Figure 4-20 is known as the Carlin Trend. Boundaries of the cumulative effects area generally include Rock Creek (tributary to Boulder Creek) in the west, the town of Elko in the east, the Humboldt River and Rain Mine in the south, and upper Maggie Creek and its tributaries in the north. Descriptions of specific cumulative effects areas for each resource are included in the individual analyses in this section.

PAST AND PRESENT ACTIVITIES

Grazing and mining are the dominant activities occurring in the cumulative effects area. Livestock grazing is a primary activity on private and public lands. Grazing improvements have included development of springs and shallow groundwater sources for livestock watering, fencing, construction of windmills, development of irrigated pasture, and development of wells and surface diversion systems for irrigation.

Mining is a principal land use within the Carlin Trend and cumulative effects area (Figure 4-20 and Table 4-20). Mining activities have included exploration (drilling, trenching, sampling), underground mining, open-pit mining, ore milling and processing, waste rock disposal, tailing disposal, and heap leaching. Recent mining activity has included dewatering systems to prevent groundwater from entering open pits by lowering the water table adjacent to the mine. History of mining and ore processing in the Carlin Trend is discussed in Chapter 2.

REASONABLY FORESEEABLE ACTIVITIES

Foreseeable activities within the South Operations Area and the Carlin Trend include mine development, mine exploration, land management activities, wildlife habitat restoration projects, transmission line and substation construction, and restoration of aquatic habitat. Reclamation of lands disturbed by active and new mining operations would occur in the foreseeable future.

Mining Activities

The Carlin Trend is a major producer of gold and will be the site of future mining activities. This section presents an assessment of reasonably foreseeable activities through year 2001 for the following categories: (1) location of major mining disturbance, (2) acreage of major mining disturbance, and (3) likely dewatering activities. Figure 4-20 shows locations of existing and reasonably foreseeable mining activity in the Carlin Trend. This figure includes locations of 15 existing and reasonably foreseeable mining operations, five areas of exploration not included in an existing mining area, and ten known but undeveloped gold deposits.

The boundaries shown in Figure 4-20 for the 15 existing and reasonably foreseeable mining operations delineate the area within which major disturbance has occurred or is expected to occur. Such disturbance is characaterized by mine pits, processing facilities, heap leach pads, waste dumps, tailing impoundments, and haul roads. Exploration on undisturbed land and other activities are not necessarily included within the depicted boundaries. These boundaries represent the outer limits of major surface disturbance but do not imply that all of the area within will be disturbed.

Acreage of mining disturbance, the relationship between existing and reasonably foreseeable activities, and additional information concerning each of the 15 operations are presented in Table 4-20. Disturbance acreage is listed for three time periods: pre-1981, 1981-1992, and 1992-2001. Existing disturbance is represented by the pre-1981 and 1981-1992 time categories; reasonably foreseeable future disturbance is estimated in the 1992-2001 time period.

Of the 15 operations listed in Table 4-20 and shown in Figure 4-20, only three are presented as new operations: (1) map numbers 4, 29, and 17, an open-pit mine combining Newmont's existing Bootstrap Mine and the Tara exploration project; (2) map number 7, Barrick's proposed underground Meikle Mine; and (3) map number 11, Newmont's tailing #2 impoundment. The remainder of the reasonably foreseeable surface disturbance is associated with existing mining operations.

Groundwater pumping currently is occurring at the Betze Mine (Figure 4-20, map number 6A) and the Gold Quarry Mine (Figure 4-20, map number 14A). Dewatering at the Betze Mine has been ongoing for 3 years with a current discharge rate of about 65,000 gpm, and is expected to continue until at least year 2000 (Rieger 1993). Water from the Betze project is pumped to the TS Ranch Reservoir in the Boulder Creek Basin where the water infiltrates into the subsurface, evaporates, and is routed to irrigated lands. A large portion of the water that infiltrates reappears as two spring complexes approximately 5 miles south of the reservoir.

Current groundwater pumping rates at the Gold Quarry mine average 5,000 gpm, but are expected to reach 42,000 gpm prior to cessation of dewatering in year 2001. Presently, water is being used for mining and processing at the South Operations Area; however, excess water would be discharged beginning in year 1993. At the end of proposed mining in year 2001, mineralized rock at the bottom of the Gold Quarry pit would be exposed. Depending on the price of gold, grade of exposed ore, and economics of gold recovery, additional expansion of the Gold Quarry pit or analysis of underground mining would likely be reviewed by Newmont.

Another reasonably foreseeable mining operation that would require dewatering is the proposed underground Meikle Mine (Figure 4-20, map number 7). Due to its proximity to the Betze Mine, initial dewatering at Meikle could be accomplished with the existing Betze dewatering system. The expected 10-year mine life of Meikle would result in dewatering through year 2006.

Wildlife Habitat Rehabilitation

Winter range rehabilitation projects for mule deer and pronghorn antelope being conducted by BLM and Nevada Department of Wildlife (NDOW) in the project area would continue. These projects consist primarily of seeding rangeland that has been degraded by fire and overgrazing with grasses and shrubs that provide food and cover for both wildlife and livestock. Wildlife has converted thousands of acres of rangeland to cheatgrass-dominated communities that provide minimal forage and habitat for wildlife and livestock. Utilizing funds donated by the mining industry, habitat improvement projects are underway on 8,000 acres of critical winter range.

Fishery Habitat Restoration

The Draft Lahontan Cutthroat Trout Recovery Plan was released for public review and comment on Feburary 22, 1993. The Plan identifies streams

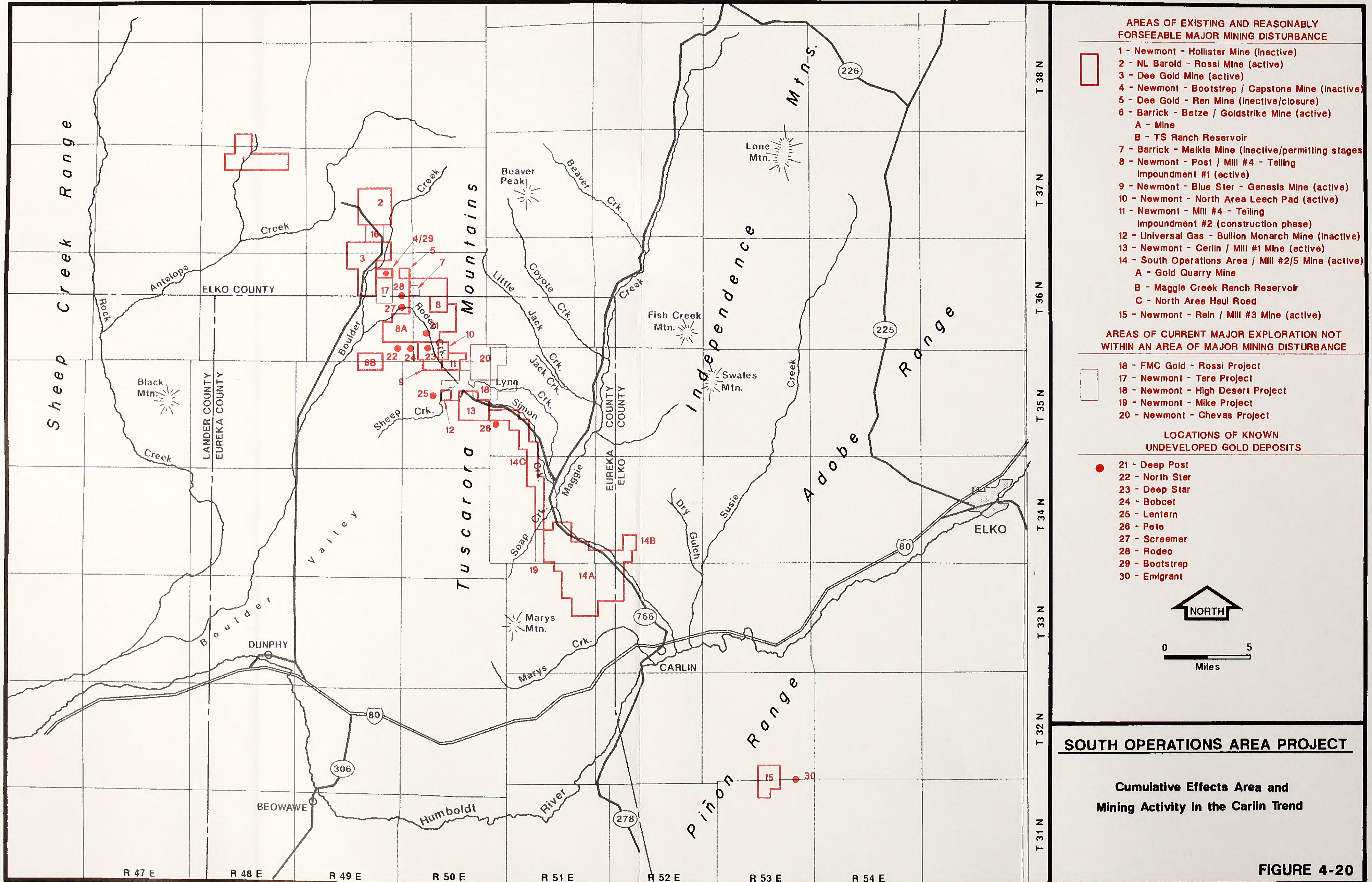

AREAS OF EXISTING AND REASONABLY FORSEEABLE MAJOR MINING DISTURBANCE
1 - Newmont - Hollister Mine (inactive)
2 - NL Barold - Rossi Mine (active)
3 - Dee Gold Mine (active)
4 - Newmont - Bootstrap / Capstone Mine (inactive)
5 - Dee Gold - Ren Mine (inactive/closure)
6 - Barrick - Betze / Goldstrike Mine (active)
A - Mine
B - TS Ranch Reservoir
7 - Barrick - Meikle Mine (inactive/permitting stages)
8 - Newmont - Post / Mill #4 - Tailing Impoundment #1 (active)
9 - Newmont - Blue Star - Genesis Mine (active)
10 - Newmont - North Area Leach Pad (active)
11 - Newmont - Mill #4 - Tailing Impoundment #2 (construction phase)
12 - Universal Gas - Bullion Monarch Mine (inactive)
13 - Newmont - Carlin / Mill #1 Mine (active)
14 - South Operations Area / Mill #2/5 Mine (active)
A - Gold Quarry Mine
B - Maggie Creek Ranch Reservoir
C - North Area Haul Road
15 - Newmont - Rain / Mill #3 Mine (active)
AREAS OF CURRENT MAJOR EXPLORATION NOT WITHIN AN AREA OF MAJOR MINING DISTURBANCE
16 - FMC Gold - Rossi Project
17 - Newmont - Tara Project
18 - Newmont - High Desert Project
19 - Newmont - Mike Project
20 - Newmont - Chevas Project
LOCATIONS OF KNOWN UNDEVELOPED GOLD DEPOSITS
21 - Deep Post
22 - North Star
23 - Deep Star
24 - Bobcat
25 - Lantern
26 - Pete
27 - Screamer
28 - Rodeo
29 - Bootstrap
30 - Emigrant
NORTH
0
5
Miles
SOUTH OPERATIONS AREA PROJECT
Cumulative Effects Area and Mining Activity in the Carlin Trend
FIGURE 4-20
Sheep Creek Range
Tuscarora Mountains
Independence Mtns.
Adobe Range
Piñon Range
Boulder Valley
ELKO COUNTY
LANDER COUNTY
EUREKA COUNTY
EUREKA COUNTY
ELKO COUNTY
Black Mtn.
Beaver Peak
Lone Mtn.
Fish Creek Mtn.
Swales Mtn.
Marys Mtn.
Lynn
ELKO
CARLIN
DUNPHY
BEOWAWE
Humboldt River
Marys Crk.
Maggie Crk.
Susie Creek
Dry Gulch
Soap Crk.
Simon Crk.
Sheep Crk.
Rodeo Crk.
Antelope Creek
Rock Creek
Boulder Creek
Beaver Crk.
Coyote Crk.
Little Jack Crk.
Jack Crk.
80
225
226
766
278
306
T 38 N
T 37 N
T 36 N
T 35 N
T 34 N
T 33 N
T 32 N
T 31 N
R 47 E
R 48 E
R 49 E
R 50 E
R 51 E
R 52 E
R 53 E
R 54 E

TABLE 4-20
Existing and Reasonably Foreseeable Mining disturbance in the Carlin Trend

Map Reference Number	Facility Name	Existing and Reasonably Foreseeable Mining Disturbance (Acres)				Comments	Source of Disturbance Information
		Pre-1981	1981-1992	1992-2001	Total		
7	**Newmont-Hollister Mine**	0	342	581	923	Existing gold mine and heap leach facility, recently sold by Ivanhoe Gold to Newmont Gold Company, likely to be further developed in 1992-2001 period.	Ivanhoe Gold Company, 1991, "Plan of Operation for the Ivanhoe Expansion Area," February 1991.
2	**NL Barite Rossi Mine**	100	100	30	230	Active barite mine, currently under exploration for gold.	BLM Case File N16-81-003F, Map 4 and Map 5. Stadelman, J., 1992, Personal Communication, Resource Specialist, BLM, Elko.
3	**Dee Gold Mine**	0	540	470	1,010	Active gold mine.	Dee Gold Mining Co., 1992, "Plan of Operation Amendment for BLM Plan N16-83-005P," January 1992.
 4/29 17	**Newmont** Bootstrap Mine Tara Project	 193 0	 0 0	 474 291	 667 291	Bootstrap mined pre-1981 and will be mined after 1995.	Conner, T., 1992, Personal Communication, Newmont Gold Company.
5	**Dee Gold-Ren Mine**	0	62	0	62	Closed mine and heap leach facility, closure and reclamation in progress.	"Final Environmental Assessment for the Dee Gold Mining Company REN Project," BLM, Feb. 3, 1989.
 6 A B	**Barrick** Goldstrike Betze Mine Mine TS Ranch Reservoir	 0	 2,190 480	 2,189 0	 4,379 480	Active gold mine with dewatering.	BLM, 1991d, "Final Environmental Impact Statement Betze Project," June 1991.
7	**Barrick-Meikle Mine**	0	0	50	50	Proposed underground gold mine with dewatering, likely to be mined in 1992-2001 period.	Barrick Goldstrike Mines, Inc., 1992, "Plan of Operations for Barrick Goldstrike Mines, Inc., Proposed Meikle Mine Development and Associated Facilities," April 1992.
8	**Newmont-Post/Mill #4 & Tailing #1** Impoundment #1	0	197	0	197	Existing mill and tailing facility, likely to remain in operation through 2001.	JBR Consultant Group, 1990, "Comprehensive Environmental Document for Newmont Gold Co., Mill No. 4, Eureka County, Nevada," prepared for Newmont Gold Company, Nov. 8, 1990.
9	**Newmont** Blue Star/Genesis Mine	 0	 605	 73	 678	Active gold mines, likely to be in operation through 1994.	"Draft Environmental Assessment for the Newmont Gold Company's Blue Star Operations Area, Eureka County, Nevada," BLM, January 1989.
10	**Newmont-North Area Leach Pad**	0	310	184	494	Existing leach pad, likely to remain in operation through 2001.	"Draft Environmental Assessment for the Newmont Gold Company's Blue Star Operations Area, Eureka County, Nevada," BLM, January 1989.
10	**Newmont-Mill #4-Tailings** Impoundment #2	0	0	280	280	Permitted tailing facility, likely to be in operation 1992 - 2001.	Newmont Gold Company, 1992h, "Newmont Gold Company Mill 4 Tailings Facility No. 2 Pipeline Proposal," June 15, 1992.
12	**Universal Gas-Bullion Monarch Mine**	50	0	0	50	Closed mine, mill and tailing facility; closure and reclamation in progress.	Denver Knight-Piesold and Co., 1991a, "Waste Characterization Plan Permit No. Nev 9002, Bullion-Monarch Project, Eureka County, Nevada," prepared for Westmont Gold, Inc., May 1991.
13	**Newmont** Carlin Mill #1 Mine	 900	 737	 662	 2,299	Active gold mine.	Conner, T., 1992, Personal Communication, Newmont Gold Company.
 14 A B C	**Newmont** South Operations Area Mine Maggie Creek Ranch Reservoir North Area Haul Road	 0	 4,061 116 	 1334 50 189	 5,395 166 189	Active gold mine with proposed expansion to include dewatering.	Newmont Gold Company and Shepherd Miller, Inc., 1993. South Operations Area Reclamation Plan.
15	**Newmont** Rain Mine	0	383	0	383	Active gold mine, likely to be in operation through 1995.	Newmont Services, Ltd., 1987, "Final Environmental Assessment, Rain Project," prepared for Newmont Gold Company, March 1987.
TOTAL DISTURBANCE ACRES		1,243	10,123	6,857	18,223		

considered important or critical to the recovery effort and presents management prescriptions for enhancing habitat and reintroducing Lahontan cutthroat trout to waters having suitable habitat. Within the Maggie Creek drainage, portions of Maggie, Coyote, and Beaver creeks have been preliminarily identified as potential recovery sites while Little Jack, Toro Canyon, Williams Canyon, Little Beaver and Susie creeks have been preliminarily identified as potential recovery sites. Management to improve aquatic and riparian habitat could include reduction of livestock grazing in riparian areas, fencing of riparian corridors, and planting of vegetation to stabilize streambanks and provide shade.

Livestock Grazing

Livestock grazing within the project area would continue to be a major land use. It is anticipated that grazing allotments would continue to be managed at present levels. BLM is implementing rangeland improvement projects (e.g., Cherry Spring and Marys Mountain pipelines) to distribute water to various grazing allotments.

Energy and Transmission Systems

Demands for additional electrical power will continue from ongoing and future mining activity in the Carlin Trend. Utility companies would satisfy increasing demands for electricity by constructing new substations, upgrading existing substations, and constructing new transmission and distribution lines. Sierra Pacific Power Company proposes to construct a Valmy-to-Falcon 345-kV powerline. Construction activities would include the Falcon Substation; 36 miles of 345-kV line between the Valmy Generating Station and the Falcon Substation; expansion of the Maggie Creek Substation; 13 miles of 120-kV line between Falcon and Bell Creek Substations; and 20 miles of 120-kV line between the Falcon and Maggie Creek Substations. Figure 4-21 shows transmission line routes proposed by Sierra Pacific Power Company.

CUMULATIVE EFFECTS ANALYSIS

Geology and Minerals

The cumulative effects area for geology and mineral resources includes mining activities depicted in Figure 4-20 and incorporates reasonably forseeable mining activity through year 2001. The area included in this analysis extends from the Rain Mine in the southeast to the Newmont-Hollister Mine in the northwest.

Because gold mining is a major activity in the Carlin Trend, it is reasonable to assume that large-scale mining will continue and result in creation of open pits, waste rock disposal areas, heap leach pads, and tailing storage facilities. Future exploration may also result in delineation of deeper oxide and refractory ore zones that would require dewatering systems for economical recovery of ore. It is difficult to quantify the total volume of ore, waste materials, and gold that could be economically excavated or recovered from the Carlin Trend in the future. Topography of the area would continue to be modified as a result of mine excavations and waste rock and tailing disposal. Continued mining may afford the opportunity to backfill mined-out pits with waste rock from future operations. Such opportunities would be judged individually and based on accessibility as well as influence on future mining activities. Backfilling would restore land surface where open pits were located.

Paleontology

The cumulative effects area for paleontological resources includes disturbance areas associated with existing and possible mining activities in the Carlin Trend through year 2001 (Figure 4-20). Vertebrate and invertebrate fossils in the Carlin Trend occur primarily in Tertiary sediments of the Carlin Formation. Open-pit mining that intercepts and disturbs Tertiary sediments would have the greatest potential impact on paleontological resources. Other mining-related excavations (e.g., leach pads, tailing and waste rock disposal areas) are shallow and would primarily affect unconsolidated soil surfaces. Disturbances associated with construction of powerlines are typically shallow and would not affect paleontological resources.

Air Resources

The cumulative effects area evaluated for air resources consists of the general area shown in Figure 4-20, including the Boulder Valley in the west, the town of Carlin in the east, the Humboldt River and Rain Mine in the south, and upper Maggie Creek in the north. Existing and future mining activities in the cumulative effects area, including drilling, blasting, loading, hauling, and dumping waste rock and ore, produce both particulate and gaseous pollutants. Particulates resulting from mining consist primarily of large, suspended particles that settle out of the atmosphere very near the emission source. Gaseous pollutants from equipment exhaust and blasting, however, along with fine particles, may be transported long distances downwind before they are removed through settling or washout.

Cumulative effects on air resources in the study area would include elevated levels of TSP and PM-10 particulates as mining and construction activities continue throughout the Carlin Trend through year 2001. Gaseous pollutants from operation of diesel-powered mining and construction equipment and ore processing would also increase. These effects on air resources would depend, to a degree, on whether future mining activities are concurrent or sequential with ongoing operations. Because of air quality control measures required as part of operating permits and the naturally low concentrations of fine particles and gaseous pollutants, the cumulative effects of various mining activities on air quality in the Carlin trend are expected to be minimal.

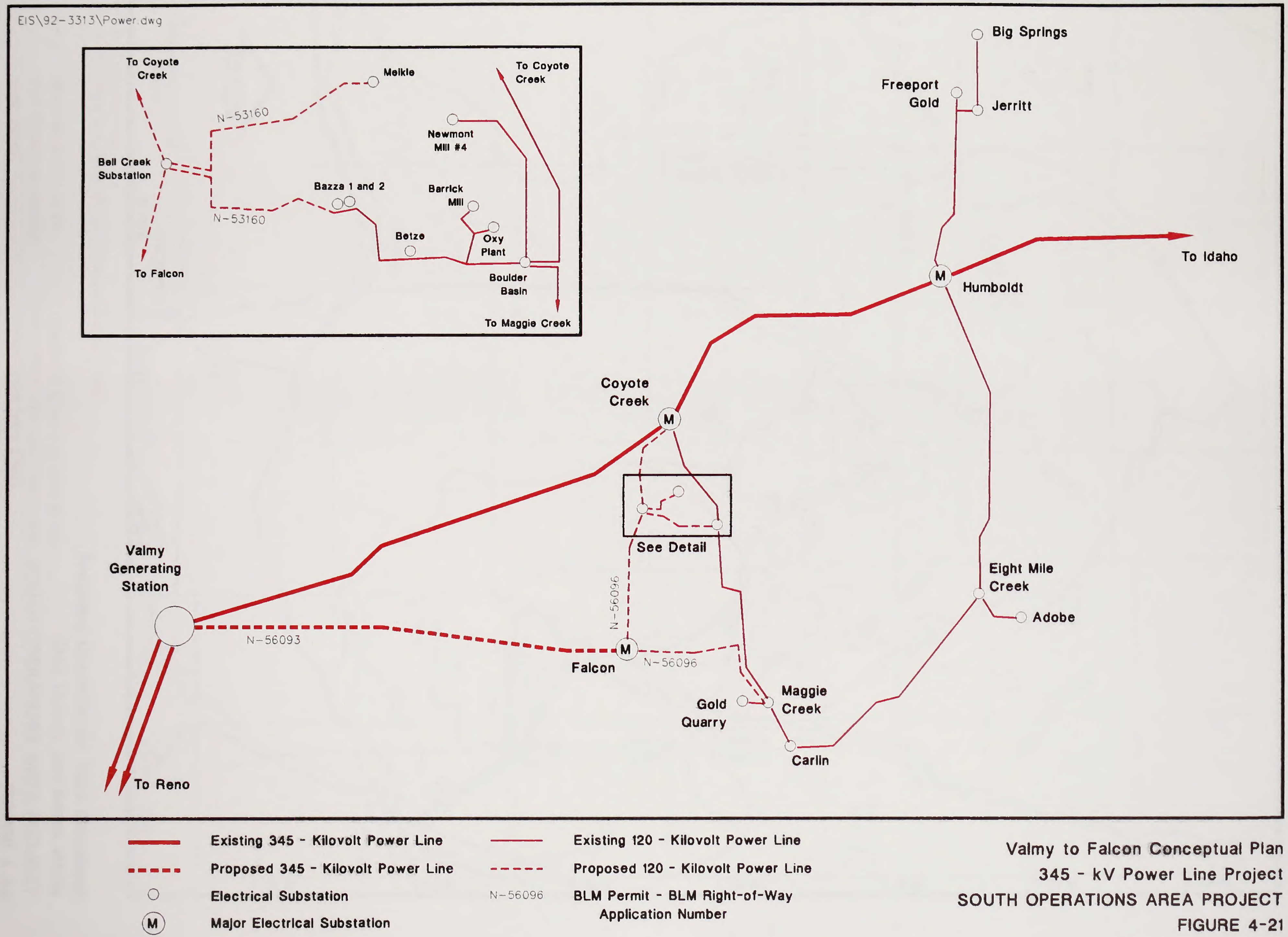
Water Resources

The cumulative effects area evaluated for water resources consists of the general area shown in Figure 4-20, including the following basins: Maggie Creek, Susie Creek, Marys Creek, and Boulder Valley. In addition, effects on the Humboldt River are evaluated downstream to Rye Patch Reservoir. Most existing and reasonably foreseeable mines in the Carlin Trend contribute or would contribute to water resource impacts. These impacts include: (1) increased sedimentation to drainageways from disturbed areas; (2) potential leakage or spills of cyanide or other processing fluids; and (3) potential leakage or spills of solvents, fuels, and lubricants. These impacts are expected to be limited and should not cause significant cumulative effects.

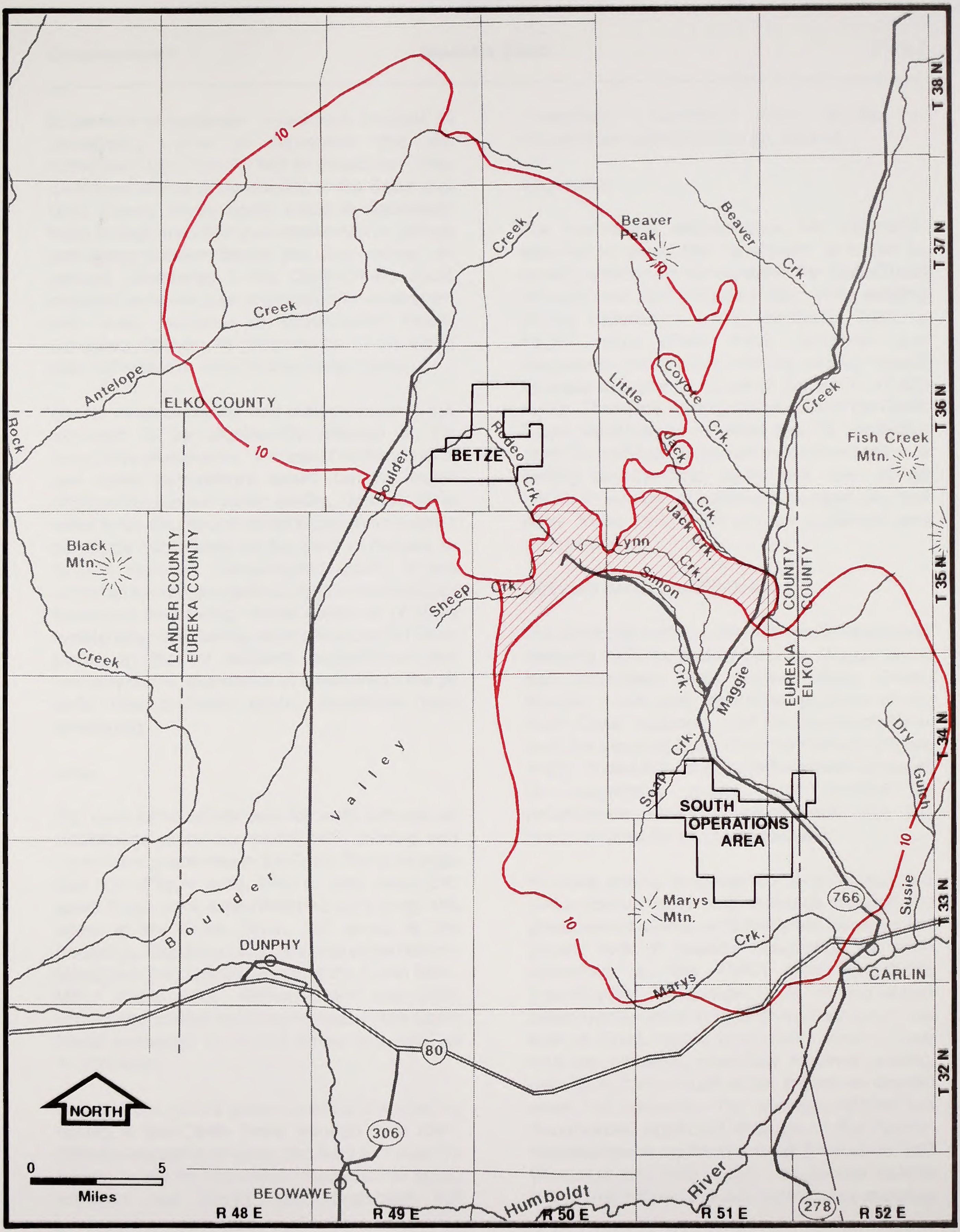
Mine dewatering is currently ongoing at the Barrick Goldstrike Betze open-pit mine located in the Boulder Valley approximately 15 miles northwest of the Gold Quarry Mine. Groundwater is being pumped at a rate of about 145 cfs (65,000 gpm) at the Betze Mine and discharged to a storage reservoir. Some of this water is used for irrigation and the remainder is lost through seepage and evaporation. The Betze Mine is expected to operate until year 2000. The Meikle Mine also is expected to require dewatering in the foreseeable future. This proposed underground mine is located near the Betze Mine and is expected to be dewatered through year 2006. The pumping rate and duration of dewatering that would be required at the Meikle Mine are anticipated to be somewhat less than the maximum rates associated with the Betze Mine.

Extent of the 10-foot groundwater drawdown contour for the Betze and Gold Quarry mines projected for year 2005 is shown in Figure 4-22. After year 2005, the cone of depression associated with the Gold Quarry Mine would begin to decrease in size; however, the cone of depression for the Betze Mine is projected to expand an additional 0.5 to 5 miles beyond the area shown in Figure 4-22 until year 2036. These groundwater drawdown areas would result in impacts on flows in springs, seeps, streams, and the Humboldt River. Lowering of groundwater levels also could affect the use of some wells within the cones of depression. Magnitude and extent of effects depend on ultimate dewatering rates, period of dewatering, and disposition of excess mine water.

The Betze drawdown area is predicted to extend into the west side of upper Maggie Creek Basin, especially in the vicinity of Jack, Little Jack, Coyote, and Beaver creeks. In addition, the area between Simon and Jack creeks would be subject



Valmy to Falcon Conceptual Plan
345 - kV Power Line Project
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-21



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Source: HCI 1992a and 1992d; Barrick Goldstrike Mines Inc. 1993

Maximum Extent of 10-Foot Drawdown Contour (year 2005)

Combined Effects Area of 10-foot Drawdown from Gold Quarry and Betze Mines (year 2005)

Predicted Groundwater Table Drawdown Gold Quarry and Betze Mines

SOUTH OPERATIONS AREA PROJECT

FIGURE 4-22

to additive groundwater drawdowns because of overlapping cones of depression that are individually less than 10 feet of drawdown. The combined effects of dewatering at the Betze and Gold Quarry mines could result in decreased flows in Jack and Little Jack creeks and in springs and seeps between Simon and Jack creeks. In general, dewatering in the Carlin Trend could expand the overall area of groundwater drawdown and delay recovery of groundwater levels. Complete recovery of groundwater levels could take 100 years or more in the Carlin Trend.

Quality of groundwater and surface water is not expected to be significantly affected in the cumulative effects area. Increased sediment load and water temperature would be the major changes to surface water quality. Excess mine water to be discharged would be required to meet standards established by the State of Nevada in NPDES permits. Groundwater quality is not expected to change significantly due to drawdown from mine dewatering. Water quality of pit lakes formed after dewatering ceases is expected to be similar to that of ambient groundwater due primarily to the abundance of limestone in the pit walls that prevents acidic conditions from developing.

Soils

The cumulative effects area for soils includes all disturbance areas associated with existing and future mining activities in the Carlin Trend through year 2001 (Figure 4-20). Prior to 1981, only 1,243 acres in this area were disturbed by mining: 100 acres at the Rossi Mine, 193 acres at the Bootstrap/Capstone Mine, 50 acres at the Bullion-Monarch Mine, and 900 acres at the Carlin Mine, Mill 1 (Table 4-20). Between 1981 and 1992, mining and related soil disturbances in the Carlin Trend increased by 10,123 acres to a total of 11,366 acres.

An estimated 18,223 acres would be disturbed by mining in the Carlin Trend through year 2001. With the exception of open pits, land disturbed by mining would be reclaimed. Reclamation would minimize soil losses and reestablish soil productivity. Cumulative effects on the soil resource are anticipated to be minimal.

Vegetation

The cumulative effects area for vegetation includes all areas that have been or could be directly affected by mining within the Carlin Trend through year 2001 (Figure 4-20). While existing mining disturbance within the Carlin Trend is 11,366 acres (Table 4-20), proposed and reasonably foreseeable mining activity would increase this area by about 62 percent to 18,223 acres. Therefore, mining disturbance in the Carlin Trend would result in direct loss of vegetative cover on 6,857 additional acres for the duration of mining activity, and permanent loss of an unknown number of acres due to open pits and other areas that could not be reclaimed and revegetated.

Riparian Areas and Wetlands

The cumulative effects area for riparian areas and wetlands includes lands drained by Maggie Creek and tributaries, Susie Creek, Marys Creek, Boulder Creek and tributaries, portions of the Rock Creek drainage, and the Humboldt River from the mouth of Susie Creek to Palisade (Figure 4-20). Evaluation of cumulative effects is based on magnitude, extent, and duration of groundwater drawdown which could take 100 years or more for complete recovery.

Previous mining probably has directly impacted some riparian areas and wetlands through the placement of dredge or fill materials; however, the general lack of baseline information for older operations in the Carlin trend precludes quantification. Because most mining-related disturbances occur in upland environments, the area of direct impact is probably small. Other land use practices, especially livestock grazing, have likely had a much larger impact on riparian areas and wetlands. For example, NDOW has documented significant changes in the riparian communities along the Humboldt River since 1950 (Rawlings and Neel 1989). In general NDOW found that willow, bulrush, cattail, and meadow have decreased while agricultural fields, annual weeds, and stream deposits have increased substantially. Potential reasons for this shift include changes in river channel morphology (i.e., straighter, wider, more entrenched channel), willow removal, season-long grazing of streambank vegetation, and increased agricultural use (Rawlings and Neel 1989). JBR (1992a) likewise found a trend toward drier riparian communities along the Humboldt River from 1985 to 1992 related to drought, grazing pressure, development, and natural succession.

The most significant cumulative impact on riparian areas and wetlands related to mining would result from the combined dewatering operations of Gold Quarry and Betze Mine pits. Additional dewatering impacts may result from Barrick Goldstrike's proposed Meikle Mine. Direct impacts from dewatering of the Gold Quarry pit have been previously discussed. Impacts on riparian areas and wetlands from dewatering the Betze pit were analyzed in the Betze project EIS (BLM 1991d). Gold Quarry dewatering could affect up to 1,356 acres of riparian areas and wetlands while Betze dewatering could affect an equal amount of riparian and wetland acres. In the area where dewatering effects from the Gold Quarry and Betze mines would overlap (near Jack and Little Jack creeks and tributaries), impacts could be more pronounced.

Within the cumulative effects area, riparian areas and wetlands associated with streams or springs connected to the regional hydrologic system could be impacted. The degree of impact, however, would depend on magnitude of drawdown and site-specific hydrologic conditions. Riparian vegetation and wetlands dependent on mountain spring domain hydrology, isolated alluvial systems, or seasonal runoff would likely remain relatively unaffected.

Riparian areas and wetlands along Maggie, Susie, lower Marys, James, Soap, Lynn, Simon, West and East Cottonwood, Indian, Jack, Little Jack, Coyote, upper Boulder, Rodeo, Bell, Antelope, and Brush creeks could be impacted by cumulative dewatering. Riparian communities on some drainages, however, such as James and Soap creeks, may be related more to mountain spring domain hydrology and seasonal runoff, and therefore would be less likely to be affected by dewatering.

Cumulative effects on riparian areas and wetlands on the Humboldt River floodplain would depend on management activities and land use upstream of and surrounding the cumulative effects area. The current trend toward drier riparian types and loss of wetlands (Rawlings and Neel 1989; JBR 1992a) will likely continue unless basin-wide management practices are developed to protect and enhance floodplain vegetation.

To some extent, adverse effects on riparian areas and wetlands related to mining and other land uses could be mitigated by:

1) The Lahontan Cutthroat Trout Recovery Plan, which will require improved management of riparian areas through livestock reduction, fencing, and streambank stabilization.

2) BLM management direction (BLM 1991c) for riparian and wetland areas which includes:

    - Restoration and maintenance of riparian and wetland areas so that 75 percent or more are in proper functioning condition by 1997.

    - Protection of riparian wetland areas and associated uplands through proper land management and avoidance or mitigation of negative impacts.

    - An aggressive riparian-wetland information/outreach program, including training and research.

    - Improved partnerships and cooperative restoration and management processes in implementing riparian/ wetland goals.

3) Mine water discharge systems at the Gold Quarry and Betze operations, which would utilize impoundments to store water from pit dewatering. These reservoirs and associated discharge systems would provide open and flowing water and could allow development of riparian vegetation along reservoir shorelines and streams receiving discharged water. The storage reservoir (TS Ranch Reservoir) is responsible for the formation of two large spring systems in the Boulder Valley. These two springs (designated Knob Spring and Sand Dune Spring) are located approximately 5 miles south of the TS Ranch Reservoir and were first measured during spring 1992. Riparian and wetland vegetation is naturally invading these recently-formed spring areas (Barss 1993). Such beneficial effects of the mine discharge systems, however, would be reduced following cessation of mine dewatering.

4) Mitigation required for the Betze Mine, which includes a $660,000 fund for replacement of affected riparian areas. To date, the fund has not been used to mitigate affected riparian areas and no impacts have been documented at the Betze Mine (Barss 1993).

5) Section 404 of the Clean Water Act, which requires mitigation for wetlands affected by placement of dredge or fill materials. Direct impacts caused by pit dewatering on public land not subject to Section 404 would be addressed by BLM.

Once dewatering ceases and hydrologic conditions approximate pre-mining levels, riparian areas and wetlands would naturally reestablish. To expedite the natural process, suitable sites could be developed by seeding and planting.

Terrestrial Wildlife

The cumulative effects area for terrestrial wildlife includes the Maggie Creek drainage, portions of the Susie Creek drainage, and the Humboldt River from Carlin to Palisade (Figure 4-20). The proposed action would add about 1,573 acres of surface disturbance to the 11,366 acres of habitat already disturbed by nine active mine projects in the Carlin Trend. Effects of this action would be cumulative on many species of wildlife. Successful reclamation would result in a habitat mosaic in the area that would differ from pre-mining conditions. This mosaic would include undisturbed pre-mining habitats, as well as a variety of reclaimed habitats. Depending on the site, reclaimed habitats would provide variable topography, combinations of native and introduced plants, younger age classes of shrubs, and patches of vegetation that were not present before mining. While some wildlife species might not regain their pre-mining distribution and density, others not present (or present in limited numbers and distribution) before mining may benefit from reclaimed habitat.

Species dependent upon relatively scarce riparian habitats would be adversely affected. Temporary reduction or loss of flow in springs, seeps, and small streams as a result of dewatering at the Gold Quarry, Betze, and Meikle mines would affect many species dependent on aquatic and wetland habitat. After mining and dewatering cease, many of these water sources would return to their pre-mining condition, as would many wildlife populations found in association with them. However, it may take many years for mature trees and shrubs to recover. Less mobile species or genetically distinct populations of some species may not recover.

Mule deer and pronghorn would be subject to the greatest cumulative effects. Until reclamation replaces disturbed acreage, the proposed action would directly remove nearly 1 percent of the local pronghorn herd's current crucial winter range. In addition, mining to the north and northwest of the South Operations Area has already impacted another 4,000 acres of pronghorn summer range, 400 acres of crucial winter range, and important migration corridors (Evans 1992). Additional disturbance from construction and maintenance of roads, pipelines, and reservoirs as well as increased human use of the area could additionally stress pronghorns. In many cases, pronghorn habituate rapidly to human activity, so the duration of this effect would probably be short-term. Upon cessation of mining and/or successful reclamation, most disturbed areas would again be available to pronghorn.

Mining activity, fires, and habitat conversions have already impacted the migratory mule deer herd's summer range along the flanks of the north Tuscarora Mountains and the west flanks of the Independence Range, its linkage or transitional range (approximately 6,300 acres disturbed), and its winter range (approximately 1,400 acres disturbed) (Evans 1992; Gray 1992). Mule deer traditionally migrated along both flanks of the Tuscarora Mountains to and from wintering areas, but within the past 10 years the pattern has shifted to the east side (south of Simon Creek) due to disturbance to habitats from mining and fire (See figure 3-12). Some mule deer that once used the Dunphy Hills winter range may now be crossing to the north of the Boulder Valley and may be wintering in the Izzenhood and Sheep Creek Range (Gray 1992). Winter ranges in much of the area have been severely degraded by overgrazing and fire, resulting in loss of the shrub component and dominance by annual grasses.

Until reclamation and/or cessation of mining, implementation of the proposed action combined with reasonably foreseeable actions would additionally stress migrating mule deer by introducing more potential barriers (e.g., fences, the North Area Haul Road, transmission lines, MAC and Tusc developments), reducing transitional habitat, removing non-crucial year-round habitat, increasing potential sources of direct mortality from vehicle collisions, and increasing human activity in the area. The total impacts to mule deer transitional range and non-crucial year-round range in the Carlin Trend area would be 7,146 acres and 2,843 acres, respectively. Mule deer populations in the area appear to be stable; implementation of reclamation and other mitigation measures discussed earlier, would help maintain this stability. Without mitigation and reclamation, additional stress from winter range degradation and increased mining activity could lead to permanent reduction in mule deer numbers.

Sierra Pacific Power Company's proposed 20-mile 120-kV transmission line between the proposed Prospector Substation and the existing Maggie Creek Substation would cross the project area north of the South Operations Area. General impacts on wildlife would include habitat loss, habitat degradation, and displacement. Sage grouse could suffer increased predation by raptors. Some primarily sagebrush-grassland habitat would be at least temporarily lost to the transmission line; this could contribute to cumulative effects on mule deer, raptors, sage grouse, songbirds, and small mammals. Noise and activity related to construction and maintenance would disturb wildlife, although most wildlife probably would return after construction is completed. Depending on the site, natural revegetation and/or reclamation of surface disturbances within the transmission line corridor would change the species composition or densities of some wildlife species, such as songbirds or small mammals, while providing foraging sites for big game and predators.

Depending on exact routing of the proposed transmission line and timing of construction and maintenance, effects on mule deer could be substantial. Several thousand mule deer migrate along the east slopes of the south Tuscarora Mountains and most cross in the vicinity of Welches Canyon on their way to and from winter range. Disturbance to migrating mule deer may cause further stress and displacement. This impact could be easily mitigated by timing construction to avoid migration (i.e., November, March, and April).

Potential effects of the proposed transmission line on raptors include loss of foraging habitat for some species, while other species may benefit from habitat alterations that result in higher densities of preferred prey. Some raptors may experience increased mortality due to collisions with transmission lines while flying during times of poor visibility or while pursuing prey, engaging in courtship flights, or defending territory. Other potential effects include mortality from indiscriminate shooters using increased access provided by the transmission line right-of-way, and loss from electrocution. Losses from any of these causes would likely be minimal if proper mitigation measures are implemented. Transmission lines, especially when designed with proper nesting and perching structures, may benefit raptors by providing additional sites for nesting, roosting, and obtaining prey.

Sage grouse would be affected by construction and maintenance of the proposed transmission line through loss of nesting (mature sagebrush) habitat, increased predation by raptors, and disturbance from human activity. Depending on exact routing, the proposed transmission line would pass within a few miles of sage grouse display sites (leks) on the east flanks of Richmond Mountain. Disturbance of sage grouse could be minimized by careful routing and timing of construction and maintenance activities.

Aquatic Habitat and Fisheries

The cumulative effects area for aquatic habitat and fisheries includes the Maggie Creek drainage; portions of the Susie Creek drainage shown on Figure 4-20; Boulder, Antelope, Rodeo, Brush, and Bell creeks in the Boulder Valley and Little Boulder Basin; and the Humboldt River from Carlin to Palisade. Continued dewatering at the Betze and proposed Meike mines potentially could decrease flows in the lower reaches of Jack, Coyote, Little Jack creeks.

Reductions in flow are projected to occur at least through year 2005 and could adversely affect aquatic life in these streams.

Threatened, Endangered, and Candidate Species

The cumulative effects area evaluated for threatened, endangered, and candidate species includes the Maggie Creek drainage, portions of the Susie Creek drainage shown in Figure 4-20, and the Humboldt River from Carlin to Palisade. Cumulative effects on Lahontan cutthroat trout in the Humboldt River Basin would result from degradation of aquatic habitat (primarily from overgrazing by livestock), inadequate streamflows, and competition with non-native trout. Most Lahontan cutthroat trout streams in the Humboldt River Basin generally are declining in habitat quality.

Continued dewatering at the Betze and proposed Meikle mines would have the potential to decrease flows in lower Little Jack Creek, a reach of stream that is intermittent during periods of low flow. Beaver and Coyote creeks -- streams with reproducing populations of Lahontan cutthroat trout -- also could be affected by continued dewatering at the Betze and proposed Meikle mines. Depending on the magnitude of flow reductions, cutthroat populations and aquatic habitat could be adversely affected by groundwater drawdown from these mines. However, most occupied Lahontan cutthroat trout habitat at elevation is above approximately 6,000 feet in the mountain spring domains. In these areas of primarily perched springs, most stream reaches are perennial and may be unaffected by drawdown from Gold Quarry, Betze and Meikle dewatering. Stream reaches predicted to be affected generally are intermittent during part of the year; this condition is due, in part, to hydrological changes brought about by prolonged drought and long-term livestock overgrazing.

Historically, reaches of Little Jack and Coyote, creeks that are now intermittent, supported populations of Lahontan cutthroats (Evans 1993). Riparian management to exclude overgrazing and improve streamside vegetation could restore suitable habitat conditions to degraded portions of these streams. Reduced streamflows from dewatering would reduce the potential to improve currently degraded habitat.

Loss of Lahontan cutthroat trout habitat and reduced flows as a result of mine dewatering at both Gold Quarry and Betze could adversely affect recovery of this species in the Maggie Creek drainage.

Livestock Grazing

The cumulative effects area for livestock grazing includes areas of direct disturbance associated with mining in the Carlin Trend and areas that are predicted to be affected by groundwater drawdown from mine dewatering (Figures 4-20 and 4-22). Existing mining disturbance within the cumulative effects area is estimated at 11,366 acres. Disturbance from proposed and reasonably foreseeable mining activity would increase the disturbed area by 62 percent to 18,223 acres. Therefore, mining disturbance in the Carlin Trend would result in direct loss of vegetative cover on 6,857 additional acres for the duration of mining activity, and permanent loss of an unknown number of acres due to open pits and other unreclaimed lands.

There would be a loss of vegetative cover and grazing potential during the life of the mines in areas that can be reclaimed. Permanent loss of grazing potential would be limited to unreclaimed areas (e.g., mine pits) and steep slopes inaccessible to livestock. Short-term effects on livestock operators would depend on availability of alternative pasture and replacement of stockwater sources affected by dewatering. Long-term effects include loss of grazing potential on unreclaimed areas, and potential loss of forage due to lack of stock water. Ongoing and proposed dewatering at the Gold Quarry, Betze, and Meikle mines would affect springs, seeps, and surface water sources within individual groundwater cones of depression and areas of drawdown overlap. Adverse effects on springs and streamflow in the Carlin Trend would reduce grazing potential in this area.

Recreation and Wilderness

The cumulative effects area for recreation and wilderness includes all of Elko County and portions of Eureka and Lander counties as shown on Figure 3-15. Population forecasts by the Nevada Demographer's Office indicate Elko County's population to be 39,740 by year 1997 an increase of about 6,346 individuals over the 1990 census. Eureka County's population is forecast to be 1,640 in 1997, an increase of 93 individuals over the 1990 census.

Land disturbed by mining increased from 1,243 acres prior to 1981 to 11,416 acres in 1992. An additional 6,857 acres is projected to be disturbed between 1992 and 2001 (Table 4-20); this amount of disturbance may result in road closures and decreased access to public lands along the Carlin Trend. Additional land is projected to be disturbed by mining in the Independence Range and would result in road closures and reduced access.

Increased population (Table 4-22) due to mining and decreased land available for dispersed recreation would adversely affect the quality of recreation in the Carlin Trend and Independence Range areas. Recreational resources for which demand currently exceeds supply (e.g., miles of stream available for fishing, cross-country ski trails, bicycling trails, and hiking and backpacking trails) would continue to be overused. Existing recreational facilities in communities would be greatly overstressed by additional population. Additional golf courses, tennis courts, baseball fields, and other community recreational facilities also would be needed to meet recreational demand. Tent camping sites and picnic areas would be inadequate due to the large influxes of construction workers and new permanent residents.

Depending on visibility from the various wilderness and wilderness study areas, the glow from high, intensity lighting used at mine sites could impact visitors' sense of solitude. While the experience of visitors to the wilderness might be affected by activities outside the wilderness boundary, the Wilderness Act does not require that those adverse affects be mitigated.

Visual Resources

The cumulative effects area for visual resources extends from the Humboldt River in the south to the Independence Mountains in the northeast and east and the Tuscarora Mountains on the west and northwest (Figure 4-20). Impacts on visual resources from reasonably foreseeable mining activities would be minimized through the implementation of proposed reclamation measures. None of the reasonably foreseeable mining activities in the Carlin Trend are expected to compromise the Visual Resource Management Objectives for Class III or Class IV lands, and cumulative effects are expected to be minimal.

Noise

The cumulative effects area for noise extends from the South Operations Area to the town of Carlin (Figure 4-20). As mining continues to develop along the Carlin Trend, overall noise levels may increase from both mining and ore-processing activities and associated traffic. After cessation of mining, some noise would continue during reclamation activities. The major population centers in the vicinity of the Carlin Trend, including Elko, Carlin, and Battle Mountain, would not be adversely impacted by noise generated at area mines.

Land Use and Access

As mining continues to develop along the Carlin Trend, more land will be removed from public access and use. Based on reasonably foreseeable activities, approximately 18,273 acres will be disturbed by mining operations by year 2001. A portion of these lands would remain as open pits. Lands used for waste rock and tailing disposal, heap leach pads, and other mine facilities would be reclaimed for post-mining land uses. Use of groundwater and surface water could be temporarily affected in areas where groundwater levels are significantly lowered and streamflows are reduced.

Cultural Resources and Ethnography

As depicted in Figure 4-23, the cultural resources and ethnography cumulative effects area (i.e., the Study Area) consists of approximately 387,840 acres. To date, 75 mining-related cultural resource inventories have resulted in Class III level examination of approximately 37,408 acres, or about 9.6% of the cumulative effects area. As shown in Table 4-21, these inventories have documented 1,512 sites[1]; this results in an average site density of approximately one per 25 acres, of which about one site per 225 acres is considered NRHP eligible.

Mining activity in the cumulative effects area has resulted in approximately 11,339 acres of surface disturbance to date. It is projected that an additional 7,546 acres of mining-related surface disturbance will occur by 2001. This would result in loss of an estimated 302 sites, 34 of which would be potentially NRHP eligible.

Because no direct or indirect impacts on Newe/Western Shoshone traditional values, practices, properties or human remains and cultural items would occur as a result of the proposed action and alternatives, there are no cumulative impacts on ethnographic resources.

Social and Economic Resources

Cumulative socioeconomic effects would result from expansion of mining along the Carlin Trend, construction of a 345-kV Sierra Pacific transmission line and other transmission lines to provide additional power to the Elko/Carlin area, expansion of the Cortez Mine southwest of Elko, and other construction projects taking place in the area (e.g., school facilities).

Proposed or planned mining developments in the socioeconomic study area have project lives ranging from 1993 to 2011. Estimated average numbers of construction and operations workers are 1,138 and 1,443, respectively (see Table 4-22). These numbers exclude family members who may accompany in-migrating workers, people moving into the area seeking secondary jobs, and Newmont's proposed construction work force associated with the South Operations Area Project.

[1]This number includes 219 prehistoric "localities" and 242 historic "features" recorded within site 26EK3032, the Tosawihi Quarries Archaeological District (Elson et al 1987; Zeier 1987). Data from 150 cultural resource properties for which no recording forms are available (Armentrout and Hanes 1988) were not used for this analysis.

TABLE 4-21
Mining-Related Cultural Resource Inventories and Results in the Area of Cumulative Effects

Number of Mining Related Projects	Acres of Inventory	Sites Present	Number NRHP[1] Eligible Sites
75	37,408	1,512	173 (11.4%)

[1] NRHP = National Register of Historic Places.

TABLE 4-22
Estimated Number of Workers Associated with Mining Developments

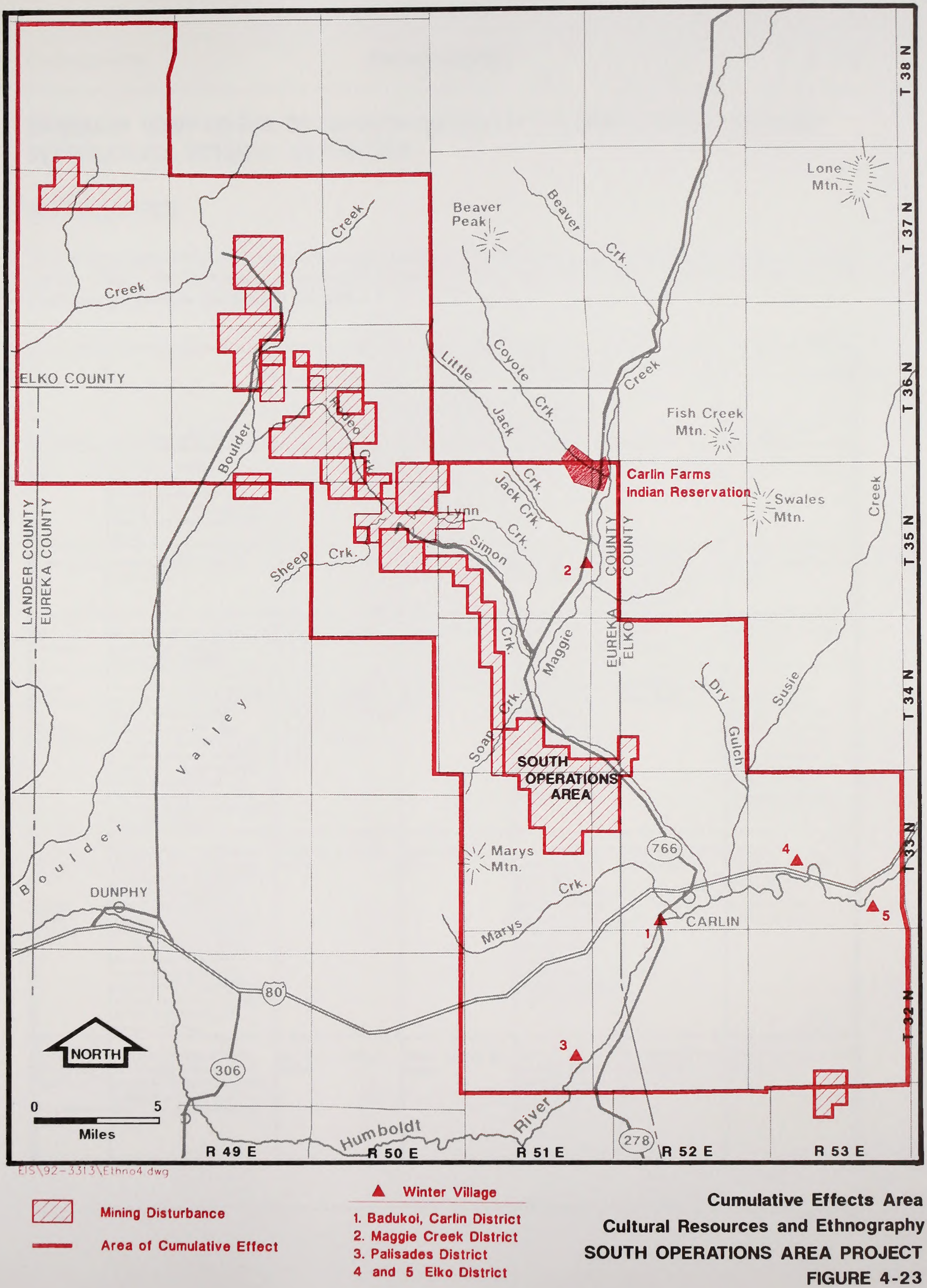
Project	Construction Workers	Operations Workers
Santa Fe Gold Mule Canyon	375 - 500	225 - 350
Barrick Meikle	100 - 250	220
Independence Mine Jerritt Canyon EIS	0	150 - 200[1]
Proposed Jerritt Canyon Project - New Tailings Impoundment	70	0
Dee Gold Expansion	50 - 70	30
Dee Gold Underground	20 - 30	0
U.S. Placer Dome Pipeline	185	265
U.S. Placer Dome South Pipeline	185	265
TOTAL AVERAGE	1,138	1,443

[1] Construction and operations workers undifferentiated in Plan of Operations.
Source: Woodward-Clyde Consultants 1993.

Increased population in the Elko area would result from an influx of construction and operations workers and their families. Future expanded operations would partially rely on existing work forces at area mines. Currently, there is a large construction work force in Elko and Eureka counties employed at the various mine expansion projects.

Depending on timing of construction activities, it may be possible for the existing construction work force to satisfy construction labor demands without large influxes of new workers. However, if all construction activities were to occur concurrently, substantial numbers of new employees would be needed.

Increased numbers of construction and operations workers and their families moving into the area would stress temporary housing and some community services. Some workers would camp or live in mobile homes on federal lands or in recreation areas. Permanent residents of the area would be displaced from some recreation areas and perceive their quality of life to be degraded by uncontrolled growth. Increased traffic, crime, and demands for retail and community services would be likely to occur if the temporary work force were to increase significantly. Permanent residents would likely bear a disproportionately large tax burden to pay for increased community services required by temporary construction workers and their families. Permanent operations workers would share in the tax burden.



Cumulative Effects Area
Cultural Resources and Ethnography
SOUTH OPERATIONS AREA PROJECT
FIGURE 4-23

SUMMARY COMPARISON OF IMPACTS BETWEEN THE PROPOSED ACTION AND ALTERNATIVES WITHOUT MITIGATION

INTRODUCTION

This section summarizes and compares impacts between the Proposed Action and the alternatives, including the No Action Alternative and the Agency Preferred Alternative. Detailed descriptions of impacts are contained in previous sections of Chapter 4.

Resource	Impacts of Proposed Action	Alternatives				
		1 Supplemental water cooling	2 Backfill of MAC Mine pit with waste rock from Tusc Mine	3 Water discharge to Humboldt River via Pipeline	No Action	Agency Preferred Alternative
Geology and Minerals	Relocation of approximately 332 million tons of rock material,maintain future access to ore reserves in the Gold Quarry,MAC, and Tusc Mines.	Similar to Proposed Action.	Elimination or reduction in access to ore reserves in the MAC Mine area.	Similar to Proposed Action.	No recovery of about 7 million ounces of gold.	Similar to Proposed Action.
Paleontology	Impacts limited to area of disturbance.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Elimination of potential effects to paleontological resources.	Similar to Proposed Action.
Air Resources	Air quality would remain at or near present levels in the South Operations Area.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.
Water Resources - Surface Water Quality	Increased channel erosion on Maggie Creek and Humboldt River, increased water temperature to Palisade, decreased dissolved oxygen concentrations in receiving waters. Increased sediment load in Maggie Creek and Humboldt river. Increased ice-free reaches during winter in Humboldt River.	Water temperature in Maggie Creek and Humboldt River closer to ambient near mouth of Maggie Creek.	Similar to Proposed Action.	Existing conditions maintained in Maggie Creek. Increased water temperatures in Humboldt River to Palisade. Reduced sediment load in Humboldt River.	Existing conditions maintained.	Increased water temperatures in Maggie Creek and Humboldt River to Palisade, reduced sediment load in Humboldt River and Maggie Creek. Increase in ice-free reaches during winter.
Water Resources - (cont.) Surface Water Quantity	Altered channel stability and general stream morphology resulting from discharge into Maggie Creek; channel modification at mouth of Maggie Creek. Increased baseflow in lower Maggie Creek and Humboldt River during dewatering and reduced baseflow during post-discharge period. Total of eight streams would have sections of reduced or eliminated flows.	Similar to Proposed Action.	Similar to Proposed Action.	Decreased surface water quantity in lower Maggie Creek during and after dewatering period. Increase in Humboldt River flow; little or no channel modification in Maggie Creek and Humboldt River.	Existing conditions maintained.	Maggie Creek channel stabilized; sediment load reduced; little or no channel modification in Humboldt River.
Water Resources (cont.) Groundwater Quality	Seepage of treated waters into Maggie Creek alluvium; generally similar groundwater quality in and near Gold Quarry pit after dewatering ceases.	Similar to Proposed Action.	Similar to Proposed Action.	Elimination of seepage water in lower Maggie Creek channel and alluvium.	Existing conditions maintained.	Similar to Proposed Action.

Resource	Impacts of Proposed Action	Alternatives				
		1 Supplemental water cooling	2 Backfill of MAC Mine pit with waste rock from Tusc Mine	3 Water discharge to Humboldt River via Pipeline	No Action	Agency Preferred Alternative
Water Resources - (cont.) Groundwater Quantity	Lowered groundwater table in project area during dewatering; reduced groundwater outflow rates during and after dewatering.	Similar to Proposed Action.	Similar to Proposed Action.	Elimination of seepage water into Lower Maggie Creek channel and alluvium.	Slightly lowered groundwater levels from current operation.	Similar to Proposed Action.
Water Resources - (cont.) Springs and Seeps	Reduced or loss of flow in 25 springs and seeps in the project area.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Slight impacts to 2 to 4 springs and seeps from current operation.	Similar to Proposed Action.
Soils	Soils disturbed on 1,573 acres; redistribution of topsoil on 1, 376 acres during reclamation; soil losses minimal.	Similar to Proposed Action.	Redistribution of topsoil on 1,416 acres.	Additional disturbance of 56 acres during construction of pipeline; redistribution of topsoil on pipeline corridor.	Existing conditions maintained.	Additional disturbance of 56 acres during construction of pipeline; redistribution of topsoil on pipeline corridor.
Vegetation	Removal of 1,573 acres of vegetation; reestablishment of vegetation on 1,376 acres during reclamation; minimal impacts.	Similar to Proposed Action.	Reestablishment of vegetation on 1,416 acres during reclamation.	Temporary loss of 56 additional acres of vegetation; reestablishment of vegetation on additional 56 acres disturbance.	Existing conditions maintained.	Temporary loss of 56 additional acres of vegetation; reestablishment of vegetation on additional 56 acres disturbance.
Riparian Areas and Wetlands	Total of 1,356 acres of riparian areas and wetlands along Maggie Creek, tributaries, and Humboldt River would be affected. Loss of additional 14 acres of riparian habitat associated with springs and seeps.	Similar to Proposed Action.	Similar to Proposed Action.	Increased impacts to riparian habitat along Maggie and Susie creeks due to elimination of recharge into lower Maggie Creek basin.	Slight impacts to riparian areas and wetlands from current operation.	Creation of riparian habitat along lower Maggie Creek.
Terrestrial Wildlife	Loss of habitat associated with disturbance of 1,573 acres; impedence of mule deer migration; reduction or loss of flow in springs and seeps would displace wildlife to adjacent areas. Reclamation would restore habitat on 1,376 acres; recovery of the groundwater table after dewatering would reestablish springs and seeps for wildlife use.	Similar to Proposed Action.	Additional 40 acres reclaimed for wildlife habitat. Total 1,416 acres reclaimed.	Similar to Proposed Action.	Existing conditions maintained.	Similar to Proposed Action.
Aquatic Habitat and Fisheries	Potential stress on aquatic life in the Humboldt River from Carlin to Palisade due to discharge of warm water low in dissolved oxygen; decreased streamflow in tributary streams during and after dewatering. Increased fishery values in lower Maggie Creek as a result of discharge; increased sediment loads would adversely affect aquatic life in the Humboldt River.	Water temperatures closer to ambient near mouth of Maggie Creek; reduced thermal effects in Humboldt River.	Similar to Proposed Action.	Reduction or elimination of sediment load to Humboldt River.	Existing conditions maintained.	Reduction of sediment load to Humboldt River.

Resource	Impacts of Proposed Action	Alternatives				
		1 Supplemental water cooling	2 Backfill of MAC Mine pit with waste rock from Tusc Mine	3 Water discharge to Humboldt River via Pipeline	No Action	Agency Preferred Alternative
Threatened, Endangered, and Candidate Species	Lahontan cutthroat trout habitat would be affected by temporary reductions in flow in portions of Maggie and Susie creeks resulting from the dewatering program.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Existing conditions maintained.	Similar to Proposed Action.
Livestock Grazing	A total of 8,092 AUMs would be temporarily displaced on public and private lands as a result of surface disturbance, dewatering of springs and seeps, and modifications to fence locations. Reclamation and recovery of the groundwater table would reestablish most grazing habitat.	Similar to Proposed Action.	Reclamation of MAC pit would add 40 acres livestock grazing.	Similar to Proposed Action.	Existing conditions maintained.	Similar to Proposed Action.
Recreation and Wilderness	Continued stress on existing recreational facilities in the Elko area. Glow from lights at the Gold Quarry mine may reduce wilderness solitude.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Reduction in stresses on recreational facilities.	Similar to Proposed Action.
Visual Resources	Large scale modification to landforms; visible steam plumes would be created from cooling towers.	Similar to Proposed Action.	Similar to Proposed Action.	Pipeline construction would create weak linear contrast.	Existing conditions maintained.	Pipeline construction would create weak linear contrast.
Noise	No change to existing noise levels.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Existing conditions maintained.	Similar to Proposed Action.
Land Use and Access	Some modification to land use and access would result.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Existing conditions maintained.	Similar to Proposed Action.
Cultural Resources and Ethnography	Construction activity would disturb 37 cultural resources identified in the affected area--three of which are considered NRHP eligible.	Similar to Proposed Action.	Similar to Proposed Action.	Based on site density projections, it is expected two sites would be present in the pipeline corridor; no more than 1 of these would be considered NRHP eligible.	Existing conditions maintained.	Similar to Proposed Action.
Social and Economic Resources	Temporary impacts during the construction period on community services. Increased state and local economic benefits from increased taxes and commercial activities.	Similar to Proposed Action.	Similar to Proposed Action.	Similar to Proposed Action.	Termination of mining at end of 1994; majority of work force laid-off. Reduction in local economic benefits from taxes.	Similar to Proposed Action.

CHAPTER 5

CONSULTATION, COORDINATION, AND PREPARATION

PUBLIC PARTICIPATION SUMMARY

INTRODUCTION

This Public Participation Summary is specific to the proposal presented in Newmont's Plan of Operations for the South Operations Area Project. The summary indicates means of public involvement, identifies persons and organizations to be contacted for comments and feedback, and specifies time frames for accomplishing goals in accordance with 40 CFR 1506.6.

This summary includes the necessary steps for public involvement in the EIS process to identify and deal with public concerns and needs. This process assists in: (1) broadening the information base for decision making; (2) informing the public of the proposal and long-term impacts resulting from the action; and (3) ensuring that public needs and desires are understood by BLM.

Public notice and opportunity for participation are required at four specific points in the EIS process: the scoping period, review of the Draft EIS, review of the Final EIS, and receipt of the Record of Decision.

- ♦ The 60-day scoping period provided the public the opportunity to identify potential issues associated with the proposed action that might warrant analysis during development of the Draft EIS.
- ♦ The 60-day review of the Draft EIS is initiated by publication of a Notice of Availability for the Draft EIS in the Federal Register. During the review period, public hearings will be held in Elko and Reno to obtain comments.
- ♦ The 30-day review of the Final EIS is initiated by publication of a Notice of Availability for the Final EIS in the Federal Register.
- ♦ Subsequent to the 30-day review of the final EIS, the Record of Decision will be prepared and a Notice of Availability for the Record of Decision will be published in the Federal Register.

IMPLEMENTATION

1. The scoping period was initiated by publication of a Notice of Intent (NOI) on February 14, 1992 (Fed. Reg. pages 5462 and 5463). The NOI summarized the proposed action and BLM's determination that an EIS was necessary for analysis of the proposal. All appropriate news media and the public were notified of the periods available for comment. Eighteen news organizations and two radio stations were contacted, including: Elko Daily Free Press, Elko Independent, Elko Radio Stations (KELK and KRJC), Battle Mountain Bugle, Ely Daily Times, Humboldt Sun, Reese River Reveille, Las Vegas Review-Journal, Associated Press, Eureka Sentinel, Mining World News, United Press International, Deseret News, Twin Falls Times News, Reno Gazette-Journal, Salt Lake Tribune, High Desert Advocate, and The Idaho Statesman.

   Written notification of the scoping period was given to the: Elko, Eureka, Lander, Humboldt, and Pershing county commissioners; Elko County Manager;

Elko City Manager; Elko City planning commissioners; and the Elko City Council. Briefings were provided to the Elko and Eureka county commissioners.

Formal public scoping meetings were held in Elko and Reno, Nevada, on April 7 and 8, 1992 respectively. In addition to the officials and agencies identified above, 370 scoping letters were sent to various agencies, groups, and individuals. Each of the 138 individuals who participated in the scoping meetings held in Elko and Reno also received a copy of the scoping letter.

Scoping comments were accepted until April 24, 1992. During that period a total of 517 written responses were received from individuals and groups. Of the 517 individuals and groups, 448 signed a petition concerning potential recreational use of a proposed reservoir that is part of the proposed action. Comments were also received from the Nevada State Clearinghouse.

2. A Public Scoping Report was developed by BLM for distribution to persons who provided comments during the EIS public scoping period. In addition, through use of the EIS mailing list, interested parties were informed that, upon written request, the Public Scoping Report could be obtained from the Elko District BLM. This report also was made available for review at the Elko Public Library and the Elko District BLM office.

3. An EIS mailing list of interested persons was assembled from previous mining-related EIS mailing lists and from names of participants who attended a local community meeting sponsored by Elko County and State Assemblyman John Carpenter. This list will be continuously updated as needed throughout the EIS process.

4. Distribution of the Draft EIS will occur as follows:

- ♦ A Notice of Availability will be published in the Federal Register specifying the dates for the comment period and the dates, times, and locations of public hearings.
- ♦ In conjunction with the 60-day comment period on the Draft EIS, a news release will be developed and submitted to all relevant news outlets through the Elko District BLM Office.
- ♦ The Draft EIS will be distributed to interested parties identified on the updated EIS mailing list.
- ♦ Letters received from interested parties concerning the Draft EIS will be promptly acknowledged so respondents will know their comments have been received by BLM.
- ♦ Public meetings will be held in Elko and Reno to obtain comments on the Draft EIS approximately 30 to 45 days after publication of the Federal Register Notice.
- ♦ Briefings will be affected for local and state government representatives, Congressional Representatives, and State Clearinghouse.

5. The Final EIS will be completed considering comments from the review of the Draft EIS and released as follows:

- ♦ A Notice of Availability will be published in the Federal Register.
- ♦ Copies of the final document will be sent to all those on the updated mailing list.
- ♦ A news release will be issued to all relevant news outlets through the Elko District BLM office.

6. The Record of Decision will be distributed to people and organizations on the updated mailing list, and a Notice of Availability will be published in the Federal Register. Briefings will be offered to the Nevada Clearinghouse and conducted, as required. A news release will be issued to all relevant news outlets to announce distribution of the Record of Decision.

CRITERIA AND METHODS BY WHICH PUBLIC INPUT IS EVALUATED

Substantive comments from letters and testimony concerning the Draft EIS will be reviewed and evaluated by BLM to determine if information is presented that requires a formal rsponse or contains new data to be brought to the attention of the BLM which identifies deficiencies in the Draft EIS. Steps would then be initiated to correct such deficiences and to incorporate the information into the Final EIS.

Should changes from the Draft EIS to the Final EIS be deemed significant, a Draft EIS will be reissued with similar opportunity for public involvement.

CONSULTATION WITH OTHERS

The following state and federal agencies were consulted during preparation of this EIS:

- Nevada Department of Wildlife
- Nevada Department of Conservation and Natural Resources
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency Region IX
- U.S. Fish and Wildlife Service

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CHAPTER 6 - REFERENCES AND GLOSSARIES

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LIST OF ACRONYMS

AARL	Anglo American Research Laboratories
AGP	acid-generating potential
ANP	acid-neutralizing potential
ARD	acid rock drainage
ADE	area of direct effects
AUM	animal unit month
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
B.P.	before present
CFB	circulating fluidized bed
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIL	carbon-in-leach
CIP	carbon-in-pulp
COE	U.S. Army Corps of Engineers
Db	decibels
DBA	A-weighted decibel sound scale
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
gpm	gallons per minute
HDPE	high-density polyethylene
kV	kilovolt
MCE	maximum credible earthquake
mg/l	milligrams per liter
$\mu g/m^3$	micrograms per cubic meter
MM	million

MSHA	Mine Safety and Health Administration
msl	mean sea level
NAAQS	national ambient air quality standards
NAC	Nevada Administrative Code
NAES	Nevada Agricultural Experiment Station
NAS	National Academy of Sciences
NDCNR	Nevada Department of Conservation and Natural Resources
NDEP	Nevada Division of Environmental Protection
NDH	Nevada Division of Health
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife
NENDA	North East Nevada Development Authority
NEPA	National Environmental Policy Act
Newmont	Newmont Gold Company
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atomspheric Administration
NPDES	National Pollution Discharge Elimination System
NRHP	National Register of Historic Places
ORV	off-road vehicle
OSHA	Occupational Safety and Health Administration
PLS	pure live seed
POO	plan of operations
ppm	parts per million
PSD	prevention of significant deterioration
R	range
RA	resource area
RCRA	Resource Conservation and Recovery Act
RFA	reasonably foreseeable action
RMP	resource management plan
SARA	Superfund Amendments and Reauthorization Act
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SCS	Soil Conservation Service
SHPO	State Historic Preservation Officer
SRA	state recreation area
SRMA	special recreational management area

T	township
TDF	tailing disposal facility
TPQ	threshold planning quantity
TSP	total suspended particulate
USC	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
VRM	visual resource management
WAD	weak acid dissociable
WSA	wilderness study area

GLOSSARY

Acre-feet. The volume of liquid or solid required to cover 1 acre to a depth of 1 foot, which is equivalent to 43,560 cubic feet; measure for volumes of water, reservoir rock, etc.

Activated Carbon. Highly adsorbent carbon formed by heating granulated charcoal to exhaust contained gases.

Adit. A nearly horizontal passage, driven from the surface, by which a mine may be entered, ventilated, and/or dewatered.

Alluvial. Pertaining to material or processes associated with transportation or deposition of soil and rock by flowing water (e.g., streams and rivers).

Alluvium. Soil and rock deposited by flowing water (e.g., streams and rivers); consists of unconsolidated deposits of sediment, such as silt, sand, and gravel.

Ambient. Surrounding, existing.

Assay. Qualitative or quantitative analysis of a substance (e.g., ore body).

Baghouse. Dust collection and control facility.

Basic Elements (visual). The four major elements (form, line, color, and texture) which determine how the character of a landscape is perceived.

Bio-oxidation. Process by which chemicals are transformed into their oxidized state by living organisms.

Carbonaceous Ore. Ore containing large amounts of carbon.

Contrast (visual). The effect of a striking difference in form, line, color, or texture of the landscape features within the area being viewed.

Critical (Crucial) Habitat. Habitat that is present in minimum amounts and is a determining factor for population maintenance and growth.

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 Hz).

Decant. To remove or pour off a liquid without disturbing associated sediment or solids.

Decibel (dB). One-tenth of a Bel is a measure on a logarithmic scale which indicates the ratio between two sound powers. A ratio of 2 in power corresponds to a difference of 3 decibels between two sounds. The decibel is the basic unit of sound measure.

Dissolution. The process of dissolving or, more rarely, melting.

Disturbed Area. Area where natural vegetation and soils have been removed.

Doré Bars. Product of retort furnace containing gold, silver, and impurities.

Ecological Site. Subdivisions of rangeland differentiated by the potential natural vegetation they are capable of supporting.

Electrolyte. A substance, usually in solution, which will transmit an electrical current.

Electrowinning - Electrometallurgy. The art or science of electrolytically depositing metals, or separating them from their ores or alloys.

Endangered Species. Species in danger of extinction throughout all or a significant portion of its range.

Ephemeral Stream. A stream or portion of a stream which flows briefly in direct response to precipitation in the immediate vicinity, and whose channel is at all times above the water table.

Evapotranspiration (ET). The portion of precipitation returned to the air through evaporation and transpiration.

Feeder Zones. Deep pathways followed by mineralizing fluids to form an orebody, often containing rich ore.

Floodplain. The low and relatively flat areas adjacent to rivers and streams. A 100-year floodplain is that area subject to a 1 percent or greater chance of flooding in any given year.

Flume. A structure built in an open channel that constricts water flow through a designed opening to measure rate of water flow.

Flux. A substance which promotes the fusing of minerals or metals.

Forage. Vegetation used for food by wildlife, particularly big game wildlife and domestic livestock.

Game Species. Animals commonly hunted for food or sport.

Hertz (Hz). The unit of frequency (i.e., sound) formerly designated as cps - cycles per second.

Host Rock. A rock body or wall rock enclosing mineralization.

Hydraulic Gradient. For groundwater, the rate of change of total head per unit of distance of flow at a given point and in a given direction.

Hydrostratigraphic Unit. Grouping of stratified, mainly sedimentary rocks that have similar groundwater flow conditions.

Igneous. Rock or mineral that solidified from molten or partly molten material.

Intermittent Stream. Stream that flows only part of the time or during part of the year.

Isopleth. A line, on a map or chart, drawn through points of equal size or abundance.

Key Observation Point (KOP). An observer position on a travel route used to determine visible area.

Lithic Scatter. 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.

Makeup Water. Water needed to supplement water removed by milling or processing of ore and losses to evaporation.

Maximum Credible Earthquake. The largest conceivable earthquake that could occur in an area.

Mesic. Moist habitats associated with springs, seeps, and riparian areas.

Mitigation. Actions to avoid, minimize, reduce, eliminate, replace, or rectify the impact of a management practice.

Peak Flow. The greatest flow attained during melting of winter snowpack or during a large precipitation event.

Perched Water Table. Unconfined groundwater separated from the underlying main body of groundwater by unsaturated rock.

Perennial Stream. A stream that flows throughout the year and from source to mouth.

Permeability. The capacity of porous rock, sediment, or soil to transmit a fluid.

pH. The negative $\log_{10}$ of the hydrogen ion activity in solution; measure of acidity or basicity of a solution.

PM-10. Particulate matter less than 10 microns in aerodynamic diameter.

Probable Maximum Precipitation (PMP). The greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular location at a certain time of year.

Raptor. A bird of prey (e.g., eagles, hawks, falcons, and owls).

Refractory Ore. Ore difficult to treat for recovery of valuable substances.

Retort. A furnace in which ore may be heated for removal of its metal content.

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.

Run-of-Mine Ore. Ore taken from a mine or pit directly to a mill for processing.

Scoping. Procedures by which agencies determine the extent of analysis necessary for a proposed action, (i.e., the range of actions, alternatives, and impacts to be addressed; identification of significant issues related to a proposed action; and the depth of environmental analysis, data, and task assignments needed).

Sediment Load. The amount of sediment (sand, silt, and fine particles) carried by a stream or river.

Seepage Collection System. A system of drains, ponds, and pumps to collect and return tailing impoundment and embankment seepage.

Significant. As used in NEPA, 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 CFR 1508.27)

Sulfides. That part of a lode or vein not yet oxidized by air or surface water and containing sulfide minerals.

Steppe. Vast plains devoid of forest.

Tackifier. An agent that binds seed, fertilizer, and mulch to a site, often used when seeding slopes.

Threatened Species. Any species of plant or animal which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Total Suspended Particulates (TSP). Particulates less than 100 microns in diameter (Stokes equivalent diameter).

Total Dissolved Solids (TDS). Total amount of dissolved material, organic or inorganic, contained in a sample of water.

Total Suspended Solids (TSS). Undissolved particles suspended in liquid.

Weak Acid Dissociable (WAD). Compound that in the presence of a weak acid would disassociate into its ionic forms in solution.

Weir. An overflow structure built across an open channel, usually to measure rate of water flow.

Wetlands. Areas inundated by surface water or groundwater with a frequency sufficient to support vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

STATUTE GLOSSARY

INTRODUCTION

The Statute Glossary is comprised of summary descriptions of the principal federal and state environmental and cultural resources laws, rules, and regulations. The federal enactments are included in the first part of this section followed by State of Nevada enactments.

FEDERAL ENACTMENTS

AMERICAN INDIAN RELIGIOUS FREEDOM ACT OF 1978 (P.L. 95-341)

This Act makes it a policy of the government to protect and preserve for American Indians their inherent right of freedom to believe, express, and exercise their traditional religions. This includes access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. Compliance with the Act requires that federal agencies consult with Native American religious leaders, consider their views in the decision-making process, and avoid unnecessary interference with Indian religious practices in project implementation.

ANTIQUITIES ACT OF 1906 (34 STAT. 225)

This Act was the first general act providing protection for archaeological resources. It provides for protection of all historic or prehistoric ruins or monuments or any object of antiquity on federal lands, and established criminal sanctions against the injury, destruction, or unauthorized excavation of such resources.

ARCHAEOLOGICAL RESOURCES PROTECTION ACT OF 1979 (P.L. 96-95)

This Act supplements the provisions of the Antiquities Act of 1906 in securing the protection of archaeological resources and sites on public lands. It stipulates that no person may excavate, remove, damage, or otherwise alter or deface any archaeological resource on public lands unless such activity has been permitted in accordance with the Act. Criminal and civil penalties for violation of the law are included. Applicable regulation is 43 CFR 7.

NATIONAL HISTORIC PRESERVATION ACT OF 1966 (P.L. 89-665), AS AMENDED

This Act establishes as policy the preservation of prehistoric and historic resources and provides mechanisms for assessing the cultural and scientific value of such resources and their eligibility for listing in the National Register of Historic Places. It further requires that federal agencies with jurisdiction over Federal, federally assisted, or federally licensed undertakings take into account the effects of such activities on properties eligible for listing in the National Register of Historic Places. Applicable regulations are 36 CFR 60, 36 CFR 61, and 36 CFR 800.

NATIVE AMERICAN GRAVES PROTECTION AND REPATRIATION ACT OF 1990 (P.L. 101-601)

This Act establishes as policy that Native American human remains and associated funerary objects which are discovered or excavated on federal land are the property of Native Americans. It establishes mechanisms by which the treatment and disposition of such materials is to be accomplished and sets criminal and civil penalties for violation of the Act.

ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT OF 1974 (P.L. 93-291)

Congress amended the Reservoir Salvage Act to extend the provisions of the Act to all Federal construction activities and all federally licensed or assisted activities that will cause loss of scientific, prehistoric, or archaeological data. It requires the Secretary of the Interior (Secretary) to coordinate this effort, and to report annually to the Congress on the program. It permits agencies either to undertake necessary protection activities on their own or to transfer to the Secretary up to 1 percent of the total authorized for expenditure on a federal or federally assisted or licensed project to enable the Secretary to undertake the necessary protection activities.

CLEAN AIR ACT (42 U.S.C. 7401) AND AMENDMENTS OF 1970

National Primary and Secondary Ambient Air Quality Standards-40 CFR 50.
State Implementation Plan Requirements-40 CFR 51.

The purposes of this Act are to "protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare and the productive capacity of its population; to initiate and accelerate a national research and development program to achieve the prevention and control of air pollution; to provide technical and financial assistance to State and local governments for aid in their development and execution of air pollution control programs; and to encourage and assist the development and operation of regional air pollution control programs."

The Act requires the Environmental Protection Agency (EPA) to publish national primary standards to protect public health, and more stringent national secondary standards to protect public welfare (40 CFR 50). States and local governments are to be responsible for the prevention and control of air pollution.

States, that are divided into air quality control regions are required to submit State Implementation Plans (SIPs) for EPA approval (40 CFR 51). SIPs provide strategies for implementation, maintenance, and enforcement of national primary and secondary ambient air quality standards for each air quality control region.

Other provisions of the Act include: (1) standards of performance for new stationary sources, (2) motor vehicle emission and fuel standards, (3) national emission standards for hazardous air pollutants, (4) a study of particulate emissions from motor vehicles, and (5) a study of the cumulative effect of all substances and activities that may affect the stratosphere, especially ozone in the stratosphere.

CLEAN WATER ACT (33 U.S.C. 1251 *et seq.*)

Public Law 92-500, as amended

The Clean Water Act strives to "restore and maintain the chemical, physical, and biological integrity of the nation's water." To achieve this objective the Act sets forth the following goals: "(1) that the discharge of pollutants into the navigable waters of the United States be eliminated by 1985; (2) that as an interim goal there be attained by 1983 water quality which provides for the protection and propagation of fish, shellfish and wildlife, and provides for recreation in and on the water; (3) that the discharge of toxic pollutants in toxic amounts be prohibited; (4) that Federal financial assistance be provided to construct publicly owned waste treatment works; (5) that area wide waste treatment management planning processes be developed and implemented to assure adequate control of source pollutants in each State; (6) that a major research and demonstration effort be made to develop technology necessary to eliminate the discharge of pollutants into navigable waters, waters of the contiguous zone, and the oceans; and (7) it is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution."

The goals of the Act are achieved primarily through a system of water quality standards, discharge limitations, and permits. The Act authorizes EPA to require owners and operators responsible for point source discharges to monitor, sample, and maintain effluent records.

If the water quality of a water body is potentially affected by a proposed action (i.e., construction of a waste water treatment plant), a National Pollutant Discharge Elimination System (NPDES) permit (Section 402) may be required. In most cases the EPA has turned this responsibility over to the states as long as the state program is deemed acceptable.

Similarly, if a project may result in placement of material into waters of the United States, a Corps of Engineers Dredge and Fill Permit (Section 404) may be required. It should be noted that the 404 permit also pertains to activities in wetlands and riparian areas.

Prior to issuance of either a NPDES or 404 permit, the applicant must obtain a section 401 certification. This declaration states that any discharge complies with all applicable effluent limitations and water quality standards. Certain federal projects may be exempt from the requirements of Section 404 if the conditions set forth in section 404(r) are met.

ENDANGERED SPECIES ACT OF 1973 (P.L. 93-205)

The purpose of this Act is to provide protection for animal and plant species that are currently in danger of extinction (endangered) and those that may become so in the foreseeable future (threatened).

Section 7 of this Act requires federal agencies to ensure that all federally associated activities within the United States do not have adverse impacts on the continued existence of threatened or endangered species or on designated areas (critical habitats) that are important in conserving those species. Action agencies must consult with the U.S. Fish and Wildlife Service (FWS), which maintains current lists of species that have been designated as threatened or endangered, to determine the potential impacts a project may have on protected species.

Section 9 of the Act prohibits any person subject to United States jurisdiction to possess, sell, deliver, carry, transport, or ship any species listed under this Act, except by authorized permit.

The FWS has established a system of informal and formal consultation procedures. Preparation by FWS of a "Biological Opinion" will conclude formal consultation. The result of informal or formal consultations with FWS under Section 7 of the Endangered Species Act Amendments of 1978 should be described and documented in the environmental assessment (EA) or environmental impact statement (EIS). This should include:

A list of endangered, threatened, or candidate species occurring in the project areas and what impacts, if any, the project could have on endangered fish and wildlife and their habitat.

Action or project features included to enhance, mitigate, or reduce adverse impacts on threatened or endangered species.

A description of the formal and informal consultation with the FWS and the Biological Opinion, if appropriate.

The "Alternatives Including the Recommended Plan" chapter should include any threatened and endangered species mitigation or enhancement features included in the proposed alternative and the reasonable alternatives.

The "Affected Environment and Environmental Consequences" chapter should compare threatened and endangered species impacts for the proposed alternative, the "Without Project (no action)" alternative, and all reasonable alternatives. If a threatened or endangered species is located within the project area and is affected by the project, it may be desirable to attach a more detailed endangered species assessment to the end of the EA or EIS.

Additional detail on Endangered Species Act compliance is found in Reclamation Instructions (RI) 376.6.

EXECUTIVE ORDER 11514 (AMENDED BY EXECUTIVE ORDER 11991 PROTECTION AND ENHANCEMENT OF ENVIRONMENTAL QUALITY, 1977)

This Executive Order requires federal agencies to initiate measures needed to direct their policies, plans, and programs toward meeting national environmental goals.

Federal agencies are responsible for developing procedures (i.e., public hearings, information on alternative courses of action) to ensure timely public review and understanding of federal plans and programs that impact the environment and to allow opportunity for public comment.

This order directs the Council on Environmental Quality (CEQ) to develop regulations requiring EIS's to be more concise, clear, and to the point, and therefore more useful to decision-makers. CEQ has also issued regulations for implementing the procedural provisions of NEPA (40 CFR 6).

EXECUTIVE ORDER 11593, 1971 (PROTECTION AND ENHANCEMENT OF THE CULTURAL ENVIRONMENT) (16 U.S.C 470)

This executive order requires federal agencies to take a leadership role in preservation by surveying all lands under their ownership or control and nominating to the National Register all properties that appear to qualify. It also requires agencies to avoid inadvertently destroying such properties prior to completing their inventories (codified as part of 1980 amendments to the National Historic Preservation Act).

EXECUTIVE ORDER 11988 (FLOODPLAIN MANAGEMENT, 1977)

This executive order requires construction agencies to avoid, where practicable alternatives exist, the short- and long-term adverse impacts associated with floodplain development.

Federal agencies are required to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility.

EXECUTIVE ORDER 11990 (PROTECTION OF WETLANDS, 1977)

This executive order requires executive agencies, in carrying out their land management responsibilities, to take action that will minimize the destruction, loss, or degradation of wetlands, and take action to preserve and enhance the natural and beneficial values of wetlands.

Each agency shall avoid undertaking or assisting in wetland construction projects unless the head of the agency determines that there is no practicable alterative to such construction and that the proposed action includes measures to minimize harm.

Also, agencies shall provide opportunity for early public review of proposals for construction in wetlands including those projects not requiring an EIS.

FISH AND WILDLIFE COORDINATION ACT OF 1958 (P.L. 85-624)

The objective of this Act is to provide that wildlife conservation receive equal consideration and be coordinated with other features of water-resource development programs.

Sections 1 and 2 of the Fish and Wildlife Coordination Act (FWCA) mandate that fish and wildlife receive equal consideration with water resources development programs throughout planning, development, operation, and maintenance. Whenever the Bureau of Reclamation proposes to impound, divert, channelize, or otherwise alter or modify any stream, river, or other body of water for any purpose, it must first consult and coordinate its actions and projects with the FWS and the affected state fish and game agency(ies) wherein the impoundment, diversion, or other control facility is to be constructed. This consultation and coordination will address ways to conserve wildlife resources by preventing loss of and damage to such resources as well as to further develop and improve these resources.

Compliance with the FWCA must be completed before the draft EIS is filed.

The FWS is authorized to survey, investigate, prepare reports, and recommend methods to determine possible damage to wildlife resources and to determine means and measures that should be adopted to prevent loss of or damage to such wildlife resources, as well as to concurrently develop and improve such resources. The FWCA report shall be made a part of any Bureau of Reclamation report submitted to Congress. The Bureau of Reclamation shall give full consideration to the report of the state agency. The project plan shall include such justifiable fish and wildlife means and measures as deemed necessary to obtain maximum overall project benefits.

The usual FWS procedure is to provide the Bureau of Reclamation with periodic planning aid memorandums or planning aid letters throughout the planning process, and to provide a FWCA report as part of the EA or EIS.

The recommendations of the FWS must be summarized in the EA or EIS and responses to each recommendation included. This summary is usually made a part of the Consultation and Coordination section. If a recommendation is not included in the plan, the reasons must be given. Additional details on FWCA compliance are found in RI 376.13.

THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 (NEPA), as amended (P.L. 91-90, 42 U.S.C. 4321 *et seq.*)

This Act establishes a national policy for protection and enhancement of the environment and directs federal agencies to use a systematic interdisciplinary approach that ensures the integrated use of natural and social sciences and the design arts in planning and decision making affecting the human environment. The Act also establishes the Council on Environmental Quality.

RESOURCE CONSERVATION AND RECOVERY ACT OF 1976 (RCRA) (P.L. 94-580)

Identification and Listing of Hazardous Waste -40 CFR 261. Standards Applicable to Generators of Hazardous Waste-40 CFR 262.

The objectives of RCRA are to promote the protection of health and the environment and to conserve valuable material and energy resources. The first serious federal attempt to address the problems of solid waste and hazardous waste management began with passage of RCRA.

Subtitle C of RCRA establishes a hazardous waste program designed to regulate all areas of hazardous waste management from generation to disposal. States can assume authority for implementation of a hazardous waste program (40 CFR 271), and to date only a few have not acquired this authority. State programs must be at least equivalent to the federal program and many are more stringent.

SAFE DRINKING WATER ACT OF 1974 (P.L. 93-523), AS AMENDED BY THE SAFE DRINKING WATER ACT AMENDMENTS OF 1986

National Primary Drinking Water Regulations-40 CFR 141.
National Interim Primary Drinking Water Regulations Implementation-40 CFR 142.
National Secondary Drinking Water Regulations-40 CFR 143.

The Safe Drinking Water Act provides for the safety of drinking water supplies throughout the United States by establishing National standards of which the States are responsible for enforcing.

The Act provides for the establishment of primary regulations for the protection of the public health and secondary regulations relating to the taste, odor, and appearance of drinking water. Primary drinking water regulations, by definition, include either a maximum contaminant level (MCL) or, when a MCL is not economically or technologically feasible, a prescribed treatment technique which would prevent adverse health effects to humans. An MCL is the permissible level of a contaminant in water that is delivered to any user of a public water system. Primary and secondary drinking water regulations are stated in 40 CFR 141 and 143, respectively.

STATE OF NEVADA ENACTMENTS

BUREAU OF AIR QUALITY

Permit to Construct

The Nevada Division of Environmental Protection, Bureau of Air Quality, within the Department of Conservation and Natural Resources, has responsibility for issuance of air quality permits to construct. The purpose of those permits is to ensure, through enforceable permit conditions, that adequate air pollution control equipment is used in industrial processes to protect the ambient air quality standards and public health and safety, prevent injury to plant and animal life, prevent damage to property, and preserve visual, scenic, aesthetic, and historic values within the state.

Nevada Revised Statutes 445.401 through 445.601 embody the powers and duties of the State Environmental Commission (SEC) and the Department of Conservation and Natural Resources as they pertain to air quality. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Department is responsible for implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance. The regulations applicable to sources of air pollution in the State of Nevada are contained in Nevada Administrative Code 445.430 through 445.846.

BUREAU OF AIR QUALITY

Operating Permit

The Nevada Division of Environmental Protection, Bureau of Air Quality, within the Department of Conservation and Natural Resources, has responsibility for issuance of air quality operating permits. The purpose of these permits is to reaffirm, through testing, inspection, and/or monitoring, that the initial determination of compliance relied on for issuance of the permit to construct is valid. This is accomplished through the use of enforceable permit conditions and orders to achieve the overall goals of protecting public health and welfare, preventing damage to plant and animal life and property, and preserving visual, scenic, aesthetic and historic values within the state.

Nevada Revised Statues 445.401 through 445.601 embody the powers and duties of the State Environmental Commission (SEC) and the Department of Conservation and Natural Resources as they pertain to air quality. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Department is responsible for implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance. The regulations applicable to sources of air pollution in the State of Nevada are contained in Nevada Administrative Code 445.430 through 445.846.

BUREAU OF WATER PERMITS AND COMPLIANCE

Nevada State Groundwater Permit

The Nevada Division of Environmental Protection, Bureau of Water Permits and Com-pliance, within the Department of Conservation and Natural Resources, has the responsibility for issuance of groundwater permits under the authority of Nevada Revised Statues, Chapter 445. The purpose of these permits is to prevent pollution of groundwater and to protect the environment.

Nevada Revised Statues 445.131 through 445.354 embody the powers and duties of the State Environmental Commission (SEC) and the Division of Environmental Protection as they pertain to water pollution control. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Division is responsible for implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance when needed. The regulations applicable to control of water pollution in the State of Nevada are contained in Nevada Administrative Code 445.070 through 445.241.

BUREAU OF WATER PERMITS AND COMPLIANCE

National Pollutant Discharge Elimination System (NPDES) Permit

The Nevada Division of Environmental Protection, Bureau of Water Permits and Compliance, within the Department of Conservation and Natural Resources, has the responsibility for issuance of NPDES permits. The purpose of these permits is to regulate discharge into "Waters of the U.S." to prevent water pollution, protect the environment, and to preserve the beneficial uses that have been designated for those waters.

Nevada Revised Statutes 445.131 through 445.354 embody the powers and duties of the State Environmental Commission (SEC) and the Division of Environmental Protection as they pertain to water pollution control. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Division is responsible for implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance when needed. The regulations applicable to control of water pollution in the State of Nevada are contained in Nevada Administrative Code 445.070 through 445.241.

BUREAU OF MINING REGULATION AND RECLAMATION

Nevada Water Pollution Control Permit

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation, within the Department of Conservation and Natural Resources, has responsibility for protecting waters of the State from discharges associated with mining activities. This responsibility is met through issuance of water pollution control permits and requirements for surface stabilization and reclamation upon closure.

Nevada Revised Statutes 445.131 through 445.354 embody the powers and duties of the State Environmental Commission (SEC) and the Division of Environmental Protection as they pertain to water pollution control. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Division is responsible for implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance when needed. The regulations applicable to control of water pollution in the State of Nevada are contained in Nevada Administrative Code 445.242 through 445.24388.

BUREAU OF MINING REGULATION AND RECLAMATION

Nevada Mining Reclamation Permit

The Nevada Division of Environmental Protection, Bureau of Mining Regulation and Reclamation, within the Department of Conservation and Natural Resources, has the responsibility for protecting the environment from adverse impacts associated with mining activities. This responsibility is met through issuance of exploration project and mining operation reclamation permits.

Nevada Revised Statutes 519A.010 through 519A.290 embody the powers and duties of the State Environmental Commission (SEC) and the Division of Environmental Protection as they pertain to mine reclamation. The SEC is statutorily granted the authority to adopt regulations necessary to accommodate the statement of purpose. The Division is responsible for the implementing and enforcing the SEC's regulations as well as providing recommendations and technical assistance when needed. The regulations applicable to mine reclamation in the State of Nevada are contained in Nevada Administrative Code Chapter 519A.

BUREAU OF WASTE MANAGEMENT

Hazardous Waste Management Permit

The Nevada Division of Environmental Protection, Waste Management Bureau, within the Department of Conservation and Natural Resources, is authorized to regulate hazardous wastes and to issue RCRA permits under authority of Nevada Revised Statutes (NRS) 459,400 through 45,600. The basis for regulation of hazardous wastes and issuance of these permits is to ensure proper management of hazardous wastes by generators, transporters, and treatment, storage, and disposal facilities.

APPENDIX A

SPRING AND SEEP INVENTORIES

The following tables are spring and seep inventories conducted in the vicinity of the South Operations Area. The study area utilized for these inventories is shown in Figure 3-8. This appendix is divided into three primary inventories, as follows:

(1) Newmont has been conducting semiannual surveys of 52 selected springs and seeps since fall 1990. Information collected during these monitoring episodes includes flow rate, water temperature, pH, specific conductance, and dissolved oxygen. The semiannual surveys generally are conducted in spring (April-May) during high-flow conditions and in late-fall or early winter (October-December) during low-flow conditions. The collected data are compiled in semiannual summary reports prepared by Newmont.

(2) The BLM conducted a spring and seep survey on public land in the general study area during the period of July through September 1982. Information collected includes location, elevation, and flow rate. Approximately 50 springs and seeps were identified during the 1982 survey. Also included with the BLM spring and seep data is a table of reservoirs, ponds, and water tanks in the study area that were inventoried by BLM in 1982. Each reservoir, pond, or water tank may by supplied by more than one spring or seep, or by a portion of a single spring. For example, the three water tanks listed are all supplied by one spring. All information pertaining to BLM's 1982 inventory is on file with the BLM office in Elko, Nevada.

(3) During May and June 1992, JBR Consultants Group conducted a comprehensive spring and seep inventory in the study area. JBR Consultants Group performed the work under contract to Newmont. The field work was done during the highest flow conditions of that year. Approximately 200 spring and seep sites were located during this inventory. Some smaller springs and seeps affecting less than 200 square feet were not inventoried unless part of a larger spring complex. Information collected at each site during the inventory included location, drainage basin, slope, flow rate, cultural features, vegetative community, and soil conditions. The data are contained in JBR Consultants Group report, "Newmont Inventory, Seep and Spring Report" prepared for Newmont Gold Company, Denver, Colorado; August 7, 1992.

APPENDIX A
Spring and Seep Inventory by Newmont in the South Operations Study Area

Location	Spring	Date	Temp	pH	Cond.	DO	Flow	Geology	Control	Elevation
35, 50- 13-NW,NW	1(D)	11/14/90 05/03/91 12/17/91 05/07/92	7.6 11 5 13.7	6.5 7.9 7.6 8.1	2600 3110 2200 261	-- 4.9 9.8 6.4	>1<5 >1<5 >1<5 <1	Dc	Fault	6150
35, 51- 30-SE,SE	2(D)	04/23/91 12/17/91 04/29/92	13 4 12.4	7.0 7.3 6.9	80 80 101	4.3 9.5 7.2	<1 <1 <1	Qal/Ts3	Contact	5550
35, 51- 32-NW,NW	3(D)	04/23/91 12/17/91 04/30/92	14 -- 14	6.8 -- 8.0	80 -- 224	4.2 -- 7.6	<1 Dry <1	Qal/Ts3	Contact	5440
35, 52- 28-NW,NE	4	11/14/90 04/22/91 11/21/91	9.4 10 8	8.0 8.0 7.9	709 600 420	-- 4.2 8.8	10 <1 <1	Tr3/Ts3	Contact	5530
35, 52- 35-NW,NW	5	11/14/90 04/22/91	9.7 16	8.4 8.5	397 480	-- 4.3	<1 <1	Tr3/Ts3	Contact	5400
35, 52- 26-SW,SW	6	11/14/90 04/22/91	11.5 15	8.2 8.7	413 150	-- 4.1	<1 <1	Tr3/Ts3	Contact	5400
35, 52- 26-SW,SW	7	11/14/90 04/22/91	11 11	9.3 7.8	373 300	-- 4.1	5 <1	Tr3/Ts3	Contact	5400
35, 52- 26-SE,SW	8	11/14/90 04/22/91	11 11	7.9 7.6	327 240	-- 4.1	5 <1	Tr3/Ts3	Contact	5400
35, 52- 26-SE,SW	9	11/14/90 04/22/91 11/06/91 04/28/92	12.2 14 11 14	7.5 8.8 8.0 7.2	289 320 797 309	-- 4.3 11 4.2	10 <1 <1 <1	Tr3/Ts3	Contact	5400 (Mud Springs)
35, 52- 27-NE,NE	10	11/14/90 04/22/91	9.6 11	7.1 7.7	1789 300	-- 4.2	5 <1	Tr3/Ts3	Contact	5450
35, 52- 27-NE,NE	11(D)	11/14/90 04/22/91	12 10	7.2 7.4	178 182	-- 4.1	5 <1	Tr3/Ts3	Contact	5400
35, 52- 27-NE,NE	12(D)	11/14/90 04/22/91	10.3 13	7.5 7.9	300 310	-- 4.4	<5 <1	Tr3/Ts3	Contact	5400
35, 52- 27-NE,NE	13(D)	11/14/90 04/22/91 11/06/91 04/28/92	10.9 14 15 26	7.4 8.5 7.5 7.7	259 200 196 300	-- 4.2 6.4 5.2	<5 <1 <1 9	Tr3/Ts3	Contact	5400
34, 51- 29-SW,SE	13(D)	11/02/90 04/23/91 12/18/91 05/05/92	5.5 11 3 16	8.6 8.2 8.3 8.1	-- 350 210 404	-- 4.2 11.8 9.0	50 34 22 13	Dc/Ts3	Contact	5560
34, 51- 30-SE,SE	15	11/02/90 04/23/91 05/05/92	4.0 10 24	8.4 8.5 7.8	-- 390 603	-- 4.8 4.4	10 5.5 3.2	Ts3	Fault	5800

APPENDIX A
Spring and Seep Inventory by Newmont in the South Operations Study Area

Location	Spring	Date	Temp	pH	Cond.	DO	Flow	Geology	Control	Elevation
34, 51- 33-NW,NW	16(D)	11/05/90	9.0	7.9	315	--	20	DC/Ts3	Fault	5540
		04/23/91	13	8.4	320	4.9	<1			
		05/05/92	21	8.9	367	5.6	<1			
33, 51- 9-NW,NW	17	11/05/90	12	5.5	255	--	50	Dc	Contact	5700
		04/24/91	12	8.2	290	4.1	56			
		11/01/91	10	7.7	298	6.7	1.8			
		05/04/92	17	7.5	442	8.2	16			
33, 51- 17-NW,NW	18	11/06/90	3.4	7.8	255	--	100	Ds	Contact	6600
		05/05/91	12	7.7	145	4.6	117			
		05/07/92	15	8.1	113	7.8	40			
33, 50- 1-SE,NE	19	11/06/90	16	9.3	110	--	--	Ds	Contact	6400
		04/24/91	16	9.7	95	4.9	<1			
		05/04/92	21	6.5	150	5.6	<1			
33, 51- 10-NE,NW	20	11/06/90	16	8.0	310	--	5	QTs	Contact	5550
		04/24/91	15	8.5	300	4.4	<1			
		05/04/92	17	7.2	479	5.0	<1			
33, 51- 10-SW,NW	21(D)	11/06/90	11	8.0	310	--	400	Dc/Ts3	Contact	5500
		05/05/91	11	8.2	380	4.6	148			
		12/13/91	7	8.6	275	9.9	112			
		05/07/92	20	8.1	129	6.4	106			
34, 53- 20-SW,SE	22	11/14/90	8.9	7.7	380	--	1	Ts3	--	5150
		05/23/91	10	7.6	350	4.5	<1			
		12/30/91	10	7.6	310	8.5	<1			
		04/29/92	16	7.8	391	6.8	<1			
34,53- 16-NW,NW	23(D)	11/14/90	15	7.3	247	--	3	Qal	Contact	5200
		05/04/91	15	7.3	215	4.6	3.2			
		12/30/91	13	7.6	180	7.0	3.2			
		04/29/92	16	7.3	262	7.2	2			
33, 53- 8-SW,NW	24(D)	11/13/90	--	7.8	1022	--	75	Ts3	Fault	5050
		05/04/91	63	7.4	1750	3.9	28			
		12/30/91	63	7.5	1425	3.6	24			
		05/08/92	62	7.1	600	2.8	16			
33, 53- 4-NW,SE	25(D)	11/13/90	12	8.0	284	--	15	Ts3	--	5100
		05/23/91	15	7.9	190	4.2	4.3			
33, 51- 28-SE,NW	26	05/23/91	18	7.0	75	4.6	<1	Tr3/Ov	Fault	6120
		01/04/92	10	7.2	125	8.8	<1			
32, 50- 14-NW,NE	27(D)	05/19/91	9	7.6	800	4.3	25	Tal	--	5720 (Primeaux Spring)
32, 50- 14-SW,NW	28(D)	11/15/90	10	7.3	500	--	50	Tal	--	5800 (Fish Pond Spring)
		05/07/91	16	8.5	1000	4.8	15			
		01/04/92	9	8.5	850	9.4	13			
		05/08/92	16	7.9	145	7.6	20			

APPENDIX A
Spring and Seep Inventory by Newmont in the South Operations Study Area

Location	Spring	Date	Temp	pH	Cond.	DO	Flow	Geology	Control	Elevation
32, 50- 13-NW,NW	29(D)	11/15/90 05/23/91 0/04/92	5.6 10 13	7.0 7.4 7.5	401 350 390	-- 5.0 7.8	< 1 < 1 < 1	Tal	--	5880 (Emigrant Spring)
32, 51- 17-NE,NE	30	--	--	--	--	--	--	Ov	--	6000
33, 51- 15-SW,NW	31(D)	11/07/90 05/20/91 05/12/92	11 11 21	7.9 7.9 6.8	448 360 784	-- 4.0 2.8	1 2.1 < 1	Dc/Ts3	--	5950
33, 51- 21-NW,NE	32	11/07/90 05/20/91 05/12/92	5.0 8 21	7.5 7.3 8.3	470 410 675	-- 2.9 5.8	5 < 1 1	Ts3	--	5900
33, 51- 21-SE,NE	33	11/12/90 05/23/91	7.8 9	7.1 7.1	485 110	-- 4.2	< 1 2.1	Dc	--	6050
33, 51- 21-SW,SE	34(D)	11/12/90 05/07/91 12/04/91 05/12/92	10.6 16 6.5 13.2	8.1 8.6 7.3 7.5	489 380 370 133	-- 6.0 8.2 2.0	25 > 1 < 5 < 1 0.4	Dc/Ts3	Contact	6050 (Cherry Spring)
33, 51- 33-NE,NW	35	05/23/91	20	7.4	140	4.4	< 1	Tr3	--	5800
33, 51- 33-NE,NW	36	05/23/91	13.3	7.5	110	4.8	< 1	Tr3	--	6050
33, 51- 33-SE,NW	37	11/12/90 05/23/91	13.3 19	7.7 7.8	349 160	-- 4.2	5 < 1	Tr3	--	6040
33, 51- 33-SW,NE	36	05/23/91	24	9.4	195	4.2	2	Tr3	--	6020
33, 51- 33-NW,SE	39(D)	05/23/91	20	7.4	150	7.4	< 1	Ts3	--	6040
33, 52- 33-SW,SE	40	11/15/90 05/19/91 12/30/91 04/29/92	21 53 60 24	7.1 7.0 7.2 7.6	592 1075 1020 827	-- 3.6 2.4 13.0	5 3 3.3 1.1	Ts3	Fault	4960
32, 51- 11-NE,SW	41	05/19/91 05/08/92	12 20.3	8.0 7.5	142 126	4.9 0.4	< 1 < 1	Tr3	--	5450
35, 52- 21-SW,NE	42(D)	05/31/91 10/31/91 09/09/92	15 14 21	7.0 7.8 7.1	230 196 317	4.2 8.3 5.2	12 16.5 12	Ts3	Fault	5600
33, 52- 33-SW,SE	43	05/03/91 12/30/91 06/02/92	67 68 67	7.2 7.6 7.0	1200 945 723	3.5 2.4 --	> 400 -- --	Ts3	Fault	4900 (Carlin Hot Spring)
33, 50- 33-SE,SE	44(D)	05/09/92	--	9.4	153	9.6	< 1	Tal	--	5800
33, 50- 15-SW,SW	45	11/26/91 05/06/92	8 21	7.8 8.3	246 92	8.8 7.0	55 38	Ov	Contact	5800

APPENDIX A
Spring and Seep Inventory by Newmont in the South Operations Study Area

Location	Spring	Date	Temp	pH	Cond.	DO	Flow	Geology	Control	Elevation
33, 50-10-SE,SE	46	--	--	--	--	--	--	--	--	6400
33, 50-10-SE,SW	47	--	18	--	--	--	--	--	--	6400
34, 50-32-SE,NE	48	05/06/92	18	8.1	215	7.6	5.29	--	--	5200
34, 50-29-SE,SE	49(D)	11/26/91 05/06/92	18	8.1	157	7.6	26.0	--	--	5100
34, 50-26-SW,NW	50	11/26/91 05/06/92	10 14	8.4 8.4	415 122	10.4 7.2	13 9	--	Contact	5360
34, 50-21-SE,SE	51(D)	05/06/92	18	7.5	256	9.4	1.1	--	--	5300
32, 52-5-SE,SW	52	05/06/92	Warm	--	--	--	10-15	--	--	5000 (Warm Spring)

Parameters

Temp: degrees Celsius
pH: standard units
Cond: specific conductance (umhos)
DO: dissolved oxygen (mg/L)
Flow: gallons per minute
Elevation: feet above mean sea level
Location: township north, range east - section - ¼ section of ¼ section
(D): developed spring or seep

Geology

Qal - alluvium
QTs - sedimentary rocks
Tal - andesite flows, breccias, and flows of intermediate composition
Ts3 - tuffaceous sedimentary rocks
Tr3 - rhyolitic flows and shallow intrusive rocks
Dc - siltstone, sandstone, limestone
Ds - Slaven chert
Ov - Vinini Formation: shale, chert, siltstone, limestone

See Figure 3-8 for spring and seep locations.

Source: Hovda 1990; Skidmore 1991, 1992; Gilbert et al. 1992.

APPENDIX A
Spring and Seep Inventory By BLM in the South Operations Study Area
July, August, and September 1982

Location[1]	Flow Rate[2] (gpm)	Elevation (feet)	Remarks[3]
33,50-02-NE,NE,NE	5	5800	
33,50-02-NE,NE,NE	Seep	5800	
33,50-02-NW,NW,NE	1.5	5700	
33,50-02-NE,SE,NE	Seep	6400	
33,50-02-SE,SE,NE	Seep	6200	
33,50-02-NE,NE,NW	0.5	5700	
33,50-02-SE,NE,NW	0.5	5700	
33,50-02-SE,NE,NW	0.3	5660	
33,50-02-SE,NE,NW	0.1	5880	
33,50-02-SW,SW,SE	0.1	6060	
33,50-02-SE,SW,SE	0.5	6040	
33,50-08-NE,SE,SE	0.1	6200	
33,50-08-SW,SE,SE	2	6120	
33,50-36-SW,NW,NE	Seep	5800	
33,50-36-SW,SE,NE	Seep	5800	
33,51-10-SW,NE,NW	Seep	5600	Newmont Spring No. 20; PWR
33,51-10-SE,SW,NW	5	5600	Newmont Spring No. 20; PWR
33,51-10-NE,SW,NW	Seep	5600	Newmont Spring No. 21; PWR
33,51-10-NE,NW,SW	2	5660	PWR
33,51-10-NW,NW,SW	Seep	5660	
33,51-32-SE,NW	Seep	5560	
33,53-04-NW,SE	NR	NR	Newmont Spring No. 25; PWR
33,53-08-NW	Numerous	NR	Newmont Spring No. 24; Hot Springs
34,50-26-SW,SW,NE	Intermittent	5700	
34,50-26-SE,NE,NW	1	5560	
34,50-26-NW,SW,NW	0.5	5360	Newmont Spring No. 50
34,50-26-SW,NW,SE	1	5700	
34,50-26-SW,SE,SE	0.5	5700	
34,50-26-SW,SE,SE	0.5	5800	
34,50-32-SW,SE,NE	2	5160	Newmont Spring No. 48

APPENDIX A
Spring and Seep Inventory By BLM in the South Operations Study Area
July, August, and September 1982

Location[1]	Flow Rate[2] (gpm)	Elevation (feet)	Remarks[3]
34,50-34-NW,NW,NE	0.1	5300	
34,50-34-SW,NW,NE	0.1	5330	
34,50-36-SW,NW,NW	0.5	6100	
35,51-06-SE,NE	2 springs; flow NR	NR	PWR
35,51-06-SW,NE	NR	NR	PWR
35,51-18-NW,NE	NR	NR	
35,51-18-SE,SE	NR	NR	
35,51-30-SW,NE,SE	Dry	5600	
35,51-30-SW,SE,SE	1.5	5580	Trough; Newmont Spring No. 2
35,51-32-NE,SW,NW	1	5400	Newmont Spring No. 3
35,51-32-NE,SW,NW	1	5400	Newmont Spring No. 3
35,51-32-NE,SW,NW	Dry	5300	Newmont Spring No. 3
35,52-02-NW,NE,NW	0.25	6380	
35,52-10-SE,NW,SW	0.5	NR	
35,52-12-SE,NE,NE	1.5	NR	
35,52-12-SW,NW,NE	0.5	6500	
35,52-12-NW,NW,SE	Intermittent	NR	
35,52-16-SE,SW,SE	Intermittent	5640	
35,52-24-SW,SE,NW	0.75	NR	Yellow Spring
35,52-26-SW,SE,SW	Intermittent	5680	Newmont Spring No. 9

[1] Location: township north, range east - section - ¼ section of ¼ section
[2] gpm = gallons per minute; NR = no record.
[3] PWR = public water reserve (for BLM).

Source: BLM 1992b.

APPENDIX A
Reservoir, Pond, and Water Tank Inventory by BLM in the South Operations Area
July, August, and September 1982

Location[1]	Flow Rate[2] (gpm)	Elevation (feet)	Type	Remarks
33,51-10-NW,NW,NW	Intermittent	5680	Reservoir	
33,51-10-SE,NW,NW	Intermittent	5580	Reservoir	
33,51-10-SE,NW,NW	Intermittent	5620	Reservoir	
33,51-10-NW,SE,NW	Perennial	5600	Reservoir	
33,51-12-SW,SE,NW	Intermittent	5300	Tank	Part of the Marys Mountain Pipeline; water supplied by a spring in Section 15, T33N, R51E
33,51-14-NW,NW,NW	Intermittent	5580	Tank	Same as above
33,52-06-SE,SW,NW	Intermittent	5160	Tank	Same as above
34,50-22-NW,NW,SW	Intermittent	5320	Pond	Pond No. 4
34,50-28-SW,NW,SE	4	5250	Reservoir	Badger Hole Reservoir
34,52-17-SE,SE,SW	Intermittent	5500	Reservoir	Dry Reservoir
34,52-28-SW,SE,NE	Intermittent	5200	Pond	Hadley Pond
35,50-20-SW,NW,NW	Perennial	4950	Reservoir	
35,50-36-SE,NE,NE	Intermittent	5740	Reservoir	
35,51-20-SE,NW,SE	Perennial	5580	Reservoir	
35,51-30-SW,SE,SE	1.5	5580	Reservoir	
35,51-32-NE,SW,NW	1	5400	Reservoir	
35,51-32-NE,SW,NW	1	5400	Reservoir	
35,51-32-SE,SE,NW	0.12	5320	Reservoir	
35,51-32-SE,SE,NW	0.32	5320	Reservoir	

[1] Location: township north, range east - section - ¼ section of ¼ section.
[2] gpm = gallons per minute.

Note: Specific water sources for the reservoirs and ponds are not known; these features would not be affected by mine dewatering unless the sources that supply water to them are reduced or dry up.

Source: BLM 1992b.

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
31,50-02-NE,SW,NE	10	Springs in small channel; Humboldt River drainage
31,50-02-SE,SW,NE	30-40	"Rattle Snake Spring"; spring in fenced enclosure flowing to man-made pond and on to creek; Humboldt River drainage
32,50-02-NE,SW	1-2	Spring in narrow drainage of Primeaux Creek
32,50-09-NE,SE	< 1	Developed spring in drainage flowing to Bob Creek
32,50-12-SW,SE	< 1	Spring between freeway and hillside; Emigrant Creek drainage
32,50-13-NE,NW	< 1	"Emigrant Spring"; at base of hill; pipe tapping into rocks with flow onto wet meadow; Emigrant Creek drainage; Newmont Spring #29
32,50-14-SW,NW,NE	0-40	"Highway Spring"; nearly dry spring between freeway and turnout; Emigrant Creek drainage
32,50-14-SE,NW,NE	< 1	"Primeaux Springs"; springs above wet meadow; Emigrant Creek drainage; Newmont Spring #27
32,50-14-NW,NE,NW	Unknown	Spring beside freeway at base of hill; head box diverts flow; Emigrant Creek drainage
32,50-14-SE,NW	1	"Fish Pond Spring"; spring adjacent to freeway; ponded under willows; Emigrant Creek drainage; Newmont Spring #28
32,50-23-SW,NE	4-5	Spring at base of hill flowing into man-made pond; Stone Wall Creek drainage
32,50-23-SW,SE	15-20	Broad wet meadow above spring; Stone Wall Canyon Creek
32,50-24-NW,NE	Dry	Dry grassy area in creek channel; Stone Wall Canyon Creek
32,50-24-SE,NE	< 1	"Fuzzy Spring"; hillside spring flowing to unnamed channel
32,50-24-SE,NW	Dry	Sedge-covered wide spot in dry unnamed channel
32,51-04-NE,SE	0-1	Spring on floodplain beside Marys Creek
32,51-11-NE,SW	< 1	Spring water ponded in channel with large rocks; unnamed channel tributary to Maggie Creek; Newmont Spring #41
32,51-17-NE,NE	Dry	Disturbed spring at underground cable crossing with stock pond; Humboldt River drainage; Newmont Spring #30
32,51-17-SE,SE	< 1	Developed spring with remnant wet meadow and stock trough below; Maggie Creek drainage
32,51-28-NE,SW	< 1	2 springs on hillside above Buck Rake Jack Creek
32,51-32-SW,NE	< 1	"Willy Billy Spring"; two seeps flowing into unnamed creek flowing to Buck Rake Jack Creek
32,51-32-SW,SW	< 1	Dried up spring piped to trough and unnamed creek flowing to Buck Rake Jack Creek
32,51-33-NW,SW	2-3	Spring at base of hill; Buck Rake Jack Creek drainage

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
32,51-34-SW,NE	20-30	Spring emanating from unnamed creek bed to Humboldt River
32,51-35-SE,NE	Unknown	Developed spring on hillside; water piped via head box and in fenced enclosure; Humboldt River drainage
32,51-35-NW,SW	Dry	Seep above unnamed creek flowing to Humboldt River
32,51-35-SE,SW	20-30	2 springs in head boxes in fenced enclosure; Humboldt River drainage
32,52-05-SE,SW	10-15	"Warm Spring"; spring-fed pond behind railroad track; Humboldt River drainage; Newmont Spring #52
33,50-01-SW,NW	5-10	Series of springs at base of hill adjacent to unnamed creek flowing to Welches Creek
33,50-01-SE,NE,SE	<1	Spring on hillside dry at bottom; James Creek drainage; Newmont Spring #19
33,50-02-NE,NE,NE	<1	2 seeps at bottom of hillside; Welches Creek drainage
33,50-02-NW,NW,NE	20	Spring emanating from creek bed; Welches Creek drainage
33,50-02-NE,NW	1	Spring at base of hill near unnamed creek to Welches Creek
33,50-03-NW	10-15	Spring on side of unnamed drainage to Welches Creek
33,50-09-SW,SE,SW	5-10	2 hillside springs; Mack Creek drainage
33,50-10-NE,SE,NE	<1	Spring along side of unnamed channel to Mack Creek
33,50-10-SW,SE,SW	<1	Hillside seep above unnamed drainage to Mack Creek; Newmont Spring #47
33,50-10-SW,SW,SE	Dry	Dry historic hillside seep; Mack Creek drainage
33,50-10-SE,SE,SE	<1	Hillside seep; Mack Creek drainage; Newmont Spring #46
33,50-11-NE,NE	10-15	Spring above aspen grove; Welches Creek drainage
33,50-12-NE,NE,NE	<1	Hillside spring; James Creek drainage
33,50-14-NW,NW,NW	<1	Hillside seep beneath rock outcrop; Mack Creek drainage
33,50-14-NE,SW,NW	10	Spring beside Mack Creek
33,50-14-NW,SW,NW	<1	Hillside seep; Mack Creek drainage
33,50-15-NE,NE,NE	<1	Hillside seep; Mack Creek drainage
33,50-15-NW,NE,NE	<1	Hillside spring above drainage to Mack Creek
33,50-15-SW,NE,NE	<1	Hillside seep; Mack Creek drainage
33,50-15-SW,NE,NE	<1	1 hillside seep and 2 seeps in channel; Mack Creek drainage
33,50-15-SW,SW,SW	<1	4 springs clustered beside Mack Creek; Newmont Spring #45
33,50-16-NW,NE,NE	5-10	Hillside spring; Mack Creek drainage
33,50-16-NE,NW,NE	15-20	Hillside spring; Mack Creek drainage

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
33,50-17-NE,NE	< 1	Hillside seep; Mack Creek drainage
33,50-23-NW,NE,SW	< 1	Hillside spring; Mack Creek drainage
33,50-23-NW,SE	< 1	Spring at head of Mack Creek
33,50-23-SW,SE	< 1	Spring above depression on side of hill; stock pond at base of spring; Marys Creek drainage
33,50-26-NW	< 1	Spring under broad wet meadow; Bob Creek drainage
33,50-26-SE,SW	< 1	Spring in narrow unnamed drainage to Bob Creek
33,50-26-SE,SW	< 1	Spring in narrow unnamed drainage to Bob Creek
33,50-27-SW	Dry	Dry seep in narrow unnamed channel to Bob Creek
33,50-27-NE,SE	< 1	2 springs at head of broad wet meadow; Bob Creek drainage
33,50-27-NW,SE	1-3	3 springs in narrow unnamed drainage to Bob Creek
33,50-33-SE,SE	< 1	Spring in drainage above dry reservoir; Bob Creek drainage; Newmont Spring #44
33,50-34-SW,NW	< 1	Seep near Bob Creek
33,50-34-NW,SW	5-10	Spring in Bob Creek bed
33,51-08-SW,SW	1-2	Spring in James Creek drainage
33,51-09-NE,NE	1-2	Spring in James Creek drainage
33,51-09-NW	2-3	Spring in James Creek bed; Newmont Spring #17
33,51-09-SW,SE	< 1	Spring at top of aspen grove; James Creek drainage
33,51-10-NE,NW	2-3	Altered spring on top of hill; James Creek drainage; Newmont Spring #20
33,51-10-SW,NW	30-40	3 springs at base of hill flowing to James Creek; Newmont Spring #21
33,51-10-SE,NW	< 1	Hillside spring; James Creek drainage
33,51-10-NW,SW	< 1	Series of springs at confluence of drainage and James Creek
33,51-15-SW,SW,NW	1-2	Spring head box; water piped to trough; Maggie Creek drainage; Newmont Spring #31
33,51-17-NW,NW	20	Spring at willow grove; 2nd in oxbow; James Creek drainage; Newmont Spring #18
33,51-21-SW,SE	1 +	"Cherry Spring"; artesian spring; 2 ponds and wet meadow; water mostly piped to stock water troughs miles below; Maggie Creek drainage; Newmont Spring #34
33,51-28-SE,NW	< 1	Seep at intersection of 2 drainages; Maggie Creek drainage; Newmont Spring #26
33,51-32-NW,NE	< 1	Small seep near top of narrow unnamed drainage to Marys Creek

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
33,51-32-SW,NE	< 1	Spring in narrow unnamed channel to Marys Creek
33,51-32-SW,SE,NE	< 1	Hillside seep; Marys Creek drainage
33,51-33-SW,SW,NE	2-3	2 hillside springs flowing to breached pond; Marys Creek drainage; Newmont Spring #38
33,51-33-SE,NE,NW	Dry	Remnant seep above small patch of rushes in unnamed drainage to Marys Creek; Newmont Spring #35
33,51-33-NE,SE,NW	< 1	Hillside seep; Marys Creek drainage; Newmont Spring #37
33,51-33-NW,SW	< 1	Hillside spring; Marys Creek drainage; Newmont Spring #36
33,51-33-SW,SW,SW	20-30	Series of springs in creek and main spring at head emanating through rocks; Marys Creek drainage
33,51-33-SE,SW,SW	4-5	Spring on slope flowing into reservoir; Marys Creek drainage
33,51-33-SE,SW	< 1	Small spring flowing to breached pond; Marys Creek drainage
33,51-33-SE,NW	< 1	Seep drainage to artificial pond; Marys Creek drainage; Newmont Spring #39
33,52-28-SW,SE	1-2 cfs	"Carlin Cold Springs"; pond fed by underwater springs; modified for town of Carlin use; Marys Creek drainage
33,52-33-SW,SE	< 1	Small spring in meadow on south bend of Humboldt River; Newmont Spring #40
33,53-04-NW,SE	1	"Lower Dry Susie Spring"; Small spring in fenced area; Dry Susie Creek drainage; Newmont Spring #25
33,53-08-NW	20-30	"Hot Springs"; several springs flowing from side of hill; Susie Creek drainage; Newmont Spring #24
34,50-21-SE,SE	1	2 man-made ponds by piped spring into water trough and overflowing into ponds; Welches Creek drainage; Newmont Spring #51
34,50-26-NE,NW	Dry	Dry seep in deep unnamed drainage to Welches Creek
34,50-26-SE,NW	20	Spring in narrow canyon bottom; Welches Creek drainage; Newmont Spring #50
34,50-27-SE,NE	20-30	Spring in narrow canyon bottom; Welches Creek drainage
34,50-29-SE,SE	10	Incised creek with lush vegetation; Welches Creek drainage; Newmont Spring #49
34,50-32-SE,NE	1-2	Deeply incised spring; Boulder Valley drainage; Newmont Spring #48
34,50-33-SW,SW	1	Narrow unnamed channel in Boulder Valley drainage
34,50-34-NW,NE	10-15	Several seeps alongside unnamed drainage to Welches Creek
34,50-35-SE,NE	3-5	Spring in unnamed creek bed tributary to Welches Creek
34,50-35-SW,SE	< 1	Small seep at base of hill about 100 ft from unnamed drainage to Welches Creek
34,50-36-NW,NW	3-5	Spring on unnamed creek bed tributary to Welches Creek

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
34,51-10-NW,SE	20-30	Series of springs in broad floodplain; feeding large wet meadow; Lynn Creek drainage
34,51-29-SW,SW	10	2 seeps alongside unnamed drainage to Maggie Creek
34,51-29-SE,SW	<1	2 seeps on hillside; 1 ponded; Maggie Creek drainage
34,51-29-SW,SE	20	Series of springs flowing to 3 man-made ponds; Maggie Creek drainage; Newmont Spring #14
34,51-30-SE,SW	<1	Series of springs on hillside piped and flowing to stock pond; Welches Canyon drainage
34,51-30-SE,SE	5-10	2 springs on hillside; 1 flowing to pond; Maggie Creek drainage; Newmont Spring #15
34,51-31-SW,SW	<1	Hillside seep; Welches Creek drainage
34,51-33-NW,NW	1	Hillside seep; Soap Creek drainage; Newmont Spring #16
34,52-06-SW,NW	1	Spring in unnamed drainage to Maggie Creek
34,52-06-NW,SW	<1	5 springs grouped together on hillside; Maggie Creek drainage
34,53-16-NW,NW	2	"Huntsman Ranch Spring"; spring flowing into 2 metal tanks; Susie Creek drainage; Newmont Spring #23
34,53-20-SE	3-4	Spring in narrow draw; Susie Creek drainage; Newmont Spring #22
35,50-11-SW,NE	<1	Spring in narrow canyon bottom; Rodeo Creek drainage
35,50-11-SE,SE	Dry	Dry spring in narrow canyon above dry reservoir; Sheep Creek drainage; Newmont Spring #1
35,50-12-NW,NE	1	Spring in narrow canyon channel bottom; Lynn Creek drainage
35,51-06-NE,SW,NE	Dry	Former wet meadow area; Jack Creek drainage
35,51-06-SE,SW,NE	<1	Spring complex in confluence of two drainages; Jack Creek drainage
35,51-07-SE,SE	<1	Spring in narrow channel; Lynn Creek drainage
35,51-10-NE	10	Broad springy area in creek bottom; Little Jack Creek drainage
35,51-13-NW,SW	<1	Spring in incised channel; Jack Creek drainage
35,51-13-SW,SW	4-5	Broad wet meadow in fenced pasture; Jack Creek drainage
35,51-18-NW,NE	<1	Seep near top of hill; Simon Creek drainage
35,51-18-NW,SE	<1	Spring in narrow channel and canyon; Simon Creek drainage
35,51-18-SE,SE	<1	Spring in narrow channel; Simon Creek drainage
35,51-30-SE,SE	1	Seep at head of drainage; fenced spring with stock water trough and pond at base; Simon Creek drainage; Newmont Spring #2
35,51-32-NW,NW	<1	2 enclosed springs and pond; Simon Creek drainage; Newmont Spring #3

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
35,52-01-NE,NE,NE	<1	Springs alongside unnamed tributary to Fish Creek
35,52-01-NW,NE,NE	<1	1 seep in drainage; 1 seep on hillside; Fish Creek drainage
35,52-01-SE,NE,NE	<1	Hillside seep above unnamed drainage to Fish Creek
35,52-01-SW,NW,NW	<1	Hillside seep; Fish Creek drainage
35,52-01-SE,NW,NW	<1	Series of springs on hillside and in 2 drainages; Fish Creek drainage
35,52-01-SE,NW	<1	Hillside seep; Fish Creek drainage
35,52-01-NE,SW	Dry	Dry seep above perennial creek; Fish Creek drainage
35,52-02-SW,NE,NE	3-10	Series of springs in unnamed drainage to Fish Creek
35,52-02-SE,NE,NE	1	Spring on hillside flowing to stock pond across road; Fish Creek drainage
35,52-02-NE,NW,NE	<1	Seep at base of hill; Fish Creek drainage
35,52-05-NW	10	Group of interconnected springs; Maggie Creek drainage
35,52-10-NE,NW	<1	Hillside seep; Fish Creek drainage
35,52-10-NW,SW	<1	"Mine Spring"; pipe and trough from spring are damaged; broken fence around spring; Cottonwood Creek drainage
35,52-12-SW,NE,NE	3-4	Spring in narrow unnamed drainage above Fish Creek
35,52-12-SE,NE,NE	<1	2 seeps in narrow unnamed drainage above Fish Creek
35,52-12-NW,NE	<1	Hillside spring; Fish Creek drainage
35,52-12-NW,SE	<1	Hillside spring above saddle; Fish Creek drainage
35,52-21-NE,SE	5	Artesian spring flowing to stock pond; Cottonwood Creek drainage; Newmont Spring #42
35,52-24-NW,NE,SW	<1	"Yellow Spring" in broad shallow unnamed drainage to Dry Gulch
35,52-26-SW,SE,SW	<1	Spring in shallow, rocky, broad swale; Dry Gulch drainage; Newmont Spring #8
35,52-26-SE,SE,SW	1	"Mud Springs"; cluster of springs in deep incised trenches; Dry Gulch drainage; Newmont Springs #6, #7, and #9
35,52-27-NE,NE,NE	<1	2 small springs inside fenced cabin site; Cottonwood Creek; Newmont Springs #11 and #12
35,52-27-NW,NE,NE	1	Spring starting in narrow draw; Cottonwood Creek drainage; Newmont Spring #13
35,52-27-SW,NE,NE	1-2	Hillside spring flowing across road to Cottonwood Creek; Newmont Spring #10
35,52-28-NW,NE	<1	Wet meadow with nearly dry spring; Cottonwood Creek; Newmont Spring #4
35,52-35-NE,NW	Dry	Dry seep in shallow drainage; Dry Gulch drainage; Newmont Spring #5
35,53-06-NW,NW	<1	Unvegetated spring in narrow drainage; Fish Creek drainage

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
36,50-27-SE,NE	2-3	Several seeps in narrow unnamed drainage to Cottonwood Creek
36,50-27-NE,SE	0-5	Several seeps in narrow unnamed drainage to Cottonwood Creek
36,50-34-SW,NW,NE	0-4	Several seeps in narrow unnamed drainage to Cottonwood Creek
36,50-34-SE,NW,NE	<1	Hillside seep above Cottonwood Creek
36,51-20-SE,SE	<1	Complex of springs on hillside; Little Jack Creek drainage
36,51-32-SW,NE	<1	Seep on rounded side of hill; Indian Creek drainage
36,51-30-SE,NE	2-3	Spring in narrow draw; Indian Creek drainage
36,51-30-NE,SW	2-3	Small spring at base of hill near deep channel; Indian Creek drainage
36,51-30-SW,SE	<1	Seep at base of hill; Indian Creek drainage
36,51-31-SE,SE	1-2	Spring in narrow channel; Indian Creek drainage
36,51-32-SW,NE	2-3	Spring beside grassy meadow; 2 seeps on hillside; Indian Creek drainage
36,51-32-SW,NW	3-5	Spring in narrow channel; Cottonwood Creek (west) drainage
36,51-35-NE,SW	<1	"Chicken Spring"; large stock reservoir surrounded by wet meadows; Maggie Creek drainage
36,51-36-SE,SE,NW	1	Spring beginning in narrow creek; Coyote Creek drainage
36,51-36-SE,NE,SW	2-3	Springs seeping in several locations in large wet meadow on either side of Coyote Creek
36,52-19-SW,SW	20-30	"Y"-shaped spring area in broad alluvial fans; Maggie Creek drainage
36,52-27-SE,NE	Unknown	Flooded stock pond; spring nearly flooded by backed-up water; 10-20 gpm flowing from Red House Creek
36,52-31-SW,NW	1	Small spring in narrow, shallow unnamed drainage to Maggie Creek
36,52-32-NE	0-5	Spring in creek bed; Fish Creek drainage
36,52-35-NE,NW	3-4	Cluster of springs & seeps flowing to man-made stock pond; Maggie Creek drainage
36,52-35-NE,SE	2-3	Cluster of hillside springs; Fish Creek drainage
36,52-35-NE,SW,SE	<1	Seep in drainage; Fish Creek drainage
36,52-35-NW,SW,SE	0-1	Seep below unnamed drainage to Fish Creek
36,52-35-SE,SW,SE	1-2	Seep along side and in creek; Fish Creek drainage
36,52-35-SE,SE	<1	Hillside seep; Fish Creek drainage
36,52-36-SE,NE,SE	<1	Spring adjacent to creek at base of hill; Fish Creek drainage
36,52-36-NW,SE,SE	<1	2 seeps - 1 in nearby drainage and 1 on hillside; Fish Creek drainage

APPENDIX A
Spring and Seep Inventory by JBR Consultants Group in the South Operations Study Area, May 1992

Location[1]	Flow Rate[2] (gpm)	Remarks
36,52-36-SW,SE,SE	2	Cluster of hillside seeps high above unnamed drainage to Fish Creek
36,52-36-SE,SE,SE	<1	Hillside seeps; Fish Creek drainage
36,52-36-SE,SE,SE	<1	Hillside seep; Fish Creek drainage
36,53-31-SE,SE,NW	1	Hillside spring leading to stock pond; Fish Creek drainage
36,53-31-NE,NE,SW	<1	2 hillide seeps; Fish Creek drainage
36,53-31-NW,SW	<1	Spring in narrow channel with dry seep in opposite channel "Y"; Fish Creek drainage
36,53-31-NE,SW,SW	<1	Hillside seep in slight depression; Fish Creek drainage
36,53-31-SE,SW,SW	<1	Hillside seep in gentle swale; Fish Creek drainage

Note: The Carlin Hot Spring (Newmont Spring #43) and Newmont Springs #32 and #33 are not included on this list.

[1] Location: township north, range east - section - ¼ section of ¼ section.
[2] gpm = gallons per minute.

Source: JBR 1992b.

APPENDIX B

VEGETATION DATA

This appendix is a tabulation of vegetative cover data for the study area and vegetation species for the vegetation and riparian/wetlands study areas (see Figure 3-1). Vegetative data were collected by JBR Consultants Group during the summer of 1992 using 100-point line transects to determine cover and frequency of vegetative species by range site. The species list is a compilation of species reported in the Humboldt River study final report (JBR 1992a), spring and seep report (JBR 1992b), soils and vegetation report (JBR 1992c), draft riparian report (JBR 1992e), final riparian report (JBR 1993), and personal observations by Mr. Joe Elliott of Northwest Resource Consultants and Mr. Dean Culwell of Westech, Inc. (Elliott 1992).

APPENDIX B

MEAN PERCENT CANOPY COVER* OF CLASSES AND PLANT TAXA BY RANGE SITE, VEGETATION STUDY AREA, 1993

RANGE SITE

	Dry Floodplain	Loamy 10-12" p.z.	South Slope 8-12" p.z.	Loamy 8-10" p.z.	Chalky Knoll
	n=1100	n=1300	n=1800	n=2300	n=2500
CLASS/TAXON					
Class Percent Cover					
Bare ground	38.3	35.5	42.0	35.7	56.5
Rock	0.1	-	3.5	0.1	4.7
Litter	37.5	20.4	17.6	25.8	14.7
Shrubs	12.9	21.7	6.3	18.3	16.2
Grasses	10.5	16.5	29.2	12.1	5.8
Forbs and Moss	0.6	5.8	1.7	6.0	3.8
Total Vegetation	24.1	44.0	37.1	36.5	26.0
Total Nonvegetation	75.9	56.0	62.9	64.0	75.9
Taxon Percent Cover					
SHRUBS					
Saskatoon serviceberry *Amelanchier alnifolia*	-	-	-	-	0.9
Low sagebrush *Artemisia arbuscula*	-	-	0.9	-	-
Black sagebrush *Artemisia arbuscula nova*	-	-	-	-	0.5
Basin big sagebrush *Artemisia tridentata tridentata*	10.7	15.0	1.0	-	0.1
Wyoming big sagebrush *Artemisia tridentata wyomingensis*	-	2.6	0.2	17.3	3.1
Mountain big sagebrush *Artemisia vaseyana*	-	1.8	-	-	-
Rubber rabbitbrush *Chrysothamnus nauseosus*	0.4	1.1	1.5	-	1.7
Douglas rabbitbrush *Chrysothamnus viscidiflorus*	1.9	2.1	2.3	0.7	2.6
Buckwheat sp. *Eriogonum* sp.	-	-	-	-	0.1
Spiny hopsage *Grayia spinosa*	-	-	-	0.2	0.2
Common pricklygilia *Leptodactylon pungens*	-	-	-	0.01	0.1
Antelope bitterbrush *Purshia tridentata*	-	-	-	-	4.0
Spineless horsebrush *Tetradymia canescens*	-	-	-	0.01	2.3
Littleleaf horsebrush *Tetradymia glabrata*	-	-	0.5	-	1.2
TOTAL SHRUBS	**13.0**	**22.7**	**6.5**	**18.2**	**16.6**

APPENDIX B

MEAN PERCENT CANOPY COVER* OF CLASSES AND PLANT TAXA BY RANGE SITE, VEGETATION STUDY AREA, 1993

RANGE SITE

	Dry Floodplain	Loamy 10-12" p.z.	South Slope 8-12" p.z.	Loamy 8-10" p.z.	Chalky Knoll
	n=1100	n=1300	n=1800	n=2300	n=2500
GRASSES					
Thickspike wheatgrass *Agropyron dasystachyum*	-	0.8	-	-	1.3
Western wheatgrass *Agropyron smithii*	3.0	-	-	0.04	-
Bluebunch wheatgrass *Agropyron spicatum*	0.3	1.9	16.9	0.4	0.1
Cheatgrass *Bromus tectorum*	0.4	-	6.7	0.04	0.1
Basin wildrye *Elymus cinereus*	1.4	2.0	1.2	0.4	1.4
Idaho fescue *Festuca idahoensis*	-	0.1	-	-	-
Indian ricegrass *Oryzopsis hymenoides*	-	-	-	-	0.9
Sandberg bluegrass *Poa secunda*	4.1	8.0	2.4	6.5	1.5
Bottlebrush squirreltail *Sitanion hystrix*	1.3	2.7	1.7	2.4	0.5
Needleandthread *Stipa comata*	-	-	-	-	0.1
Thurber needlegrass *Stipa thurberiana*	0.1	0.9	0.3	2.2	-
Webber needlegrass *Stipa webberi*	-	-	-	0.04	-
TOTAL GRASSES	**10.6**	**16.5**	**29.4**	**12.1**	**5.8**
FORBS AND MOSS					
Moss	0.5	1.2	-	2.4	0.1
Crag aster *Aster scopulorum*	-	0.3	-	-	-
Arrowleaf balsamroot *Balsamorhiza sagittata*	-	0.1	1.2	-	0.9
Paintbrush *Castilleja* sp.	-	-	-	0.02	-
Thistle *Cirsium* sp.	-	0.1	-	-	-
Tapertip hawksbeard *Crepis acuminata*	-	-	-	-	0.1
Cryptantha *Cryptantha* sp.	-	-	-	-	0.5
Slenderbush eriogonum *Eriogonum microthecum*	-	-	-	-	0.1
Ovalleaved buckwheat *Eriogonum ovalifolium*	-	-	-	-	0.1

APPENDIX B

MEAN PERCENT CANOPY COVER* OF CLASSES AND PLANT TAXA BY RANGE SITE, VEGETATION STUDY AREA, 1993

RANGE SITE

	Dry Floodplain	Loamy 10-12" p.z.	South Slope 8-12" p.z.	Loamy 8-10" p.z.	Chalky Knoll
	n= 1100	n= 1300	n= 1800	n= 2300	n= 2500
Buckwheat *Eriogonum* sp.	-	0.1	-	0.02	0.03
Goldenweed *Haplopappus* sp.	-	1.3	0.2	0.2	0.7
Claspingleaf pepperweed *Lepidium perfoliatum*	0.1	-	-	-	-
White stoneseed *Lithospermum ruderale*	-	-	0.1	-	-
Lupine *Lupinus* sp.	-	1.8	0.04	0.3	0.1
Spiny phlox *Phlox hoodii*	-	-	-	2.7	1.0
Longleaf phlox *Phlox longifolia*	-	0.5	-	0.2	-
Unknowns	-	0.2	0.2	0.1	0.1
TOTAL FORBS AND MOSS	**0.6**	**5.7**	**1.8**	**6.0**	**3.7**

NOTES:

* Cover was derived by dividing absolute frequency (number of hits) by the total number of points sampled per range site.
n = number of points sampled; p.z. = precipitation zone.

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS

Binomial	Common Name
NATIVE PERENNIAL GRAMINOIDS	
Agropyron dasystachyum	Thickspike wheatgrass
Agropyron smithii	Western wheatgrass
Agropyron spicatum	Bluebunch wheatgrass
Agropyron trachycaulum	Slender wheatgrass
Agrostis exarata	Spike bentgrass
Alopecurus aequalis	Shortawn foxtail
Aristida species	Threeawn species
Carex aurea	Golden sedge
Carex deweyana	Dewey sedge
Carex douglasii	Douglas sedge
Carex lanuginosa	Woolly sedge
Carex nebraskensis	Nebraska sedge
Carex praegracilis	Slim sedge
Carex rostrata	Beaked sedge
Carex sheldonii	Sheldon sedge
Deschampsia cespitosa	Tufted hairgrass
Distichlis spicata	Inland saltgrass
Eleocharis palustris	Creeping spikerush
Eleocharis pauciflora	Fewflowered spikerush
Eleocharis rostellata	Beaked spikerush
Elymus cinereus	Basin wildrye
Elymus triticoides	Creeping wildrye
Festuca idahoensis	Idaho fescue
Glyceria grandis	American mannagrass
Hordeum brachyantherum	Meadow barley
Hordeum jubatum	Foxtail barley
Juncus balticus	Baltic rush
Juncus effusus	Common rush
Juncus ensifolius	Swordleaf rush
Juncus torreyi	Torrey rush
Koeleria pyramidata	Prairie junegrass
Oryzopsis hymenoides	Indian ricegrass
Phalaris arundinacea	Reed canarygrass
Phragmites australis	Common reed
Poa cusickii	Cusick bluegrass
Poa nevadensis	Nevada bluegrass
Poa scabrella	Pine bluegrass
Poa secunda	Sandberg bluegrass
Scirpus acutus	Hardstem bulrush
Scirpus americanus	American bulrush
Scirpus microcarpus	Panicled bulrush
Scirpus validus	Softstem bulrush
Sitanion hystrix	Bottlebrush squirreltail
Sporobolus airoides	Alkali sacaton
Stipa comata	Needleandthread
Stipa thurberiana	Thurber needlegrass
Stipa webberi	Webber needlegrass

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
INTRODUCED PERENNIAL GRAMINOIDS	
Agropyron cristatum	Crested wheatgrass
Agrostis stolonifera	Redtop bentgrass
Bromus inermis	Smooth brome
Phleum species	Timothy species
Poa bulbosa	Bulbous bluegrass
Poa compressa	Canada bluegrass
Poa palustris	Fowl bluegrass
Poa pratensis	Kentucky bluegrass
Native Annual Graminoids	
Beckmannia syzigachne	American sloughgrass
Cenchrus longispinus	Sandbur
Deschampsia danthonioides	Annual hairgrass
Eragrostis hypnoides	Creeping lovegrass
Juncus bufonius	Toad rush
Muhlenbergia filiformis	Pullup muhly
Muhlenbergia minutissima	Annual muhly
Poa annua	Annual bluegrass
INTRODUCED ANNUAL GRAMINOIDS	
Bromus tectorum	Cheatgrass
Crypsis alopecuroides	
Polypogon monspeliensis	Rabbitfootgrass
Setaria glauca	Yellow bristlegrass
NATIVE PERENNIAL FORBS	
Achillea millefolium	Common yarrow
Agoseris glauca	Pale agoseris
Allium anceps	Kellogg onion
Allium lemmonii	Lemmon onion
Allium species	Onion species
Angelica kingii	King angelica
Antennaria dimorpha	Low pussytoes
Arabis lignifera	Woody rockcress
Artemisia ludoviciana	Louisiana sagewort
Asclepias speciosa	Showy milkweed
Aster campestris	Meadow aster
Aster chilensis	Longleaved aster
Aster eatonii (bracteolatus)	Eaton aster
Aster occidentalis	Western mountain aster
Aster scopulorum	Crag aster
Astragalus curvicarpus	Sickle milkvetch
Astragalus eremeticus	Hermit milkvetch
Astragalus iodanthus	Humboldt River milkvetch
Astragalus newberryi	Newberry milkvetch
Astragalus purshii	Pursh milkvetch
Astragalus species	Milkvetch species
Balsamorhiza hookeri	Hooker balsamroot

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
NATIVE PERENNIAL FORBS (continued)	
Balsamorhiza sagittata	Arrowleaf balsamroot
Castilleja chromosa	Desert Indian paintbrush
Castilleja species	Paintbrush species
Caulanthus crassicaulis	Thickstem wildcabbage
Chaenactis douglasii	Douglas duskymaiden
Cicuta douglasii	Douglas waterhemlock
Cirsium species	Thistle species
Crepis acuminata	Tapertip hawksbeard
Crepis occidentalis	Western hawksbeard
Cryptantha humilis	Low cryptantha
Cryptantha interrupta	Bristly cryptantha
Cryptantha species	Cryptantha species
Cymopterus species	Cymopterus species
Delphinium andersonii	Anderson larkspur
Epilobium ciliatum	Hairy willowweed
Erigeron clokeyi	Clokey fleabane
Erigeron nevadincola	Nevada fleabane
Erigeron species	Fleabane species
Eriogonum caespitosum	Mat eriogonum
Eriogonum ovalifolium	Ovalleaved buckwheat
Eriophyllum lanatum	Eriophyllum
Fragaria virginiana	Blueleaf strawberry
Geum macrophyllum	Largeleaf avens
Gilia species	Gilia species
Haplopappus lanceolatus	Lanceleaf goldenweed
Helenium autumnale	Common sneezeweed
Heracleum lanatum	Cow parsnip
Heterotheca villosa	Hairy goldaster
Heuchera cylindrica	Roundleaf alumroot
Hymenoxys acaulis	Stemless hymenoxys
Iris missouriensis	Wildiris
Iva axillaris	Povertyweed
Lathyrus species	Peavine species
Lemna minor	Duckweed
Lemna obscura	Duckweed
Linum lewisii	Lewis flax
Lithophragma tenellum	Slender woodlandstar
Lithospermum ruderale	White stoneseed
Lomatium nevadense	Nevada biscuitroot
Lupinus arbustus	Spurred lupine
Lupinus argenteus	Silvery lupine
Lupinus polyphyllus	Meadow lupine
Lupinus species	Lupine species
Mentha arvensis	Wild mint
Mentzelia laevicaulis	Blazingstar mentzelia
Mertensia oblongifolia	Oblongleaf bluebells
Mertensia species	Bluebells species
Mimulus guttatus	Common monkeyflower
Oenothera caespitosa	Tufted eveningprimrose
Penstemon kingii	King penstemon
Penstemon rydbergii	Rydberg penstemon
Penstemon speciosus	Royal penstemon
Perideridia species	Yampa species
Phlox austromontana	Desert phlox
Phlox hoodii	Spiny phlox
Phlox longifolia	Longleaf phlox

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
NATIVE PERENNIAL FORBS (continued)	
Physaria chambersii	Chambers twinpod
Potentilla anserina	Silverweed cinquefoil
Potentilla gracilis	Potentilla
Ranunculus aquatilis	Hairleaf water buttercup
Ranunculus cymbalaria	Alkali buttercup
Rumex triangulivalvis	Trianglevalve dock
Scutellaria antirrhinoides	Snapdragon skullcap
Senecio hydrophilus	Water groundsel
Senecio integerrimus	Lambstongue groundsel
Sidalcea neomexicana	New Mexico checkermallow
Solidago canadensis	Canada goldenrod
Solidago occidentalis	Western goldenrod
Solidago spectabilis	Basin goldenrod
Sphaeralcea parvifolia	Smallflower globemallow
Stanleya pinnata	Desert princesplume
Stephanomeria spinosa	Spiny skeletonweed
Townsendia scapigera	Ground daisy
Trifolium wormskjoldii	Sierra clover
Triglochin maritimum	Seaside arrowgrass
Typha latifolia	Common cattail
Urtica dioica	Nettle
Veratrum californicum	California false-hellebore
Veronica americana	American speedwell
Viola beckwithii	Western pansy violet
Viola nephrophylla	Wanderer violet
Viola nuttallii	Nuttall violet
Zigadenus paniculatus	Foothill deathcamas
INTRODUCED PERENNIAL FORBS	
Acroptilon repens	Russian knapweed
Cardaria draba	Whitetop
Cirsium arvense	Canada thistle
Euphorbia esula	Leafy spurge
Iris pseudacorus	Yellow iris
Lepidium latifolium	Broadleaf pepperweed
Marrubium vulgare	Common hoarhound
Nasturtium officinale	Watercress
Plantago major	Broadleaf plantain
Rumex crispus	Curly dock
Taraxacum officinale	Common dandelion
Trifolium fragiferum	Strawberry clover
Veronica anagallis-aquatica	Water speedwell
FERNS AND ALLIES	
Azolla filiculoides	Duckweed fern
Azolla mexicana	Waterfern
Equisetum arvense	Field horsetail
Equisetum variegatum	Variegated horsetail

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
NATIVE ANNUAL/BIENNIAL FORBS	
Agoseris heterophylla	Annual agoseris
Ambrosia species	Ragweed species
Amsinckia retrorsa	Rigid fiddleneck
Amsinckia species	Fiddleneck species
Amsinckia tessellata	Bristly fiddleneck
Arabis holboellii	Holboell rockcress
Artemisia biennis	Biennial sagewort
Aster frondosus	Alkali aster
Atriplex species	Saltweed species
Bidens cernua	Nodding beggarticks
Blepharipappus scaber	Blepharipappus
Boisduvalia densiflora	Dense spike-primrose
Centaurium exaltatum	Exalted centaury
Cirsium neomexicanum	Lavender thistle
Claytonia perfoliata	Claspleaf minerlettuce
Collinsia parviflora	Blue-eyed Mary
Conyza canadensis	Canada horseweed
Cryptantha torreyana	Torrey cryptantha
Descurainia pinnata	Pinnate tansymustard
Descurainia richardsonii	Richardson tansymustard
Epilobium paniculatum	Autumn willowweed
Eriogonum baileyi	Bailey buckwheat
Eriogonum species	Eriogonum species
Eriogonum vimineum	Broom eriogonum
Galium aparine	Catchweed bedstraw
Gayophytum ramosissimum	Much branched groundsmoke
Gilia inconspicua	Shy gilia
Gilia leptomeria	Slender gilia
Grindelia species	Gumweed species
Lappula redowskii	Stickseed
Lepidium densiflorum	Prairie pepperweed
Lupinus brevicaulis	Shortstem lupine
Mentzelia species	Mentzelia species
Microsteris gracilis	Slender false phlox
Nicotiana attenuata	Coyote tobacco
Oenothera species	Eveningprimrose species
Polygonum aviculare	Prostrate knotweed
Polygonum douglasii	Douglas knotweed
Ranunculus sceleratus	Celeryleaf buttercup
Rumex maritimus	Seaside dock
Solanum rostratum	Buffalobur
Solanum triflorum	Cutleaf nightshade
Suaeda species	Seepweed species
Thelypodium integrifolium	Entireleaved thelypody
Veronica peregrina	Purslane speedwell
Xanthium strumarium	Canada cocklebur

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
INTRODUCED ANNUAL/BIENNIAL FORBS	
Alyssum desertorum	Desert alyssum
Arctium minus	Small burdock
Bassia hyssopifolia	Fivehook bassia
Brassica species	Mustard species
Centaurea diffusa	Diffuse knapweed
Chenopodium album	Lambsquarters
Chorispora tenella	Common bluemustard
Conium maculatum	Poison-hemlock
Erodium cicutarium	Cutleaf filaree
Filago arvensis	Field filago
Halogeton glomeratus	Halogeton
Lepidium perfoliatum	Claspingleaf pepperweed
Melilotus alba	White sweetclover
Onopordum acanthium	Scotch thistle
Ranunculus testiculatus	Bur buttercup
Salsola kali	Russian thistle
Sisymbrium altissimum	Tumblemustard
Thlaspi arvense	Pennycress
Tragopogon dubius	Yellow salsify
Tragopogon species	Salsify species
SHRUBS	
Amelanchier alnifolia	Saskatoon serviceberry
Amelanchier utahensis	Utah serviceberry
Artemisia arbuscula nova	Black sagebrush
Artemisia arbuscula	Low sagebrush
Artemisia cana	Silver sagebrush
Artemisia pygmaea	Pygmy sagebrush
Artemisia spinescens	Bud sagebrush
Artemisia tridentata tridentata	Basin big sagebrush
Artemisia tridentata wyomingensis	Wyoming big sagebrush
Artemisia vaseyana	Mountain big sagebrush
Atriplex confertifolia	Shadscale
Chrysothamnus nauseosus	Rubber rabbitbrush
Chrysothamnus viscidiflorus	Douglas rabbitbrush
Cornus stolonifera	Redosier dogwood
Eriogonum microthecum	Slenderbush eriogonum
Eriogonum sphaerocephalum	Rock eriogonum
Eurotia lanata	Winterfat
Grayia spinosa	Spiny hopsage
Leptodactylon pungens	Common pricklygilia
Opuntia erinacea	Grizzlybear pricklypear
Prunus virginiana	Common chokecherry
Purshia tridentata	Antelope bitterbrush
Rhus trilobata	Skunkbrush sumac
Ribes aureum	Golden currant
Rosa woodsii	Woods rose
Salix bebbiana	Bebb willow

APPENDIX B

LIST OF VASCULAR PLANTS DOCUMENTED FOR THE VEGETATION AND RIPARIAN/WETLANDS STUDY AREAS (continued)

Binomial	Common Name
SHRUBS (continued)	
Salix boothii	Booth willow
Salix commutata	Undergreen willow
Salix exigua	Coyote willow
Salix laevigata	Polish willow
Salix lutea	Yellow willow
Sarcobatus vermiculatus	Black greasewood
Symphoricarpos species	Snowberry species
Tetradymia canescens	Spineless horsebrush
Tetradymia glabrata	Littleleaf horsebrush
TREES	
Elaeagnus angustifolia	Russian-olive
Juniperus osteosperma	Utah juniper
Populus angustifolia	Narrowleaf cottonwood
Populus balsamifera trichocarpa	Black cottonwood
Populus tremula tremuloides	Quaking aspen
Salix lasiandra	Pacific willow
Tamarix ramosissima	Saltcedar

Source: JBR 1992a; JBR 1992b; JBR 1992c; JBR 1992e; JBR 1993; Elliott 1992; Woodward-Clyde 1992.

Nomenclature follows USDA Soil Conservation Service (1991), where possible. Other nomenclature follows Kartesz (1988) and USDA Forest Service (1987).

APPENDIX C

VISUAL CONTRAST RATING WORKSHEETS

This appendix contains visual contrast rating worksheets completed for five key observation points (KOPs). The information is recorded on BLM Form 8400-4. The five KOPs were selected to be representative of locations where views of the South Operations Area could occur. The worksheets include information about texture, color, line, and form for the characteristic landscape and the proposed mine expansion. The five KOPs are: (1) on Interstate 80, 1 mile east of E. Carlin interchange; (2) junction of Maggie Creek road and Carlin Mine road; (3) south summit of Marys Mountain; (4) junction of Maggie Creek road and Carlin landfill road; and (5) on Carlin Mine road, 4 miles north of Highway 766.

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

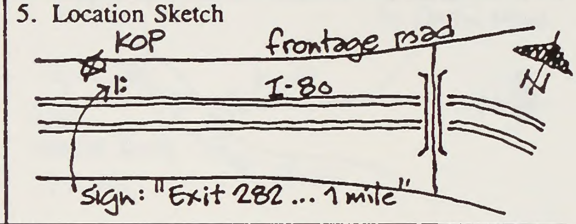
Date	21 September 1992
District	Elko
Resource Area	Elko
Activity (program)	mining

SECTION A. PROJECT INFORMATION

1. Project Name: Newmont Gold Quarry
2. Key Observation Point: #1- I80, 1 mi E of E. Carlin Interchg
3. VRM Class: II

4. Location
Township: 33N
Range: 53E
Section: 19

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	flat to rolling w/angular forms @ mine, hwy & R.R.	simple - indistinct	angular - horizontal
LINE	horizontal - weak diagonal diagonal stronger in afternoon	weak	broken - irregular - indistinct
COLOR	chalky buff & reddish tan	gray-green foreground gray/tan/buff/yellowish dk. green line @ Carlin (trees)	black - dk. gray haze over mine yellows, white, brown & tan
TEXTURE	smooth - uniform	fine - uniform - random (subtle)	random, clumped

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	flat - angular	/	angular - horizontal
LINE	horizontal	/	broken - irregular - indistinct
COLOR	light gray, tan, brown	/	& yellow - white - brown - tan
TEXTURE	smooth - uniform	/	random - clumped

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	Land/Water Body (1) Strong	Moderate	Weak	None	Vegetation (2) Strong	Moderate	Weak	None	Structures (3) Strong	Moderate	Weak	None
Form			X					X			X	
Line				X				X			X	
Color			X				X				X	
Texture				X				X			X	

2. Does project design meet visual resource management objectives? ☒ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended ☐ Yes ☒ No (Explain on reverse side)

Evaluator's Names	Date
Jeff Johnson	
Ted Wirth	

SECTION D. (Continued)

Comments from item 2.

Changes consist of increased height of embankments and additional buildings.

Additional Mitigating Measures (See item 3)

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

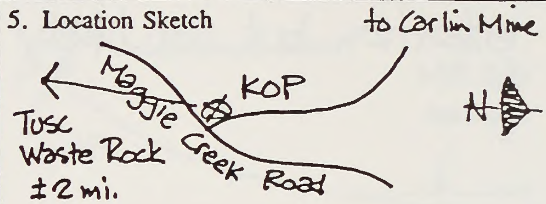
Date 21 September 1992
District Elko
Resource Area Elko
Activity (program) mining

SECTION A. PROJECT INFORMATION

1. Project Name: Newmont Gold Quarry
2. Key Observation Point: #2: Jct. of Maggie Cr. & Carlin Mine Rds
3. VRM Class: IV

4. Location
Township 34 N
Range 51 E
Section 10

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	rolling - smooth - rounded moderate/gentle	no distinct form random	rectangular/linear (powerlines)
LINE	undulating - flowing broken @ canyon - diagonal	weak	weak
COLOR	gray · buff - tan - black	gray/green to buff	—
TEXTURE	medium - coarse fine @ foreground	mottled	—

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	rolling - smooth - rounded angular/pyramidal @ mine	no distinct form random	rectangular/linear
LINE	undulating - flowing diagonal/angular	weak	weak
COLOR	gray - buff - tan - black ?	gray/green to buff	–
TEXTURE	medium - coarse fine @ foreground	mottled	–

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	LAND/WATER BODY (1)				VEGETATION (2)				STRUCTURES (3)			
	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None	Strong	Moderate	Weak	None
Form		X					X				X	
Line		X				X					X	
Color			X			X					X	
Texture			X				X				X	

2. Does project design meet visual resource management objectives? ☒ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended ☒ Yes ☐ No (Explain on reverse side)

Evaluator's Names: Jeff Johnson, Ted Wirth, Evelyn Trieman
Date

SECTION D. (Continued)

Comments from item 2.

Change will consist of construction of Tusc Waste Rock storage facility – visible on slope to south. Will ~~be~~ attract attention but not likely to be dominant.

Additional Mitigating Measures (See item 3)

Scheduling of mining activity to allow use of waste rock from Tusc Pit to backfill Mac Pit will eliminate need for or reduce size of waste rock storage facility.

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

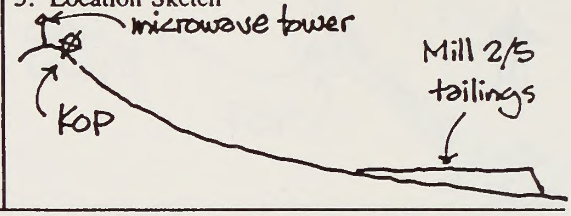
Date	21 September 1992
District	Elko
Resource Area	Elko
Activity (program)	mining

SECTION A. PROJECT INFORMATION

1. Project Name: Newmont Gold Quarry
2. Key Observation Point: #3: South Summit Mary's Mtn.
3. VRM Class:

4. Location
   - Township: 33N
   - Range: 51E
   - Section: 29

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	rounded/angular - f.g. - m.g. flat - rolling then rough backgd	no distinct forms petchy/irregular	angular - complex
LINE	diagonal foregd, horizontal midgd, diagonal backgd } undulating	irregular - soft - broken	diagonal/horizontal subangular
COLOR	gray - buff - yellowish tan	gray/green - yellowish tan	cream - pastel reds
TEXTURE	coarse - contrasty	random - nondirectional discontinuous stippled - f.g.	contrasty - directional

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	rounded/angular flat rough	no distinct forms petchy - irregular	angular - complex blocky
LINE	diagonal then horizontal then diagonal - undulating	irregular - soft - broken	diagonal/horizontal subangular
COLOR	gray - buff - yellowish tan	gray/green - yellowish tan	cream - pastel reds beige/buff
TEXTURE	coarse - contrasty	random - nondirectional discontinuous - stippled f.g.	contrasty - directional clumped

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	Land/Water Body (1) Strong	Moderate	Weak	None	Vegetation (2) Strong	Moderate	Weak	None	Structures (3) Strong	Moderate	Weak	None
Form			X				X		X			
Line			X				X			X		
Color			X				X			X		
Texture			X				X			X		

2. Does project design meet visual resource management objectives? ☒ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended ☐ Yes ☒ No (Explain on reverse side)

Evaluator's Names	Date
Jeff Johnson	Evelyn Trieman
Ted Wirth	

Comments from item 2.

Changes visible from KOP 3 will consist primarily of new structures (water treatment plant & roasters). Will attract attention but likely will not be dominant.

Additional Mitigating Measures (See item 3)

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

VISUAL CONTRAST RATING WORKSHEET

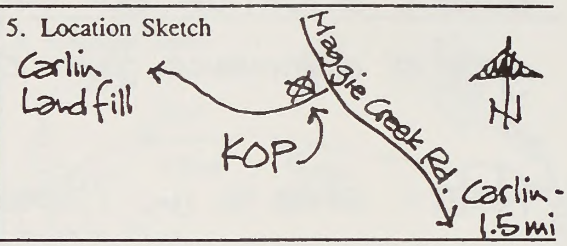
Date	21 September 1992
District	Elko
Resource Area	Elko
Activity (program)	mining

SECTION A. PROJECT INFORMATION

1. Project Name: Newmont Gold Quarry
2. Key Observation Point: #4 - Maggie Cr. Rd. / Carlin Landfill Rd.
3. VRM Class: II / IV

4. Location
Township: 33N
Range: 52E
Section: 22

5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	flat to rolling angular/geometric	indistinct	irregular blocky
LINE	horizontal - angular	weak - undulating	weak
COLOR	chalky buff - gray pastel reds	gray/green	buff - white - gray
TEXTURE	fine - patchy - random	fine	discontinuous - random

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	flat to rolling angular/geometric	indistinct	irregular - blocky
LINE	horizontal - angular	weak - undulating	weak
COLOR	chalky buff - gray pastel reds	gray/green	buff - white - gray
TEXTURE	fine - patchy - random	fine	discontinuous - random

SECTION D. CONTRAST RATING ☐ SHORT TERM ☒ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	LAND/WATER BODY (1) Strong	Moderate	Weak	None	VEGETATION (2) Strong	Moderate	Weak	None	STRUCTURES (3) Strong	Moderate	Weak	None
Form		X					X			X		
Line			X				X				X	
Color			X				X				X	
Texture			X				X				X	

2. Does project design meet visual resource management objectives? ☒ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended ☐ Yes ☐ No (Explain on reverse side)

Evaluator's Names	Date
Jeff Johnson	
Ted Wirth	

SECTION D. (Continued)

Comments from item 2.

Change to consist of increased height of existing Mill 2/5 Tailings, ~~and~~ new water treatment plant and new roasters. Change will attract attention but should not ~~be dominant~~ have significantly greater dominance than existing operations.

Note: area is in Class II Highway corridor but separated from hwy by ridge. Views from KOP are Class IV with Class III in background.

Additional Mitigating Measures (See item 3)

Form 8400-4
(September 1985)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

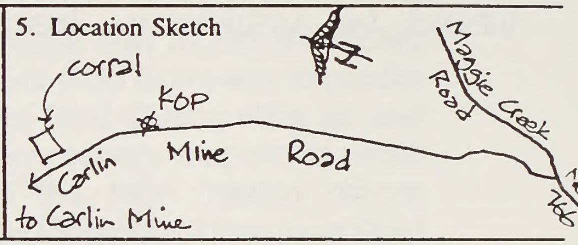
VISUAL CONTRAST RATING WORKSHEET

* VIEWS TO SOUTH and SOUTHEAST

Date: 18 March 1993
District: Elko
Resource Area: Elko
Activity (program): mining

SECTION A. PROJECT INFORMATION

1. Project Name: Newmont Gold Quarry
2. Key Observation Point: #5 - Carlin Mine Rd., 4 mi N of Nev 766
3. VRM Class: IV
4. Location: Township 35 N; Range 51 E; Section 28
5. Location Sketch



SECTION B. CHARACTERISTIC LANDSCAPE DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	flat to rolling - foreground rounded - background	indistinct irregular strip in valley	indistinct powerline
LINE	weak, indistinct, vaguely horizontal smooth, undulating - background	weak, irregular	vertical
COLOR	brownish - foreground reddish, dark gray background	gray, sage green	—
TEXTURE	smooth	medium, stippled foreground smooth background	—

SECTION C. PROPOSED ACTIVITY DESCRIPTION

	1. LAND/WATER	2. VEGETATION	3. STRUCTURES
FORM	definite, angular linear, horizontal	indistinct	indistinct powerline - no changes
LINE	straight, horizontal	weak, irregular	vertical
COLOR	pastel red, brown, tan	buff	—
TEXTURE	smooth	smooth	—

SECTION D. CONTRAST RATING ☐ SHORT TERM ☐ LONG TERM

1. DEGREE OF CONTRAST

ELEMENTS	Land/Water Body (1) Strong	Moderate	Weak	None	Vegetation (2) Strong	Moderate	Weak	None	Structures (3) Strong	Moderate	Weak	None
Form		X						X				X
Line		X						X				X
Color		X				X						X
Texture				X			X					X

2. Does project design meet visual resource management objectives? ☒ Yes ☐ No (Explain on reverse side)

3. Additional mitigating measures recommended ☐ Yes ☒ No (Explain on reverse side)

Evaluator's Names: Jeff Johnson, Evelyn Trieman
Date: 18 March 1993

SECTION D. (Continued)

Comments from item 2.

Change will consist of linear feature - Haul Road - imposed upon rolling topography. Proposed Mining activities visible from KOP2 would be visible in background.

Additional Mitigating Measures (See item 3)

APPENDIX D

SUMMARY OF NUMERICAL GROUNDWATER FLOW MODEL FOR DEWATERING AT NEWMONT'S GOLD QUARRY MINE

This appendix contains a summary of a numerical groundwater flow model (*MINEDW*) conducted by Hydrologic Consultants, Inc. (HCI) for Newmont Gold Company to predict the amount of groundwater that must be removed from the Gold Quarry Mine pit and predict the extent of groundwater drawdown, or cone-of-depression, that would result from dewatering. This summary is an excerpt from the HCI (1992a) report: Hydrogeologic Framework and Numerical Ground-Water Flow Modeling of Newmont Gold Company's Gold Quarry Mine, Eureka County, Nevada; Prepared for Newmont Gold Company; October 1992. Additional information about the finite-element program used for the model is contained in HCI (1992c).

APPENDIX D
SUMMARY OF NUMERICAL GROUNDWATER FLOW MODEL

INTRODUCTION

The initial purpose of HCI's investigation was to numerically model the groundwater flow system in the vicinity of the Gold Quarry Mine in order to estimate the amount of water that would have to be managed during the proposed mining operation and to design an effective dewatering system. This modeling work was subsequently expanded to include predicting the rate at which the pit might fill in with groundwater after dewatering operations cease at the end of year 2001. The scope of the numerical investigation was again expanded in order to predict drawdowns in the water table that might occur as a result of dewatering activities and subsequent pit infilling. The location of the maximum extent of the 10-foot drawdown contour -- the line connecting all points with 10 feet of drawdown at a given time -- was of particular interest.

HISTORY OF NUMERICAL CODE AND MODEL DEVELOPMENT

The numerical modeling work described in this document utilizes a numerical code referred to as *MINEDW* that solves the problem of three-dimensional groundwater flow with an unconfined or phreatic surface using the finite-element method. This state-of-the-art code was specifically developed by HCI (Timothy J. Durbin, P.E., a Principal in HCI's Davis, California office is the primary author) to solve problems related to mine dewatering and has several attributes (e.g., simulation of an excavation, calculation of the seepage face on the pit highwall) for that purpose (Atkinson et al. 1992). Complete documentation of *MINEDW*, including a description of its mathematical basis, several validations of its problem-solving capabilities, and instructions for users, has been produced under separate cover (HCI 1992b).

The basic core of *MINEDW* originated in an earlier three-dimensional finite-element code, referred to as *FLOW3D*, that was developed by Mr. Durbin when he was employed by the U.S. Geological Survey (USGS) in the early 1980's (Durbin and Berenbrock 1985). It was one of the first codes to incorporate the variable-flux boundary condition as an alternative to generating unnecessarily large model grids. *FLOW3D* was used by the USGS on several projects, and its application in the assessment of a groundwater basin in southern California is documented by Mitten et al. (1988).

MINEDW was developed from *FLOW3D* in 1991. It incorporates many of the features of *FLOW3D*, but instead of using a deforming grid, *MINEDW* calculates the position of the phreatic surface using a algorithm for saturated-unsaturated flow. *MINEDW* also includes routines to calculate the height of the seepage face on a pit wall, non-Darcian groundwater flow (which can occur near a pit), element removal (to simulate excavation of a pit), and pit infilling, all of which are fully described and validated in HCI (1992b). These attributes, in conjunction with the discretization detail that can be incorporated into a finite-element grid, give *MINEDW* unique capabilities for solving the problems that were addressed in this investigation.

CONCEPTUAL HYDROGEOLOGIC MODEL

The available geologic, hydrologic, and climatologic data have been incorporated into a conceptual hydrogeologic model that describes the surface water and groundwater flow system of the lower Maggie Creek Basin and some adjacent areas. This comprehensive conceptual model is the framework upon which the numerical model that mathematically describes the flow system has been constructed. Essential components of the conceptual hydrogeologic model used in this investigation are: (1) areal and vertical extent and hydraulic characteristics of the primary hydrostratigraphic units and significant geologic structures; (2) recharge to the study area; (3) surface water outflow from the study area; (4) outflow from the shallow, unconfined groundwater system in the study area; and (5) groundwater throughflow in the carbonate system.

Two primary groundwater flow systems have been considered in this investigation: (1) shallow, unconfined system, and (2) deep, generally semiconfined system consisting primarily of carbonate rocks. The regional water table occurs in the shallow, unconfined system that, depending on location, is comprised of alluvium, Tertiary strata, the siltstone unit, or the carbonate unit. The crests of the mountain ranges that border the basins and form surface water drainage divides tend to function as drainage divides for the shallow, unconfined groundwater system. Fractures, joints, and major faults in the study area can have an effect on groundwater flow by providing preferred pathways or functioning as barriers to flow.

MODEL GRID AND DISCRETIZATION

A finite-element grid was constructed that contains 7,380 nodes and 12,905 elements. The grid in the pit area was very finely discretized both for numerical reasons and so that removal of elements from the grid during mining simulations could reasonably represent the geometry of the proposed mine pit. As a result, nearly 75 percent of the model elements lie within a radius of about 3,000 feet from the center of the pit. In the finite-element method, hydraulic properties are assigned to elements, and hydraulic heads and fluxes are associated with nodes. Therefore, every element in the numerical model is assigned a "rock type" with specified values for horizontal and vertical hydraulic conductivity, specific storage, and specific yield (which is only utilized if the water table occurs in the element). The assumption was made that the hydraulic characteristics of similar lithotypes were similar in different areas of the study area.

In the immediate mine pit area where local hydrogeologic domains are well understood, more detail has been incorporated into the numerical model. The central part of the pit area contains siltstones and carbonate rocks of extremely high hydraulic conductivity that are bounded to the north and south by siltstones of moderate to low hydraulic conductivity. Siltstones in the eastern side of the pit area are overlain by Tertiary sediments.

In addition to the major hydrostratigraphic units, four specific geologic structures were incorporated into the finite-element grid as narrow bands of thin elements that could be assigned relatively low hydraulic conductivities (representing fault gouge) if justified during calibration. The Tuscarora fault is represented in the model as the range-front bounding fault of the Tuscarora Mountains, while the Chukar Gulch thrust fault, calcite shell, and the Gold Quarry/Chukar Gulch fault zone were included in the grid in the pit area. Structural offsets along other known geologic features such as the Good Hope and Challenger faults were represented by abrupt changes in grid geometry so that elements of differing hydraulic properties are juxtaposed.

MODEL BOUNDARIES

The mountain ranges in the study area function as local hydrologic divides for surface water and shallow groundwater flow. Consequently, the crest line of the Independence Mountains to the east and the Tuscarora Mountains to the west were defined in the numerical model to be no-flow boundaries in the upper layers of the model. The Humboldt River was chosen as the southern boundary of the model domain, and the uppermost nodes along its course were assigned specified heads equal to the elevation of the river surface. Based on water levels measured in the southeastern part of the Boulder Valley, the model boundary from the Dunphy gage to the point on the crest of the Tuscarora Mountains near the Carlin Mine was assigned a specified-head boundary.

Based on available water level data, nodes defining the carbonate unit at the lateral model boundaries were given specified heads such that a hydraulic gradient of approximately 0.001 ft/ft to the southwest was established. The base of the carbonate unit, corresponding to the top of the Eureka Quartzite, is considered to be a no-flow boundary and, hence, the bottom of the model used for this investigation.

Nodes representing perennial streams in the uppermost model layer were designated drain nodes with specified elevations corresponding to the elevation of the stream bottom at that location. If the calculated head at the node exceeds or is less than its specified elevation, water is under gaining or losing conditions, respectively. The inclusion of drain nodes along stream courses allowed simple stream routing simulations to be carried out so that potentially gaining and losing reaches in the streams could be simulated and used together with the calculated streamflows to calibrate the numerical model.

MODEL CALIBRATION AND SENSITIVITY ANALYSIS

Calibration was the final step in preparing the numerical groundwater flow model for use in making predictive simulations. Heads calculated in the steady-state calibration are used as the initial heads for subsequent transient simulations with the model, both for transient calibration and predictive simulations. The goal of steady-state calibration is to match heads and fluxes calculated by the numerical model to actual conditions in the absence of significant hydraulic stresses (e.g., pumping, inflow to pits). Water levels measured in a number of wells in the study area were used as specific calibration points, as were the baseflows of Susie Creek, Maggie Creek, Marys Creek, and the Humboldt River.

Once a satisfactory steady-state calibration had been achieved with a correlation coefficient of 0.907 between observed and simulated water levels, transient calibration was conducted to demonstrate the capability of the numerical model to replicate the response of the groundwater flow system to historical hydraulic stresses. As is normally the case, some additional refinement of the hydraulic parameters was conducted during transient calibration. Transient calibrations were conducted by simulating constant discharge aquifer tests at two wells in the pit area.

A sensitivity analysis was conducted to assess which of the model input parameters might have the greatest effect on predictions made with the model. The primary purpose of such an analysis is to identify those parameters that should be the focus of continuing investigations in order to minimize the uncertainty associated with model predictions.

PREDICTIVE SIMULATIONS WITH NUMERICAL MODEL

After calibration had been completed, the specified-head boundaries defining the carbonate flow system and the shallow system in Boulder Valley were converted to variable-flux boundaries. This was done by replacing the heads specified at those nodes with their associated fluxes and was intended to prevent stresses that might encounter a transmissive boundary from adversely affecting the calculation of fluxes in the interior of the model domain.

HCI's numerical simulation of dewatering of the Gold Quarry pit through the end of year 2001 when dewatering ceases predicts that the maximum amount of water to be managed during dewatering will be approximately 42,000 gpm and will occur just before dewatering ceases. Predicted drawdown of the water table due to dewatering was calculated for years 1992, 1996, and 2001 (just prior to termination of dewatering) and is shown graphically using the 10-foot drawdown contour line.

The numerical model was used to predict the rate at which the Gold Quarry pit would begin to fill with groundwater at the end of year 2001 when the dewatering system is turned off. The initial rate of recovery is relatively rapid, followed by decreasing rates as hydraulic gradients into the pit diminish. The water table in the pit is predicted to recover to approximately 95 percent of the pre-mining static water level about 18 years after dewatering ceases, and then will continue to approach the pre-mining water level asymptotically.

The numerical simulation of pit infilling predicts that the 10-foot drawdown contour will continue to expand in early recovery time and that it will reach its maximum extent at the beginning of year 2005, about 3 years after dewatering ceases. The shape of the cone-of-depression is roughly circular, with an average radius from the center of the pit of approximately 18 miles. Subsequently, the drawdown area will contract; residual drawdown is predicted to be less than 10 feet throughout the study area by year 2042 (40 years after dewatering ceases).

In addition to declines in the water table resulting from mine dewatering and pit infilling, the model was used to predict relative changes in baseflow in Susie Creek, Maggie Creek, Marys Creek, and the Humboldt River. Baseflow in Susie Creek will decline by about 0.5 cfs for a period of about 20 years during dewatering and subsequent pit infilling. When dewatering and associated discharge cease and pit infilling begins, baseflow of lower Maggie Creek will decline by about 2 cfs in early recovery time and then gradually return to pre-mining conditions.

The numerical model predicts that baseflow in Marys Creek, consisting almost entirely of discharge from the Carlin Spring system, will decrease by as much as 2.5 cfs during dewatering and pit recovery, returning very gradually to its current value. The predicted effect on discharge of the Humboldt River with respect to baseflow at the Dunphy gage is a decrease of about 9 cfs when dewatering and associated discharge cease, followed by a gradual return to pre-mining flow rates.

APPENDIX E

SUMMARY OF GEOCHEMICAL STUDY FOR THE GOLD QUARRY MINE PIT LAKE

The following is a summary of the geochemical study conducted by PTI Environmental Services for Newmont to evaluate the evolving Gold Quarry Mine pit lake water quality associated with future filling that would occur following cessation of mining according to Newmont's proposed action. This summary is an excerpt from the PTI Environmental Services (1992) report: Chemogenesis of Water Quality in the Gold Quarry Pit Lake, Eureka County, Nevada; Interim Final; Prepared for Newmont Gold Company; December 1992.

APPENDIX E
SUMMARY OF GEOCHEMICAL STUDY

INTRODUCTION

This study was designed to predict the eventual water quality in the Gold Quarry open pit mine. Groundwater was reached in 1992 at a depth of approximately 180 meters below grade. By 2001, the pit is anticipated to be approximately 460 meters deep, 270 meters below the regional water table. Upon its completion in year 2001, both siltstone and limestone will bound the pit below the local water table and will be the primary rewatering formations.

The principal concern related to water quality is that pyrite in the wall rock will oxidize during the excavation phases, generating sulfuric acid and heavy metals that will result in a water body containing metals and acid at concentrations above environmentally acceptable levels. This study used existing chemical and hydrologic data, in conjunction with laboratory tests and computer models, to arrive at an understanding of pit/aquifer geochemical interactions, and pit-water chemogenesis following closure of the mine and inundation of the pit with groundwater.

Analysis of the existing groundwater composition quality resulted in definition of the inflow chemistry. The distribution of acid-generating material within the wall rock was based on extrapolation of measured NCV (net carbonate values) in the pit face, while the oxidation period (i.e., the time between exposure and inundation of the wall rock) was determined from the mine plan and post-dewatering inflow rates. The potential production of metals and sulfuric acid from the oxidized wall rock was based on column tests that measured analyte concentrations leaching from fully oxidized rock samples. The materials used in these tests covered the range of acid-generating potentials anticipated in the final configuration of the pit lake walls.

Prediction of the evolving pit-lake water quality necessitated the use of computer models to determine wall-rock oxidation thickness, aqueous chemical reactions, and the thermal and chemical stratigraphy in the lake. Where possible, modeling was conducted using well-established, validated codes. For example, the Davis/Ritchie model of pyrite oxidation has been field tested on pyrite tailings in Canada, and the lake model CE-THERM/CE-QUAL has been widely applied by the Army Corps of Engineers. The equilibrium geochemical code MINTEQA2 is currently distributed and supported by the U.S. EPA and has been used extensively in the scientific literature. The geochemical model PHREEQE was used to assess the result of mixing at different pit volumes with varying ratios of influent siltstone to limestone groundwater. The proprietary code developed to calculate the cumulative chemical concentration in the pit during infilling was verified extensively by comparing computed concentrations to results of analytical solutions. Predictions of pit-lake conditions were undertaken only after the numerical validity of all models had been established.

The chemogenesis of the pit lake depends on the ratio of acidic wall-rock leachate to groundwater. Consequently, the applicability of MINTEQA2 was evaluated by simulating mixtures of acidic leachate with site groundwater over the entire possible range of volumetric ratios and comparing the results to experimental data. The model was shown to accurately simulate the principal mechanisms affecting water quality, including acid/base reactions, precipitation of amorphous ferric hydroxide (AFH), and the associated adsorption of heavy metals to the precipitate.

The overall applicability of the CE-THERM/CE-QUAL lake model, and the validity of the technical approach, were demonstrated by calibrating the model to the chemical and physical conditions measured in the Berkeley Pit, a mine pit lake with similar physical dimensions to Gold Quarry. Despite the fact that the Gold Quarry pit lake does not yet exist, reliable input data were available for most parameters.

WALL-ROCK GEOCHEMISTRY

As groundwater recharges to the pit, it will interact with the wall rock, represented in the final pit configuration by NCVs that range from -3.5 (acid generating) in siltstone, to +23 (acid neutralizing) in limestone. Batch and column tests undertaken to determine leachate water quality demonstrated that oxidation of residual pyrite was essentially complete within 60 days. Beyond this time, the acid-generating materials approached a steady-state condition in both the column and batch reactions, assuring that the duration of column experiments (22 weeks) was adequate for oxidation of residual pyrite in the presence of *T. ferrooxidans* (iron-oxidizing bacteria).

The column test data demonstrated that the initial 50 effluent pore volumes contained the majority of leachable metals and acid. In addition, increasing the porosity increases the diffusion rate of oxygen into the wall rock, thus increasing both the oxidized-zone thickness and the mass of leachable metals. As a corollary, wall rock at the base of the pit will be exposed to air for the shortest time period and have the thinnest oxidized zone, while rock higher on the walls will be exposed for longer time periods and consequently have a thicker oxidized zone.

GEOCHEMICAL REACTIONS IN THE PIT LAKE

The environmental impacts of acid rock discharge are constrained by the potential and available buffering capacity. This buffering capacity is restricted to dissolved carbonate species (i.e., alkalinity) in the groundwater. As water enters the pit from acid and alkaline sources, an *in situ* neutralization reaction will occur, resulting in precipitation of AFH which sequesters dissolved metals from the pit water column by coprecipitation and/or adsorption. The AFH precipitate will settle to the base of the pit and form a layer of sludge; this layer is predicted to remain stable over time due primarily to continued oxygenation of the pit lake.

THERMAL AND CHEMICAL STRATIFICATION IN THE PIT LAKE

The oxygen profile is particularly important because seasonal pit-lake oxygen content is indicative of the capability of the water body to sustain life and to maintain insoluble AFH in the water column. Circulation of oxygen depends on seasonal heating and cooling of the lake surface, density stratification resulting from salinity gradients, and oxygen production/removal as a result of biological activity. CE-QUAL-R1 was used to simulate the distribution of oxygen in the pit lake and the long-term pit-lake hydrodynamic attributes following infilling and chemical equilibrium.

The model results demonstrate that, even under worst-case conditions (i.e., 10 mg/L dissolved organic carbon and 35 mg/L dissolved iron), the physical circulation of the pit lake provides adequate oxygen to overcome the biological and chemical oxygen demand, resulting in oxygenated waters to the base of the lake throughout the year.

PREDICTED PIT-LAKE WATER QUALITY

Even when applying highly conservative assumptions for wall-rock oxidation and acid generation, the Gold Quarry pit lake will not be highly acidic or contain levels of metals that exceed ambient siltstone water quality from the mineralized zone. This pit lake will not become acidic because influent water contains sufficient buffering capacity to overcome the acids generated in the wall rock.

Wall-rock porosity has the greatest influence on water chemistry of the pit lake, primarily because it has the most impact on thickness of the oxidized zone and consequently on the mass of metals leached from the wall rock. Results of model simulations demonstrate that the pH decreases from 8.4 at 0.5 percent porosity to 8.0 at 3 percent porosity due to decreased acid production at lower porosities.

Anion concentrations (e.g., arsenic and selenium) also increase with increasing porosity despite the pH decrease and the increased mass of AFH. Because selenium is not adsorbed, the dissolved concentrations are limited only by the mass of selenium leached from the wall rock, which increases with increasing porosity. Although arsenic is adsorbed, there is sufficient increase in the mass of arsenic leached from the wall rock to offset the increase in percent adsorbed, resulting in higher arsenic concentrations in solution with increasing porosity.

Cations (e.g., copper, cadmium, nickel, and lead) decrease in concentration at higher porosities despite decreasing pH because the mass of AFH increases from 1.4 mg/L to 2.6 mg/L to 11.8 mg/L at porosities of 0.5, 1, and 3 percent, respectively, thereby increasing adsorptive removal. The fourfold increase in AFH results in a comparable increase in the available surface sites, which offsets the slight decrease in pH, facilitating sorption of cations.

Temporal evaluation of pit water chemistry indicates a general decline in water quality during the first 8 years, after which water quality will improve as the pit approaches steady state. For example, under worst-case conditions (i.e., assuming 3 percent wall-rock porosity), acidic leachate decreases the pH from the influent value of 8.4 (i.e., the groundwater pH) through a minimum pH of 7.9 at 7 years, after which the acid is neutralized by continual groundwater inflow, gradually increasing the pH to 8.4. The combination of groundwater entering the pit at calcite saturation and evaporative concentration should result in long-term pH near 8.4 as calcite precipitates continuously in the water column. The evolution of metal concentrations during pit infilling is more complex because of adsorption reactions onto AFH.

Anion concentrations initially increase over the first 7 years due to leaching of wall rock and ineffective sorption removal. Subsequently, concentrations decrease once soluble constituents in the oxidized wall rock have been leached out as a result of flushing by cleaner groundwater.

Concentrations of highly adsorbed cations (e.g., copper, cadmium, nickel, lead and zinc) typically remain constant over the first 10 years, then gradually increase due to the evaporation of surface water, and in the case of zinc, to the relatively higher concentrations of these metals in the influent groundwater.

The predicted composition of the Gold Quarry pit lake for 1 percent wall-rock porosity at 8 years after cessation of mining (when maximum metal and acid concentrations will exist) is similar to the chemistry observed in the Kimbley and Yerington pit lakes in Nevada. Both of these pit lakes represent reasonable analogs to Gold Quarry because they are partially limestone hosted. These existing pit lakes have surface water pH values of 7.59 to 8.21, demonstrating that alkaline groundwater has neutralized any acid introduced as a result of wall-rock leaching. Finally, comparison of the predicted Gold Quarry pit lake composition to the dissolved metal concentrations present in the pre-mining ore zone indicates that the pit lake should result in a general improvement in groundwater quality in the vicinity of the excavation because relatively poor-quality groundwater associated with the pyritiferous siltstone will be dewatered as the ore body is mined.

GPO 784-061/66007