Draft
Environmental Impact Statement for the Hollister Underground Mine Project

Volume I - Text

Bureau of Land Management

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BLM

Elko District Office, Tuscarora Field Office, Nevada

BLM Mission Statement

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

BLM/NV/EK/ES/12-4+1793

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Elko District Office
3900 Idaho Street
Elko, Nevada 89801
http://www.blm.gov/nv/st/en/fo/elko_field_office.html

In Reply Refer To:
1793/3809(NVE0200)
NVN-76802

Dear Reader:

Enclosed for your review is the Draft Environmental Impact Statement (DEIS) for Rodeo Creek Gold Inc.'s (RCG) proposed Hollister Underground Mine Project. This proposal is to transition an underground exploration project to an underground gold and silver mining operation while continuing to conduct underground and surface exploration. The proposed action also includes the construction of 11.6 miles of electric transmission lines to provide electric power to the proposed mine site. The proposed action would create an additional 117 acres of surface disturbance for a total of approximately 222 acres of surface disturbance for the project. The life of the proposed project is twenty years. The Project is located approximately 47 miles northwest of Elko and 64 miles northeast of Winnemucca in Elko County, Nevada.

A 45-day public comment period begins the day the Environmental Protection Agency publishes the Notice of Availability in the Federal Register. You may submit comments related to the Hollister Underground Mine Project by any of the following methods:

- E-mail: BLM_NV_ELDOHollisterEISTeam@blm.gov;
- Fax: 775-753-0255; or
- Mail: Bureau of Land Management, Hollister Underground Mine Project, Attention: Janice Stadelman, Project Manager, 3900 Idaho Street, Elko, NV 89801.

Copies of the Hollister Underground Mine Project DEIS are available in the BLM Elko District Office at the above address, and on line at http://www.blm.gov/nv/st/en/fo/elko_field_office.html.

Before including your address, phone number, e-mail address, or other personal identifying information in your comment, you should be aware that your entire comment–including your personal identifying information–may be made publicly available at any time. While you can ask us in your comment to withhold your personal identifying information from public review, we cannot guarantee that we will be able to do so.

Should you have any questions, please contact Janice Stadelman at (775) 753-0346.

Sincerely,

Gerald Dixon, Field Manager
Tuscarora Field Office

DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS)
HOLLISTER UNDERGROUND MINE PROJECT

Project Name:	Draft Environmental Impact Statement Rodeo Creek Gold Inc. Hollister Underground Mine Project
Lead Agency:	U.S. Department of the Interior Bureau of Land Management Elko District Office, Tuscarora Field Office Elko, Nevada
Cooperating Agencies:	Nevada Department of Wildlife Elko County Board of Commissioners
Project Location:	Elko County, Nevada
Correspondence on this EIS Should be Directed to:	Janice Stadelman, EIS Project Coordinator Bureau of Land Management Tuscarora Field Office 3900 Idaho Street Elko, Nevada 89801
Date by which Comments Must be Postmarked to BLM:	Within 45 days of the date of the Notice of Availability published in the Federal Register

ABSTRACT

This Draft Environmental Impact Statement analyzes potential impacts associated with Rodeo Creek Gold Inc.'s (RCG's) proposal to develop the Hollister Underground Mine Project (Proposed Action). The Proposed Action consists of transitioning from underground exploration activities to a full-scale producing underground gold and silver mine, including continued surface exploration. The Hollister Underground Mine Project is located in the northern end of the Carlin Trend, approximately 47 miles northwest of Elko and 64 miles northeast of Winnemucca, Nevada. The Proposed Action includes construction of a shaft, ramp, or raise; haul roads; electric power transmission line and ancillary facilities; water removal from the underground workings and discharge into Little Antelope Creek and the rapid infiltration basins; and backfilling the west open pit with waste rock material. The proposed surface disturbance is 92 acres. The total surface disturbance for the project is approximately 222 acres. The proposed mine life is 20 years. The agency-preferred alternative is the Proposed Action and Backfill Alternative.

Responsible Official for Draft EIS:	Gerald Dixon Field Manager Tuscarora Field Office

Executive Summary

Introduction

Rodeo Creek Gold Inc (RCG), a wholly owned subsidiary of Great Basin Gold Ltd (GBG), proposes to construct and operate the Hollister Underground Mine Project (project). The proposed project would include transition of existing underground exploration activities to a full-scale producing underground gold and silver mine, including the development of new facilities and expanded surface exploration. The proposed project is located in the northern end of the Carlin Trend, within Elko County, Nevada, approximately 47 miles northwest of Elko, 38 miles northeast of Battle Mountain, and 64 miles northeast of Winnemucca, Nevada.

Summary of the Proposed Action

RCG is proposing an expansion of its existing surface and underground exploration activities at the Hollister Site and transition to full-scale underground mine production and associated support facilities. An amendment to the Plan of Operations (NVN-076802) for the proposed project was submitted to the Bureau of Land Management (BLM) in March 2008.

The Proposed Action would contain the following major components: continued and expanded surface and underground exploration activities; transition from underground exploration and bulk sampling activities to full-scale production of gold and silver underground mining operation; installation of the Hatter production shaft, raise, or ramp (collectively referred to as the HPS), as the geology of the area dictates; construction of a new 11.6-mile-long electric power transmission line (transmission line) and substation, including access routes; water discharge to Little Antelope Creek; construction of ancillary support facilities; and continued off-site processing of all ore.

The proposed project would utilize all of the existing support facilities at the Hollister Site. The anticipated mine life would be approximately 20 years, followed by an estimated 3 years of site closure and reclamation activities. At the end of mine life RCG would reclaim all the facilities associated with the project, except roads included in the BLM road system. The Proposed Action would result in a total of approximately 117 acres of proposed surface disturbance.

The Hollister Underground Mine Project would extract 2.0 to 3.0 million tons of ore and generate 2.6 to 3.7 million tons of waste rock. Underground mining would occur in the Vinini Formation, the host rock that is composed of quartzite, chert, and argillite, and contains the gold and silver veins to be mined under the proposed project. The underground workings would extend approximately 2,000 feet below ground surface to a bottom elevation of 4,570 feet above mean sea level.

Water would be removed from the underground workings up to a rate of approximately 1,100 gallons per minute (gpm) on a continuous basis for the 20-year mine life. Water then would be pumped to the surface and gravity-fed in an existing buried pipeline to the rapid infiltration basins (RIBs) or to the proposed National Pollutant Discharge Elimination System (NPDES) discharge point on Little Antelope Creek.

Under the Proposed Action, waste rock would be disposed of in the existing approved RCG Waste Rock Storage Facility (WRSF), in the West Pit or as backfill in the underground mine workings.

Electric power would be provided by NVEnergy through a proposed transmission line to replace current power provided by two diesel generators at the Hollister Site. A new 120-kilovolt (kV) overhead line would be routed 5.4 miles from the existing Coyote Creek substation to the proposed Rodeo Creek substation near the existing east RIB where it would be reduced to 24.9-kV to the mine site.

Summary of the Project Alternatives

Four alternatives to the Proposed Action were considered for detailed analysis in the environmental impact statement (EIS), which include: Mud Springs Road Transmission Line Alternative; Mud Springs Waste Rock Storage Facility Alternative; Backfill Alternative; and the No Action Alternative. Eight other alternatives were considered but eliminated from detailed analysis.

Summary of Impacts Associated with the Proposed Action and Alternatives

Land Use and Access

The project area encompasses 10,168 acres, of which 9,301 acres are on public land. The project is located within the Twenty-Five and Squaw Valley allotments. New project-related disturbance of 117 surface acres would reduce the amount of land available for livestock grazing and dispersed recreation. Post-reclamation land use of most of the disturbance area would be returned to open space, grazing, dispersed recreation, and wildlife habitat.

Access to the area would be similar to present access. There would be continued access to the Tosawihi Quarries Archaeological District (Tosawihi Quarries).

Geology and Minerals

Impacts of the Proposed Action on geologic and mineral resources would include the generation and disposal of about 2.6 to 3.7 million tons of waste rock and the extraction of 2.0 to 3.0 million tons of ore.

The Proposed Action would create limited changes to topography, mostly on pre-existing authorized mining-disturbed and reclaimed land. The existing West Pit would be backfilled with waste rock below the rim, and reclamation would result in a final topography closer to the original topography of the area prior to historical surface mining activities.

Groundwater and Geochemistry

Groundwater would be removed from the underground workings within the Vinini Formation to access the gold and silver ore. Under the Proposed Action, groundwater pumping rates in the Vinini Formation would increase from current operation rates of approximately 400 gpm to a maximum rate of approximately 1,100 gpm.

The geotechnical water removal from the proposed expanded Hollister underground workings and the Hatter Expansion would result in lowering the water table in the Vinini Formation. The maximum extent of groundwater drawdown is predicted to occur in approximately 40 years after the cessation of mining. The maximum extent of the 10-foot groundwater drawdown contour is predicted to extend 7.9 miles from the underground workings, just beyond Antelope Creek to the southeast and just beyond Willow Creek to the northwest. Groundwater drawdown in the Vinini Formation could reduce flows in four spring complexes.

Mining would end after 20 years and the groundwater would begin to rebound. The simulated rebound of the water table shows recovery to within approximately 100 feet of the pre-mining water levels approximately 20 years after closure of the mine, and 10 years later at the Hatter Expansion area. Ninety-five percent recovery of the water table would occur approximately 30 to 35 years after the end of mine life.

Surface Water Resources and Watersheds

Impacts from groundwater drawdown in the Vinini Formation could include a reduction in flow in four spring complexes and associated spring-derived streamflows on Antelope Creek, Alkali Creek, and Squaw Creek.

Discharges from mine groundwater pumping would increase flow in Little Antelope Creek downstream of the proposed outfall for the life of the mine. No impacts to the existing stability conditions of channels and banks are anticipated.

Soils and Reclamation

The proposed project would result in 117 acres of surface disturbance that includes potential loss of soil to wind and water erosion, changes in chemical and physical properties, and decreased biological activity. Replacement of growth media is proposed for major disturbances associated with the proposed project.

Revegetation of disturbance areas would be conducted as soon as practical to minimize impacts to soils and vegetation and facilitate post-mining land uses. A period of overall reclamation monitoring (and maintenance as necessary) is required prior to agency approval of reclamation bond release. Major effects on the desired post-mining, exploration, and transmission line site productivity from soil quality impacts are not anticipated.

Vegetation Resources

The proposed project would disturb 43.8 acres of sagebrush shrubland and 65.1 acres of grassland vegetation; and approximately 8.1 acres of disturbed/sparsely vegetated land. The loss of 43.8 acres of shrub-dominated vegetation would represent a long-term impact as it could take up to 25 years following reclamation for mature shrub species to re-establish.

To minimize mine-related impacts to vegetation, reclamation would be conducted as soon as practical, with concurrent reclamation implemented to the maximum extent possible. Satisfactory revegetation of mine-related disturbance areas is anticipated to occur approximately 3 to 15 years following reclamation. After 25 years, the reclaimed plant communities likely would consist of adequate herbaceous plant cover with sufficient diversity to substantially reduce the potential for soil erosion and provide forage for use by livestock and wildlife.

Riparian and Wetland Areas

Continuous discharge of water into Little Antelope Creek temporarily would enhance existing riparian areas and create riparian areas further downstream for the 20-year life of the mine. After water discharge has ended, newly created riparian vegetation may take 3 to 5 years to transition back to upland vegetation, and the riparian vegetation transitions back to pre-discharge conditions.

Groundwater drawdown in the Vinini Formation potentially could reduce flow in four spring complexes and affect approximately 12 acres of wetlands. Based on the projected groundwater drawdown, it is anticipated that approximately 16 wetlands have the potential to be affected by groundwater drawdown in the long term. In addition, reduced flows from springs contributing to Antelope, Alkali, and Squaw creeks may result in the long-term loss of riparian vegetation. Groundwater flows to springs and seeps potentially impacted by the Proposed Action are projected to recover in approximately 50 to 100 years following initial drawdown.

Construction of the proposed project would not remove or disturb riparian or wetland areas.

Noxious Weeds and Non-native Invasive Plant Species

Noxious weeds and non-native invasive plant species invade areas that have been subject to surface disturbance. A decrease or cessation of flow in affected seeps and springs within the maximum extent of the 10-foot groundwater drawdown contour may increase establishment of noxious weeds and non-native invasive plant species known to invade riparian/wetland habitats.

Water-loving noxious weeds and/or non-native invasive plant species have the potential to become established along the margins of Little Antelope Creek due to increased flow from the discharge. Weed monitoring and control practices would be implemented to limit the growth and spread of noxious weeds and non-native invasive plant species and to facilitate successful revegetation with the proposed seed mixes. Weed control practices would follow RCG's existing Noxious Weed Prevention and Control Plan and Bureau of Land Management (BLM) and Nevada Division of Environmental Protection regulations.

Range Resources

The proposed project would not result in changes to the existing grazing system. Currently, the area inside the existing mine perimeter fence is excluded from grazing and would continue to be excluded from grazing. The majority of rangeland in the project area currently utilized for livestock grazing would continue to be available for livestock grazing during the project mine life.

The potential loss of these water sources may affect livestock distribution within portions of the Twenty-Five, Squaw Valley, and Tuscarora allotments.

Wildlife

Impacts to mule deer would include the incremental long-term reduction of potential forage and the incremental increase of habitat fragmentation from vegetation removal associated with the proposed project. A small amount of undisturbed, limited use, and transitional mule deer habitat would be impacted. No mule deer crucial winter habitat would be disturbed as a result of the proposed project. Impacts to pronghorn would be similar to those previously discussed for mule deer. No pronghorn low density habitat would be disturbed as a result of the proposed project. Potential impacts to elk would include the incremental long-term reduction of undisturbed low-density, habitat and crucial winter habitat within the study area. Given the suitable habitat adjacent to the disturbance areas, these impacts are anticipated to be minor.

Impacts to small game and non-game species would include displacement from the disturbance areas and increased habitat fragmentation, until reclamation has been completed and vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas would be available for use by these species.

Potential impacts to migratory bird species would include the long-term loss of approximately 117 acres of potentially suitable breeding, roosting, and foraging habitat. However, this temporary loss is expected to have little effect on local bird populations based on the amount of suitable breeding and foraging habitat in the surrounding area.

Generally, transmission lines pose an electrocution hazard for raptor species attempting to perch on the structures. RCG has committed to using Avian Power Line Interaction Committee raptor-deterring design measures.

Aquatic Biological Resources

Based on groundwater modeling using the maximum extent of the 10-foot drawdown contour, groundwater pumping in the Vinini Formation could reduce flows and water levels in four spring

complexes. The effects of reduced flow would be more pronounced in small springs where changes in habitat conditions could represent a substantial portion of the habitat. Flow changes in affected springs could impact the occurrence of invertebrates.

Groundwater pumping also could reduce flow in the wetland areas in Antelope and Squaw creeks. If present, amphibian habitat could be adversely affected by flow and water level reductions. Groundwater pumping also could reduce flows in Antelope Creek and its tributaries, and Squaw and Alkali creeks from reduced flows from affected springs, which could reduce fish and invertebrate densities.

Mine discharge could cause increased temporary flow in Little Antelope Creek, which would create temporary additional aquatic habitat. Stream reaches with increased flow would provide habitat for aquatic macroinvertebrates and possibly nongame native fish species that have been observed in nearby drainages and amphibians. By adhering to the NPDES permit requirements, no adverse effects of water quality on aquatic species would occur in Little Antelope Creek.

Special Status Species

Impacts to special status species would include the temporary (short-term and long-term) reduction or loss of habitat. Short-term impacts arise from habitat removal and disturbance as well as from activities associated with mine operation.

Impacts to some special status species would include the long-term loss of approximately 117 acres of potentially suitable habitat. Based on the limited habitat to be disturbed, and available habitat in the vicinity, potential impacts to these species as a result of the proposed project would be low.

A long-term loss of approximately 43.8 acres of potentially suitable sagebrush shrubland habitat would potentially impact some special status species. These impacts would be considered low considering the small amount of disturbance and the availability of similar habitat in the study area.

Special status species dependent upon wetlands could be impacted from the loss of 12 acres of wetland and some riparian habitat as a result of groundwater drawdown. These impacts would include loss of available surface water and associated wetland and riparian vegetation. Nine springs within two spring complexes and associated habitat known to contain springsnails could be adversely affected by groundwater drawdown and associated reduction in spring flows.

Based on the results of the noise field measurements, impacts from increased human presence and noise at and near the Hollister Site on special status species and specifically greater sage-grouse is anticipated to be low. This is primarily due to the distance of the active leks in relation to the current Hollister Site, topographic shielding of the leks from the Hollister Site and Ivanhoe Road, and the existing level of human activity at the Hollister Site. Additionally, exploration activities would be prohibited from 1 hour before sunrise until 10 a.m. within 3 miles of a sage-grouse lek during the March 15 to June 15 breeding season.

Paleontological Resources

Direct adverse impacts to fossils could potentially occur from transmission line construction activities conducted on the tuffaceous portions of the Carlin Formation. Indirect impacts during construction could include erosion of fossil beds. It is anticipated that impacts to paleontological resources associated with transmission line construction would be minimal due to the previous surveys confirming that the fossils on the surface within the proposed transmission line corridor were of minimal scientific value.

There is a very low risk of impacts to fossils on previously authorized disturbed lands. Underground mining is not likely to affect paleontological resources. Impacts to paleontological resources associated with surface exploration also would be minimal because pre-exploration surveys would be conducted as part of the cultural resources inventory prior to surface disturbance activities.

Cultural Resources

Direct impacts to cultural resources could include loss of historic properties eligible for listing on the National Register of Historic Places. Mitigation would be developed and implemented in accordance with the Programmatic Agreement (PA). To minimize the potential for illegal collection, vandalism, and inadvertent damage, RCG would ensure that all its personnel and contractors are instructed on cultural resources avoidance and protection measures as part of its environmental training program.

Native American Traditional Values

Effects to Native American traditional values include potential direct impacts to historic properties, as well as groundwater drawdown impacts to springs. In consultation with the Nevada State Historic Preservation Office and the Tribes, the BLM would determine whether construction and operation of the proposed project would have an adverse effect on any historic properties of traditional religious and cultural importance to the Tribes. If the BLM determines that historic properties of traditional religious and cultural importance would be adversely affected, then mitigation would be proposed in accordance with the PA. If construction or other project personnel discover what might be human remains, then construction would immediately cease and the BLM manager would be notified. The inadvertent discovery of human remains would follow the procedures stated in the Native American Graves Protection and Repatriation Act. Four spring complexes potentially would be affected by the proposed project from groundwater drawdown in the Vinni Formation. Any effects to springs and streams may in turn affect Native American traditional values because of the sacredness of water to the Tribes.

Government-to-government consultation regarding potential effects to any identified properties of traditional religious and cultural importance and graves/burials, as well as groundwater drawdown impacts to springs, and possible mitigation is ongoing and would continue as long as it is needed. The consultation efforts have included field visits, public scoping, site visits, and interviews conducted for the ethnography report prepared for the proposed project.

Recreation and Wilderness

There would be a minor reduction in land available for dispersed recreation as a result of the Proposed Action. However, there is an ample supply of alternative public land for dispersed recreational activities in the project vicinity.

The project area does not contain any land that meets the criteria for wilderness characteristics or designation. No adverse impacts to designated wilderness or wilderness study areas have been identified.

Air Quality

Modeling results indicate that the proposed project would not exceed state or national Ambient Air Quality Standards for particulate matter with an aerodynamic diameter of 2.5 microns or less, particulate matter with an aerodynamic diameter of 10 microns or less, oxides of nitrogen, carbon monoxide, and sulfur dioxide for Hollister Mine site operations, ore haul traffic along gravel/dirt roads, or for portable drill rigs. Electric power would be brought in via an overhead transmission line to replace the two diesel generators currently providing power thereby reducing emissions at the Hollister Site.

The combined hazardous air pollutant (HAP) emissions would be less than the major source limit of 25 tons per year (tpy); therefore the Proposed Action would not constitute a major HAP source. Mineral processing of 2 to 3 million tons of ore over the 20-year life of the project would result in no more than 7.0 pounds of mercury per year at either Esmeralda or Midas mills.

Conservative VISCREEN modeling results for potential visibility impacts from ore processing at Esmeralda Mill indicate that under worst-case conditions, there could be visibility impacts at Yosemite National Park, a Class I area. Based on the complex terrain at the mill site and between the mill site and Yosemite National Park and the local meteorology of the area, it is not likely that emissions from Esmeralda Mill would impact visibility at the national park. Ore processing at Midas Mill would not adversely affect visibility in the nearest Class I area, Jarbidge Wilderness.

Greenhouse gas (GHG) emissions would contribute approximately 30,768 tpy of GHGs for the Propose Action assuming all ore was hauled to the Esmeralda Mill. Total GHG emissions would be approximately 20,997 tpy if all ore was hauled to the Midas Mill.

Social and Economic Values

The proposed project would have a minor long-term effect on the population or demographics of study area that includes Humboldt, Lander, Eureka, and Elko counties.

The local economy would benefit from continuation and a slight increase in current activity for an additional 20 years. In 2009, RCG generated $552,196 in net proceed taxes; $855,728 in sales and use taxes; and $127,295 from ad valorem property taxes. These taxes are expected to increase over the 20-year mine life. The overall social and economic effects of the proposed project would be beneficial to study area communities.

Environmental Justice

The Proposed Action would not be expected to disproportionately affect any particular population. Environmental effects that may occur would affect the study area's population essentially equally without regard to race, ethnicity or income level.

Visual Resources

Development of the proposed project would expand the amount of visual contrast that currently exists between existing and previously approved exploration-related facilities and the natural character of the landscape. The proposed project also would extend visual effects through the use of the area and proposed mining activity. The proposed project primarily would expand the visual effects in the vicinity of the existing mine area, and would be most prominent during active mining. The visual contrast effects gradually would become less prominent with reclamation. The proposed project would comply with the Visual Resource Management Class IV objective during active mining and after reclamation because the color contrast and landform contrast would be weak.

Noise

The two currently used diesel generators at the Hollister Site would be replaced by electric line power. However, the generators would be left in place for emergency backup power. All other surface equipment at the mine site would remain the same as current usage. The effect on noise from the Proposed Action would be a reduction in current noise emissions.

Hazardous Materials and Solid Waste

All hazardous substances would be transported by commercial carriers or vendors in accordance with the requirements of Code of Federal Regulations (CFR), Title 49. The probability of a release anywhere along the transportation route, within a populated area, and the probability of a release involving an injury or fatality is minimal.

Based on the facility's design features and the operational practices in place, the probability of a major release occurring at the site during the life of the mine would be low. Any release would be reported and mitigated according to federal and state law.

Energy Requirements, Climate Change, and West Nile Virus

The proposed project represents 1.2 percent of the GHG emissions from all sources in the region, approximately 0.04 percent of the emissions in Nevada, and a tiny fraction of the emissions on a global basis. As a result, the proposed project would be expected to have a negligible effect on climate.

The Proposed Action would not be creating any additional ponds that could increase the likelihood of humans contracting West Nile Virus.

BLM-preferred Alternative

The Council on Environmental Quality Regulations (40 CFR 1502.14e) direct that an EIS "identify the agency's preferred alternative or alternatives, if one or more exists, in the draft statement and identify such alternative in the final statement unless another law prohibits the expression of such a preference." The BLM has selected alternatives based on the analysis in the EIS. These preferred alternatives are those that best fulfill the agency's statutory mission and responsibilities, considering economic, environmental, technical, and other factors. The BLM has determined the preferred alternatives are the Proposed Action and the Backfill Alternative.

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	microgram per liter
µg/m^3	microgram per cubic meter
µm	micrometers
µS/cm	microSiemens per centimeter
AAQS	Ambient Air Quality Standards
ABA	acid-base accounting
ACHP	Advisory Council on Historic Preservation
AGFD	Arizona Game and Fish Department
AGP	acid generation potential
AIRFA	American Indian Religious Freedom Act
amsl	above mean sea level
ANP	acid neutralization potential
AO	Authorized Officer
APE	area of potential effect
APGI	Antler Peak Gold Inc
APLIC	Avian Power Line Interaction Committee
ARD	acid rock drainage
ARPA	Archaeological Resources Protection Act
As	Arsenic
ASTM	American Society for Testing and Materials
AUM	animal unit month
BCC	bird conservation concern
BEA	Bureau of Economic Analysis
BGMI	Barrick Goldstrike Mines Inc.
bgs	Below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
BMRR	Bureau of Mining Regulation and Reclamation
BVMP	Boulder Valley Monitoring Plan
BWPC	Bureau of Water Pollution Control
Ca	Calcium
CAA	Clean Air Act

$CaCO_3$	Calcium carbonate
CCD	counter current decantation
CDC	Center for Disease Control
CDP	Census Designated Place
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESA	Cumulative Effects Study Area
CFR	Code of Federal Regulations
cfs	cubic feet per second
CH_3Hg^+	methyl mercury
CH_4	methane
CIA	Cumulative Impact Analysis
CIL	carbon-in-leach
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
CRMP	Cultural Resources Management Plan
dBA	Decibel on the A-weighted scale
DO	Dissolved oxygen
DOI	Department of the Interior
EA	Environmental Assessment
EC	electrical conductivity
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
ET	Evapotranspiration
FLPMA	Federal Land Policy and Management Act
FR	Federal Register
$feet^2$/day	Square feet per day
$feet^3$/day	Cubic feet per day
FEMA	Federal Emergency Management Agency
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FY	fiscal year
GBC	Great Basin College
GBG	Great Basin Gold Ltd
GHG	Greenhouse Gas
gpm	gallons per minute
GWP	Global Warming Potential

HAP	Hazardous Air Pollutant
HCM	Highway Capacity Manual
HCO_3	hydrogen bicarbonate
HCT	Humidity Cell Test
HDPE	high-density polyethylene
Hg	Mercury
hp	Horsepower
HPS	Hatter production shaft, ramp, or raise
HPTP	Historic Properties Treatment Plan
HUD	Housing and Urban Development
I-80	Interstate 80
IAPP	Industrial Artificial Pond Permit
IM	Instructional Memorandum
IPCC	Intergovernmental Panel on Climate Change
JBR	JBR Environmental Consultants, Inc.
kg	kilogram
km	kilometer
KOP	Key Observation Point
kV	kilovolt
kW	kilowatt
LAC	Little Antelope Creek
L_{dn}	Day-night (average sound) level
L_{eq}	Equivalent sound level
LOS	level of service
m^2	square meter
m^2/L	square meters per liter
MBTA	Migratory Bird Treaty Act
Mg	Magnesium
mg/L	milligram per liter
mgd	million gallons per day
ml	milliliter
MOU	Memorandum of Understanding
MSA	Micropolitan Statistical Area
MSHA	Mine Safety and Health Administration
MWMP	Meteoric Water Mobility Procedure
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NAGPRA	Native American Graves Protection and Repatriation Act

NDEP	Nevada Division of Environmental Protection
NDETR	Nevada Department of Employment, Training, Rehabilitation
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife
NDWR	Nevada Division of Water Resources
NEPA	National Environmental Policy Act
Newmont	Newmont Mining Corporation
NH_3	ammonia
NHPA	National Historic Preservation Act of 1986
NNHP	Nevada Natural Heritage Program
NNP	net neutralizing potential
NNSG	Northeastern Nevada Stewardship Group
NO_2	nitrogen dioxide
NOAA	National Oceanographic and Atmospheric Administration
NOI	Notice of Intent
NO_X	nitrogen oxides
NPA	National Programmatic Agreement
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRS	Nevada Revised Statute
NSHD	Nevada State Health Division
NWIS	National Water Information System
NWR	National Wildlife Refuge
O_3	Ozone
PA	Programmatic Agreement
PAG	potentially acid generating
Pb	lead
PCPI	Per Capita Personal Income
PFYC	Potential Fossil Yield Classification
PGH	Preliminary General Habitat
PIF	Partners in Flight
PLS	Pure Live Seed
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 microns or less
PMU	Population Management Unit

PoO	Plan of Operations
PPH	Preliminary Priority Habitat
project	Hollister Underground Mine Project
PVC	polyvinyl chloride
PWR	Public Water Reserve
P.Z.	Precipitation Zone
R	range
RCG	Rodeo Creek Gold Inc
RCRA	Resource Conservation and Recovery Act
RFFA	Reasonably Foreseeable Future Action
RGM	reactive gaseous mercury
RIB	Rapid Infiltration Basin
RMP	Resource Management Plan
RO	reverse osmosis
ROW	right-of-way
RUS	Rural Utilities Services
RV	Recreational Vehicle
SAG	semi-autogenous grinding
SARA	Superfund Amendments and Reauthorization Act
Se	selenium
SEDEX	sedimentary exhalative
SEIS	Supplemental Environmental Impact Statement
SH	State Highway
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SO_4	sulfate
SOAP	South Operations Area Project
SOAPA	South Operations Area Project Amendment
SpC	Specific Conductance
SPCC	Spill Prevention, Control, and Countermeasures Plan
SR	State Route
SRSP	South Rapid Infiltration Basin Stockpile
SSURGO	Soil Survey Geographic Database
SWPPP	Storm Water Pollution Prevention Plan
T	township
t/Kt	tons per kiloton
TCP	traditional cultural property
TDS	total dissolved solids

tpd	tons per day
tph	tons per hour
tpy	tons per year
TRB	Transportation Research Board
TRI	toxic release inventory
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
vpd	vehicles per day
VRM	Visual Resource Management
WAD	weak acid dissociable
WMA	Wildlife Management Area
WNV	West Nile Virus
WPCP	Water Pollution Control Permit
WRSF	Waste Rock Storage Facility
WSA	Wilderness Study Area
yd^3	cubic yard

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1.0 Introduction

Rodeo Creek Gold Inc (RCG), a wholly owned subsidiary of Great Basin Gold Ltd (GBG), proposes to construct and operate the Hollister Underground Mine Project (project). The proposed project would include transition of existing underground exploration activities to a full-scale producing underground gold and silver mine, including the development of new facilities and expanded surface exploration. The proposed project is located in the northern end of the Carlin Trend, within Elko County, Nevada, approximately 47 miles northwest of Elko, 38 miles northeast of Battle Mountain, and 64 miles northeast of Winnemucca, Nevada (**Figure 1-1**). The community of Midas, Nevada, is located approximately 20 miles to the northwest.

RCG submitted an Amendment to the Plan of Operations (PoO) (NVN-076802) for the proposed project in March 2008, to the Bureau of Land Management (BLM) Elko District Office in compliance with 43 Code of Federal Regulations (CFR) Subpart 3809. Revisions to the PoO have since been submitted to the BLM based on BLM comments received on the original PoO and project updates. A final PoO amendment would be submitted to the BLM and available upon request to the BLM. The proposed project would include the following key components:

- Continued and expanded surface and underground exploration activities;
- Transition from underground exploration and bulk sampling activities to full-scale production of gold and silver (underground mining operation);
- Installation of the Hatter production shaft, ramp, or raise, as the geology of the area dictates;
- Continued maintenance of the existing Ivanhoe Access Road and Little Antelope Creek Road;
- Construction of road(s) within the existing mining disturbance areas and to the Hatter production shaft;
- Construction of a new 11.6-mile-long electric power transmission and distribution line (collectively referred to as 'transmission line') and substation, including access routes;
- Mine water management including installation of a National Pollutant Discharge Elimination System (NPDES) permitted outfall for discharge to Little Antelope Creek and surface monitoring and underground wells, as needed;
- Continued waste rock disposal in the existing permitted and lined waste rock storage facility (WRSF), in underground mined-out areas as backfill, and in a new WRSF located on previously disturbed and unreclaimed land in an existing open pit;
- Construction of ancillary support facilities; and
- Continued and increased transport of ore by truck to off-site existing third-party owned mineral processing facilities located on private land at the Esmeralda Mill in Mineral County, Nevada, and/or the Midas Mill in Elko County, Nevada.

The proposed project would utilize all of the existing support facilities at the mine site. The anticipated mine life would be approximately 20 years, followed by an estimated 3 years of site closure and reclamation activities. To the extent possible, reclamation would occur concurrently with mine operations. A detailed description of the proposed project is provided in Section 2.4, Proposed Action.

The proposed project would be located within Township 37 North (T37N), Range 48 East (R48E) and T38N, R48E in Elko County. The proposed project consists of three major components: 1) mine facilities, including water management facilities and mine roads; 2) transmission line; and 3) surface exploration. The majority of the proposed 92 acres of mining and transmission line components'

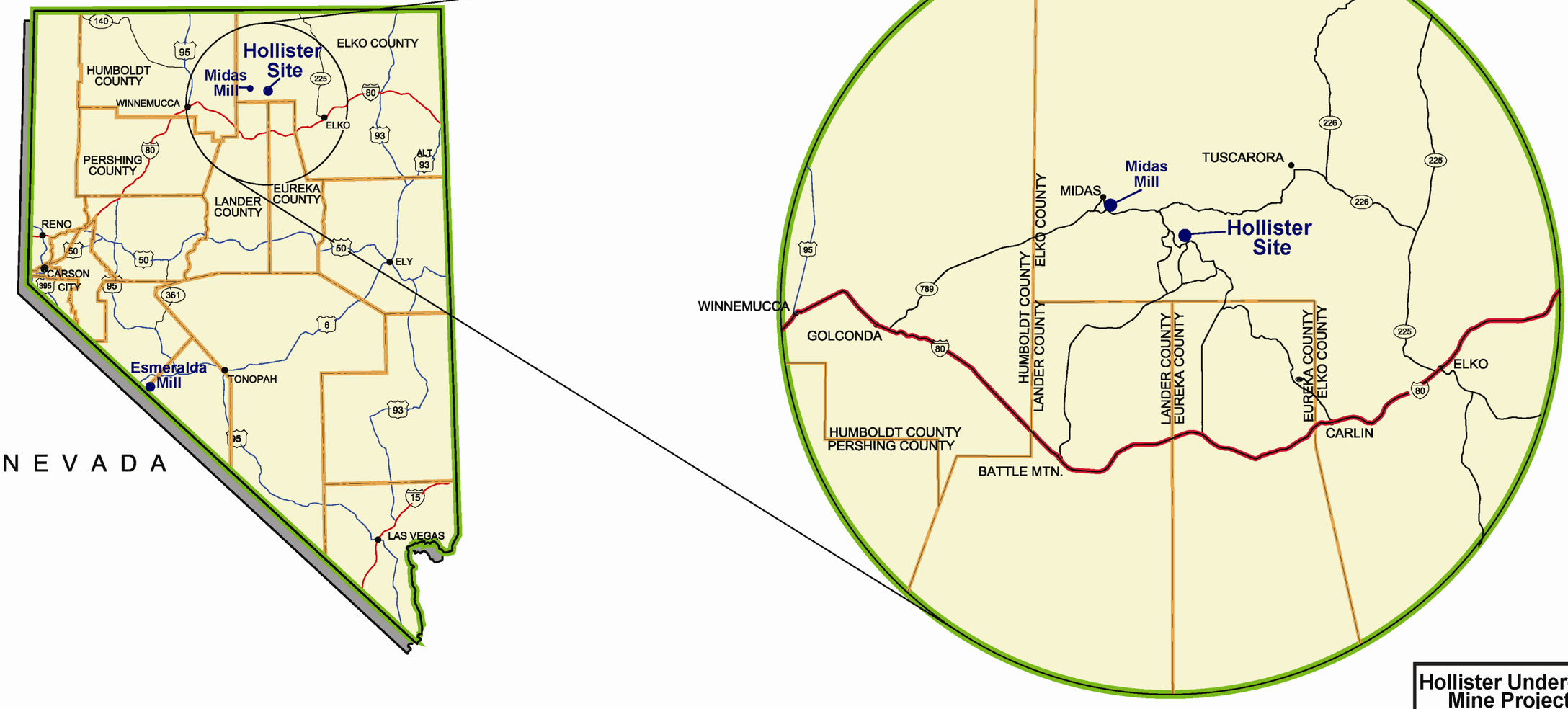
surface disturbance would be located on public lands administered by BLM. A total of 81.2 acres of public land administered by the BLM and 10.8 acres of private land are included within the project disturbance. Surface ownership in the project area is presented in **Figure 1-2**. The 92-acre surface disturbance includes 51.5 acres of new disturbance, 32.4 acres of disturbance on reclaimed lands, and 8.1 acres of previously disturbed but not reclaimed lands. The project area boundary encompasses the proposed surface and underground exploration areas and the mine facilities, including the proposed transmission line.

Also as part of the proposed project, the surface exploration program would be expanded from the existing 25 acres to a total of 50 acres within the project area. The Ivanhoe Exploration PoO (NVN-071014), the Craig Notice (NVN-075619), the Hatter Notice (NVN-071201), and the exploration program would be consolidated into the Hollister Underground Mine PoO (NVN-076802). The total project disturbance, including existing and proposed, would be approximately 222 acres. The project area and its boundary also is presented in **Figure 1-2**. Chapter 2.0 describes the existing operations and Proposed Action.

Approval is required by the BLM pursuant to the Federal Land Policy and Management Act of 1976 (FLPMA), as amended, the Use and Occupancy Under the Mining Laws Regulations (43 CFR Subpart 3715), and the surface management regulations (43 CFR Subpart 3809). The BLM is required by the National Environmental Policy Act of 1969 (NEPA) to review the impacts of the overall proposal, including impacts on both public and private lands. The BLM has determined that an environmental impact statement (EIS) must be prepared to fulfill NEPA requirements. The proposed project PoO (RCG 2012) comprises the Proposed Action for this EIS.

Subpart 3715 of 43 CFR identifies the requirements for “use and occupancy of public lands for the development of locatable mineral deposits by restricting such use or occupancy to that which is reasonably incident.” RCG is required to meet the specific conditions outlined in 43 CFR Subpart 3715.3-2 as the project would affect a total of approximately 222 acres. This surface disturbance consists of approximately 105 acres of existing disturbance and approximately 117 acres of proposed disturbance. This disturbance is on public land managed by the BLM and private land. Specifically, a total of 92 acres are associated with the proposed mining operations and an additional 25 acres are associated with the proposed surface exploration activities. In order to delineate the active mining operations area (mine site), the active mining operations area would be fenced and/or signed. Public access would be restricted and require assistance from RCG or company personnel on the mine site in order to protect the public from potential hazardous situations that can arise at a mine site and to protect the mine facilities and equipment from vandalism or damage from the public. The area within the project boundary that is not occupied by the active mining operations would be open to public access including the exploration area, Ivanhoe Road, and Little Antelope Creek Road. Fences and signs installed on public lands would be approved by the BLM. The Occupancy and Use requirements do not allow individuals to live on-site. A Programmatic Environmental Assessment (EA) for mining claims, mill site use, and occupancy for selected actions was completed by the Nevada State Office of the BLM with a finding of no significant impact (BLM 2000a). The Programmatic EA provides the basic analysis for the proposed use and occupancy of public lands related to locatable minerals. This EIS provides the site specific analysis.

The BLM is the lead agency for preparing the EIS in compliance with NEPA, the Council on Environmental Quality (CEQ) NEPA implementing regulations (40 CFR Parts 1500-1508), the BLM’s NEPA Handbook (H-1790-1), the Bureau-wide Guidelines for Assessing and Documenting Cumulative Impacts (2008a), CEQ’s Considering Cumulative Effects under NEPA (CEQ 1997a), and other applicable guidance. The Nevada Department of Wildlife (NDOW) and Elko County Board of Commissioners served as cooperating agencies for preparation and review of the EIS.

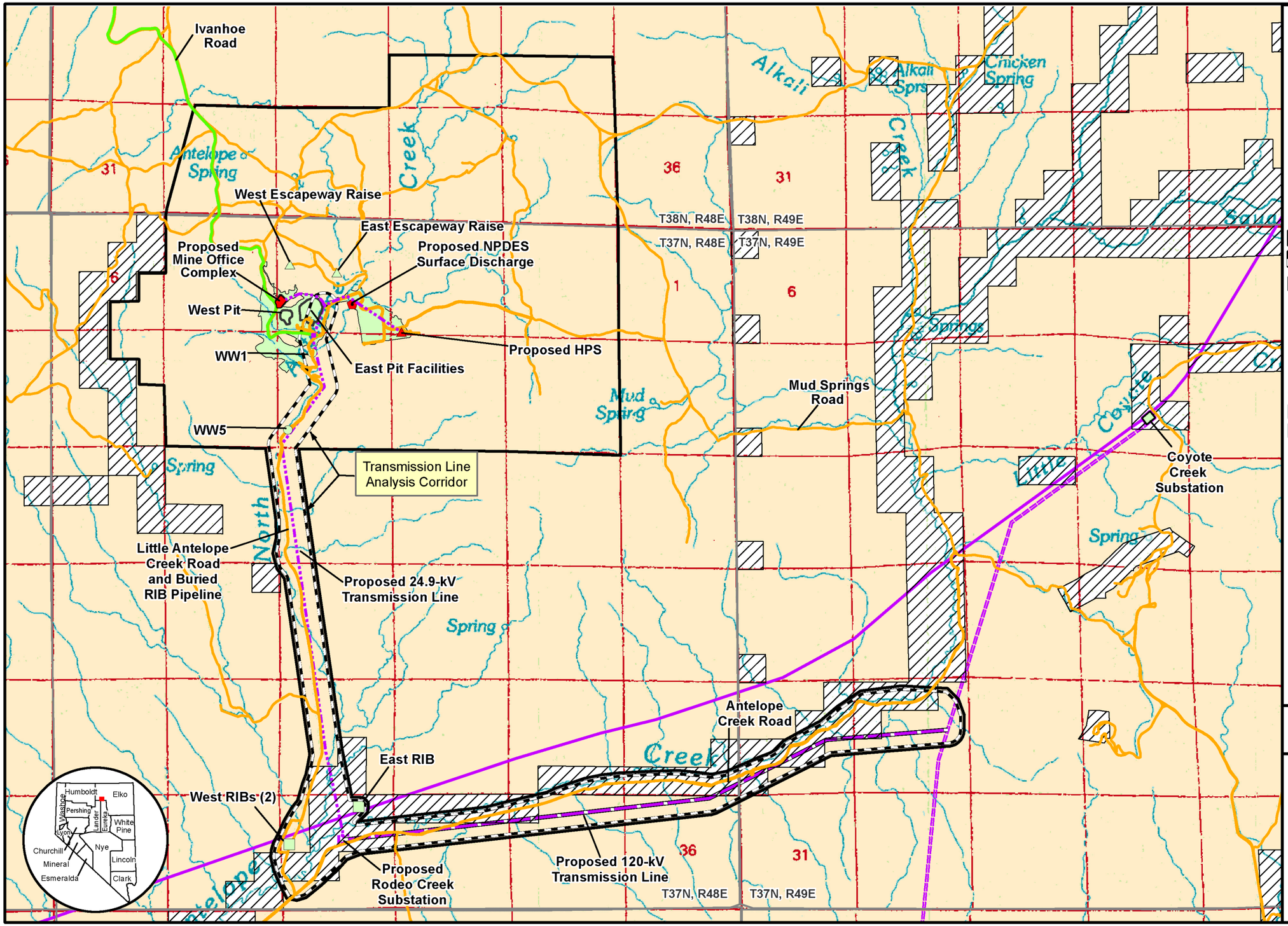


Source: RCG 2009a.

Hollister Underground Mine Project EIS

Figure 1-1

General Location of the Hollister Site and Other Facilities



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Surface Ownership

- Private Land
- BLM Land

Source: RCG 2009a.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 1-2

Project Area and Surface Ownership

10/19/2011

This EIS describes and analyzes the environmental consequences of the proposed project (Proposed Action) and project alternatives, including the No Action Alternative. The No Action Alternative would allow the current underground and surface exploration to continue under the existing PoOs and Notices as currently approved and acknowledged, respectively.

1.1 Purpose and Need

The BLM is responsible for managing mineral rights and access on federal lands as authorized by the General Mining Law of 1872, as amended. Under the law, persons are entitled to reasonable access to explore for and develop mineral deposits on public domain lands that have not been withdrawn from mineral entry.

In order to use public lands managed by the BLM for locatable mineral exploration and development, RCG must comply with the BLM's Surface Management Regulations (43 CFR 3809), Use and Occupancy Under the Mining Laws Regulations (43 CFR 3715) and other applicable statutes, such as the FLPMA 1976.

The BLM's purpose is to respond to RCG's proposed project PoO Amendment and the right-of-way (ROW) application for the transmission line. RCG is proposing to develop an underground mine on public lands to mine gold and silver, which are locatable minerals, and to construct a transmission line to provide power to this mining operation. In responding to RCG's proposed project, the BLM would determine whether to approve, approve with modifications, or deny the proposed project.

The BLM's need for the action is based on RCG's proposed project. The BLM is required to respond to RCG's proposed project to conduct mining operations for locatable minerals in accordance with the Surface Management Regulations (43 CFR 3809), the Use and Occupancy Under the Mining Laws Regulations (43 CFR 3715) and other applicable laws such as FLPMA and the NEPA. The BLM is required to respond to RCG's proposal to construct a transmission line in accordance with the BLM Right-of-Way Regulations (43 CFR 2800), and respond to the ROW application under Title V of FLPMA for a ROW grant to construct, operate, maintain, and decommission this proposed transmission line. In considering the need for the proposed project, the BLM must determine if the proposed project would create unnecessary or undue degradation to the public lands involved in the action. The NEPA mandates that the BLM evaluate or analyze the impacts of the proposed project and develop alternatives and mitigation, when necessary, to lessen any impacts to the resources.

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

1.2.1 Land Use Plan Conformance

The FLPMA requires that an action under consideration be in conformance with the applicable BLM land use plan, and be consistent with other federal, state, local, and tribal policies.

The BLM has the responsibility and authority to manage the surface and subsurface resources on public lands located within the jurisdiction of the Elko District Office. The BLM has designated lands within the project area as open to entry for locatable minerals. The Proposed Action and alternatives, as described and analyzed in this EIS, conform to the Elko Resource Management Plan, Issue – Minerals Management, Prescription No. 1 (BLM 1987, 1986a).

1.2.2 State and Local Land Use Plans and Policies

The State of Nevada's 1986 Statewide Policy Plan for Public Lands section on Mineral Resources (page 10) states the Goals for Mineral Resources as: 1) recognize that the development of Nevada's mineral resources is desirable and necessary to the nation, the state, and particularly, to the rural counties of the state; 2) retain existing mining areas and promote the expansion of mining operations and areas, while respecting other resource values; and 3) develop policies and regulations that provide for the long-term availability and responsible development of Nevada's mineral resources.

The State of Nevada recognizes that mining is an important contributor to the state's economy and encourages the development of mineral resources. In Nevada Revised Statute 519A.010, the state policy toward mining and reclamation, as defined by the Legislature, is:

"(a) The extraction of minerals by mining is a basic and essential activity making an important contribution to the economy of the State of Nevada;

(b) Proper reclamation of mined land, areas of exploration, and former areas of mining or exploration, is necessary to prevent undesirable land and surface water conditions detrimental to the ecology and to the general health, welfare, safety, and property rights of the residents of this state; and

(c) The success of reclamation efforts in this state is dependent upon cooperation among state and federal agencies."

Elko County, in cooperation with the Nevada Division of State Lands, developed an Elko County Public Lands Policy Plan (Elko County 2008). The Proposed Action is consistent with this plan that recognizes the economic importance of developing mineral resources within the county. Policy 14-1 of this plan states (that it is the objective/goal of this plan to) "…retain existing mining areas and promote the expansion of mining operations and areas not specifically withdrawn."

1.3 Authorizing Actions

Implementing the Proposed Action would require authorizing actions from other federal, state, and local agencies with jurisdiction over certain aspects of the project. **Table 1-1** lists the required permits or approvals that are already in place or would be obtained and the responsible regulatory agencies. RCG is responsible for amending existing permits and applying for and acquiring additional permits, as needed. **Appendix A** provides additional permitting and approval information.

Table 1-1 Major Permits and Approvals

Permit/Approval	Granting Agency
EIS PoO Approval ROW Grant(s) Mineral Material site(s) on public land	United States (U.S.) Department of the Interior, BLM
Explosives Permit	U.S. Department of the Treasury, Bureau of Alcohol, Tobacco, and Firearms; U.S. Office of Homeland Security
Section 106 National Historic Preservation Act Compliance Programmatic Agreement	BLM and State of Nevada Historic Preservation Office
Review of Jurisdictional Determinations for Clean Water Act Section 404 Permitting (and related permits required, if any)	U.S. Army Corps of Engineers
Surface Disturbance Permit Operating Permit to Construct Air Quality Operating Permit	Nevada Department of Conservation and Natural Resources, Nevada Division of Environmental Protection (NDEP)
Water Pollution Control Permit Reclamation Permit	Nevada Department of Conservation and Natural Resources, NDEP, Bureau of Mining Regulation and Reclamation

Table 1-1 Major Permits and Approvals

Permit/Approval	Granting Agency
Permit to Appropriate Water	Nevada Department of Conservation and Natural Resources, Nevada Division of Water Resources
Industrial Artificial Pond Permit	NDOW
NPDES Permit General Storm Water Permit General Permit to Operate and Discharge (large capacity septic systems, if any) Wastewater Holding Tanks Permit (and related permits, if any)	Nevada Department of Conservation and Natural Resources, NDEP, Bureau of Water Pollution Control
Public Drinking Water System Permit	Nevada Department of Conservation and Natural Resources, NDEP, Bureau of Safe Drinking Water
Hazardous Materials Storage Permit	State of Nevada, Fire Marshal Division
County Road Maintenance/Upgrading Building Permits	Elko County
Midas Road Usage in Humboldt County Municipal Solid Waste Disposal	Humboldt County

1.4 Applicable Plans of Operations, Notices, and Environmental Assessments

Previous PoOs, Notices, and EAs associated with the Hollister operations area are described in **Table 1-2**.

Table 1-2 Hollister Operations Area – Plans of Operations, Notices, and Environmental Assessments

Title	Company/Operator	File or EA Number	Date
Transition from Underground Development and Exploration to Full Underground Mine Production: Hollister Mine Project Plan of Operations Amendment (RCG 2012, 2009a)	Rodeo Creek Gold Inc	NVN-076802	June 2009, as revised
Hollister Development Block Project Plan of Operations and EA (BLM 2004a; GBG 2004)	Rodeo Creek Gold Inc (2007-present)	EA#:BLM/EK/PL-2004/002	March 2004
	Hecla Ventures Corporation (2004-2007)	NVN-076802	January 2004
Ivanhoe/USX Project Access Road ROW and EA (RCG 2003)	Rodeo Creek Gold Inc	NVN-077637 EA-NV-010-1988-068	September 2003 September 1988
Craig Notice (BLM 2002a)	Great Basin Gold Inc	NVN-075619	February 2002
Hatter Notice (BLM 1997)	Great Basin Gold Inc	NVN-071201	October 1997

Table 1-2 Hollister Operations Area – Plans of Operations, Notices, and Environmental Assessments

Title	Company/Operator	File or EA Number	Date
Ivanhoe Surface Exploration Plan of Operations and EA (BLM 1999, 1992, 1988a; GBG 1993)	Great Basin Gold Inc (1997-present)	BLM/EK/PL-99/036	August 1999
	Newmont Exploration Limited (1992-1997)	EA-NV-010-88-070 EA-NV-010-88-070(A)	September 1988 February 1992
	Touchstone Resources Company (1988-1992)	NVN-071014	March 1993
Ivanhoe/USX Project Access Road – ROW and Final EA (BLM 1988b; Newmont 1988a)	Newmont Exploration Limited/Newmont Mining Corporation (1992-present)	EA-NV-010-1988-068	September 1988
	Galactic Services, Inc./Touchstone Resources Inc. (1988-1992)	NVN-048616	May 1988
Ivanhoe USX Project/Ivanhoe/Hollister Mine Plan of Operations and EA (BLM 1988c; Newmont 1988b)	Newmont Exploration Limited/Newmont Mining Corporation (1992-present)	EA-NV-010-1988-064	September 1988
	Galactic Services, Inc./ Touchstone Resources Inc. (1988-1992)	NVN-070613	September 1988

1.5 EIS Organization

This EIS follows the CEQ recommended organization (40 CFR Part 1502.10). Chapter 1.0 provides descriptions of the purpose and need. Chapter 2.0 describes the Proposed Action and alternatives, including the No Action Alternative. Chapter 3.0 describes the affected environment; environmental consequences including direct, indirect, and cumulative impacts associated with the Proposed Action and alternatives; possible mitigation to reduce or minimize impacts; irreversible and irretrievable commitment of resources, and any residual adverse effects following the implementation of mitigation. Chapter 4.0 summarizes the public participation and scoping process as well as the consultation and coordination undertaken to prepare the EIS. Chapter 5.0 presents the list of EIS preparers and reviewers. Chapter 6.0 presents the list of references. Copies of supporting documents are on file at the BLM Elko District Office in Elko, Nevada.

1.6 Summary of Key Issues

Key issues identified in the scoping process associated with the Proposed Action are discussed in this EIS. They include:

Cumulative Issues

- Potential cumulative impacts from the existing project and the proposed project relative to contamination of surface flows, rainfall, and snowmelt that pass through WRSFs, ore stockpiles, and mine tailings.
- Potential cumulative impacts from the existing activities and the proposed project to all discharges to surface water.
- Potential cumulative impacts to the region's ecosystem.
- Potential cumulative impacts associated with additional aboveground disturbance, adverse affects to livestock grazing, and increased traffic from the proposed project and future planned projects.
- Potential cumulative impacts to greater sage-grouse by the proposed project and the Ruby Pipeline.
- The likely fate and transport of mercury air emissions from the proposed project and the cumulative amount of mercury that is emitted annually from gold mines in northern Nevada.

Air Resources

- Potential impacts to air quality, including particulate matter with an aerodynamic diameter of 2.5 microns or less and particulate matter with an aerodynamic diameter of 10 microns or less.
- Potential impacts associated with mercury emissions resulting from third-party off-site ore processing.
- Potential impacts from sulfur oxides, nitrogen oxides, ozone, carbon dioxides, and other gases associated with the third-party owned mill and roaster.
- Potential impacts to the National Ambient Air Quality Standards and Prevention of Significant Deterioration increments from the proposed project emissions.

Wetlands and Riparian Resources

- Potential loss of wetland areas or springs from changes in the water tables caused by groundwater pumping.
- Potential loss of riparian areas and effects to wildlife migratory routes.

Water Resources

- Potential impacts to already impaired streams.
- Potential contamination of surface flows, rainfall, and/or snowmelt that pass through waste rock storage facilities, ore stockpiles, or other mine facilities.
- Potential direct, indirect, and cumulative impacts to surface water flow, water supply wells, wetlands, springs, and seeps as a result of groundwater pumping for the project.
- Potential impacts of subsurface water through underground workings.

- Potential impacts (geomorphic flow, water quality, biological, and cultural) to Little Antelope Creek and downstream segments of Antelope and Rock creeks from the proposed mine groundwater pumping discharge.
- Groundwater withdrawals for mining operations and potential impacts of groundwater pumping on other resources.

Biological Resources

- Potential exposure of migratory waterfowl to toxic waters.
- Potential impacts to mule deer migration corridors.
- Potential impacts to sage-grouse brooding areas, lek sites, and nesting areas.
- Potential impacts to the sagebrush scrub habitat that may be used by sensitive species such as greater sage-grouse and pygmy rabbits.
- Potential impacts to Pacific chorus frogs and Columbia spotted frogs that may inhabit the riparian areas.
- Potential impacts to raptor nests and migratory bird species.
- Potential impacts to nongame mammals which are likely to be present in the proposed project area.
- Potential direct, indirect, and cumulative impacts to vegetation, wildlife, and other groundwater-dependent resources resulting from proposed project groundwater pumping.

Socioeconomics

- Potential social and economic impacts to affected communities associated with taxes and employment at the mine of approximately 175 workers for an additional 20 years, should the mine not be permitted.
- Potential impacts to tax revenues for local and county governments.

Noise

- Potential noise impacts from expansion of mining activities and increase in traffic due to haulage of ore to off-site mills for processing.

Visual Resources

- Potential visual impacts related to proposed project facilities, including installation of a new transmission line and substation.

Cultural Resources/Native American Traditional Values

- Potential impacts to chert locations; chert is used for medicinal purposes.
- Potential impacts to sacred springs as a result of groundwater pumping.
- Potential impacts from increased access to the Tosawihi Quarries area, which is a spiritual area for Native Americans.
- Potential impacts to the Tosawihi Quarry Archaeological District and nearby important cultural sites, including the Tosawihi Quarry Traditional Cultural Properties, which include Big Butte, Velvet Canyon, and Antelope, Ivanhoe, and Buttercup springs.
- Potential impacts to cultural resources and how they would be protected.

2.0 Description of Alternatives Including the Proposed Action

2.1 Introduction

This chapter describes the Proposed Action as depicted by Rodeo Creek Gold Inc (RCG) in the Plan of Operations (PoO) Amendment (NVN-076802), Transition from Underground Exploration to Full-scale Mine Production, Hollister Mine Project and supporting plans (RCG 2012). Chapter 2.0 also presents the No Action Alternative and other alternatives that are analyzed in the environmental impact statement (EIS), as well as other potential alternatives that were considered but eliminated from detailed analysis. The Bureau of Land Management's (BLM's) preferred alternative is identified in Section 2.6.

2.1.1 Background

The proposed project is located within the Ivanhoe Mining District on the northern end of the Carlin Trend in northeastern Nevada. Exploration and mining activities have occurred in the Ivanhoe Mining District over the past 100 years to locate and extract mercury, molybdenum, uranium, silver, and gold. U.S. Steel Corporation, Galactic Resources/Touchstone Resources Corporation, Newmont Exploration Limited (Newmont), Hecla Ventures Corporation (Hecla), and Great Basin Gold Ltd all have been involved in gold exploration in the vicinity of the Hollister Site.

Newmont Mining Corporation's (Newmont) Ivanhoe Mine, was the largest of the mines, and operated in the district from 1990-1992. Surface mining activities at the Ivanhoe Mine resulted in a total of 268 acres of disturbance that included two open-pits (the East Pit and the West Pit) and heap leaching operations that continued until 1996. An estimated 116,000 ounces of gold were extracted from Newmont's Ivanhoe Mine operations. Newmont is continuing the reclamation and closure activities for the previous open pit mine, although much of the surface disturbance has been reclaimed.

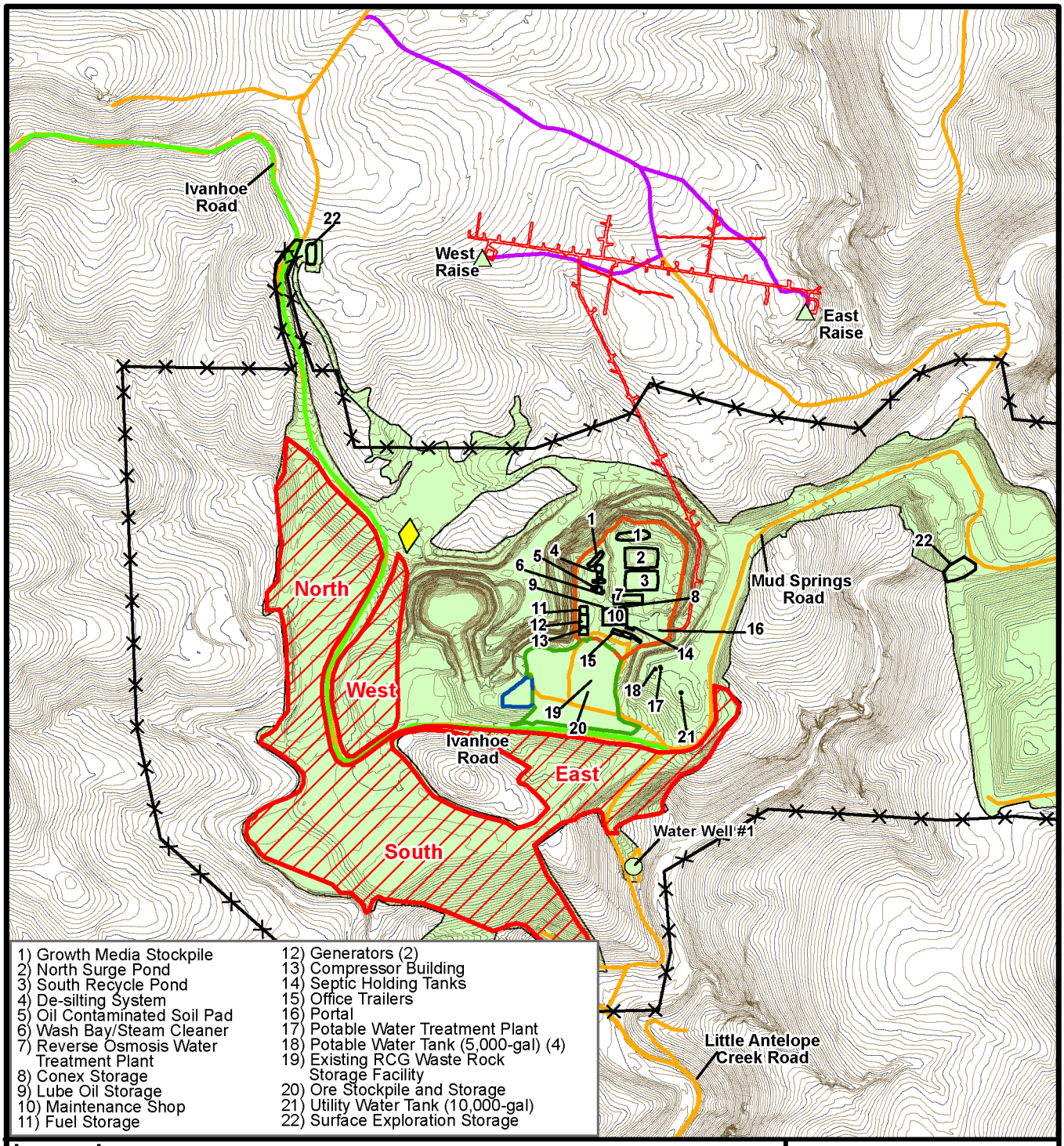
There are four Newmont reclaimed waste rock storage facilities (WRSFs) from previous surface mining activities. These four WRSFs (North, West, South, and East) have been reclaimed by Newmont and are shown in **Figure 2-1**. The North, West, South, and East reclaimed WRSFs cover approximately 15, 16, 6, and 26 acres, respectively (Shepherd Miller 1998).

A summary of the previous PoOs, Notices, and environmental assessments (EAs) for the Hollister Site is provided in **Table 1-2**. Surface exploration in the area also has occurred under numerous Notice-level projects.

2.2 Existing Hollister Operations

The Hollister Site is located approximately 20 miles southeast of the community of Midas (**Figure 1-1**) within the Little Antelope Creek drainage in the historic Ivanhoe Mining District. Primary existing facilities associated with underground exploration operations are shown in **Figure 2-1** and **Figure 2-2**, and are described below:

- Underground exploration facilities including the portal, decline, associated groundwater pumping system, water pipelines, and underground explosives storage;
- An existing lined WRSF and bulk sample stockpile area;
- Water handling and treatment facilities including associated pumps and piping, de-silting plant, reverse osmosis (RO) water treatment plant, water tanks, recycle pond, surge pond, Rapid Infiltration Basins (RIBs) and associated monitoring wells, storm water control basins, and diversion channels;



Hollister Underground Mine Project EIS

Figure 2-1

Detail of Existing Hollister Facilities and No Action Alternative

3/19/2012

Ivanhoe Road
T 38 NR 47 E
Antelope Spring
East Pit Facilities
West Escapeway Raise
East Escapeway Raise
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
Mud Springs Road
West Pit
Reclaimed Heap Leach Pad
Water Well #1
Water Well #5
Silver Cloud Mine Road
Little Antelope Creek Road and Buried RIB Pipeline
T 37 NR 47 E
East RIB and Growth Media Stockpile
Antelope Creek Road
West RIBs (2) and Growth Media Stockpiles
Humboldt
Elko
Washoe
Pershing
Lander
Eureka
White Pine
Lyon
Churchill
Nye
Lincoln
Mineral
Esmeralda
Clark

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line
- Fenceline
- Newmont Reclaimed Waste Rock Storage Facilities
- Reclaimed Heap Leach Pad

Source:BLM 2010a; RCG 2009a.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 2-2

Overview of Existing Hollister Facilities and No Action Alternative

3/19/2012

- East and West raises for underground escapeways and ventilation and associated access roads;
- Ancillary support facilities including offices, maintenance facilities, diesel fuel storage, diesel generators, water well and potable water treatment plant, water tanks and associated pipelines, vehicle and equipment wash bay, access and haul roads, septic system, and equipment supplies storage areas; and
- Surface exploration drilling activities including the drill sites for exploration holes, monitoring wells, equipment and supply storage area, water wells, and roads.

2.2.1 Work Force

Approximately 160 people, consisting of both employees and independent contractors, perform the existing exploration and bulk sampling activities at the Hollister Site. Existing workers predominately live in the community of Winnemucca, although some live in Elko, Spring Creek, Carlin, and Battle Mountain. RCG provides bus, van, or other vehicle transportation to and from the Hollister Site for workers living in Winnemucca.

2.2.2 Access Roads

Ivanhoe Road (**Figure 2-2**), the primary access route to the site, is located in Township 37 North (T37N), Range 48 East (R48E), Section 5; T38N, R48E, Sections 29, 30, 32; and T38N, R47E, Section 1. The 9-mile segment of the Midas-Tuscarora Road, from the Midas Mine to the Ivanhoe Road turnoff and the 9-mile segment of the Ivanhoe Road to the Hollister Site is maintained by RCG in accordance with the agreement between RCG and Elko County for the Midas-Tuscarora Road (County road), and the terms and conditions for the right-of-way (ROW) for the Ivanhoe Road (aka BLM Road 1065). The maintenance measures would enhance safety, reduce the risk of ore haulage incidents, minimize sediment reaching local streams, and reduce dust generation from the road. Maintenance activities include grading (“blading”), snow removal, and use of a dust suppressant such as magnesium chloride, depending on the time of year and road conditions.

The existing Little Antelope Creek Road (**Figure 2-2**) is minimally maintained by RCG. The road is occasionally bladed to provide safe access to the RIBs but not to widen the road. The buried water pipeline from the Hollister Site to the RIBs is located in the center of the Little Antelope Creek Road.

Mud Springs Road, Silver Cloud Mine Road, and Antelope Creek Road also are occasionally used by vendors and employees for mine access (**Figure 2-2**). However, RCG does not perform maintenance on these roads or promote their use as access roads to the Hollister Site.

The access roads to the East and West raises would be minimally maintained on an as-needed basis.

2.2.3 Surface Exploration

Because the limits of the Hollister ore body are not fully defined, RCG conducts surface and underground exploration work on the Hollister mining claims to further delineate known ore zones and to target potential mineralized resource areas. Drilling is conducted to determine the grade of ore deposits or confirm that an area contains no economically recoverable gold. Surface exploration activities consist of surface geologic or geophysical surveys, access road construction or maintenance, drill site construction and drilling, and exploration or condemnation hole drilling programs (surface and underground).

Surface exploration currently is conducted on the previously approved areas identified as the Craig Notice, Hatter Notice, and Ivanhoe Surface Exploration PoO areas (**Table 2-1**). The exploration plan and notice areas are depicted on **Figure 2-3**.

Table 2-1 Surface Exploration Plan and Notices

BLM Number Reference	Reference	Authorized Disturbance		
		Public Acres	Private Acres	Total Acres
NVN-075619	Craig Notice	5	0	5
NVN-071201	Hatter Notice	5	0	5
NVN-071014	Ivanhoe Surface Exploration Plan of Operations	18 [1]	0	18
Total		**28**	**0**	**28**

[1] Includes 3 acres of surface disturbance for water well #5 and associated water system facilities (i.e., pipeline, pump house, water tank, and roads).

Source: BLM 1993a.

The water well #5 water system (**Figure 2-3**) consists of water well #5, a water tank, buried pipeline, pump house, and associated roads. The surface disturbance associated with this water system is 3 acres. This system was transferred to RCG and has been utilized by RCG for exploration. This water system is currently permitted in the Ivanhoe Surface Exploration PoO.

2.2.3.1 Surface Exploration Road Construction and Maintenance

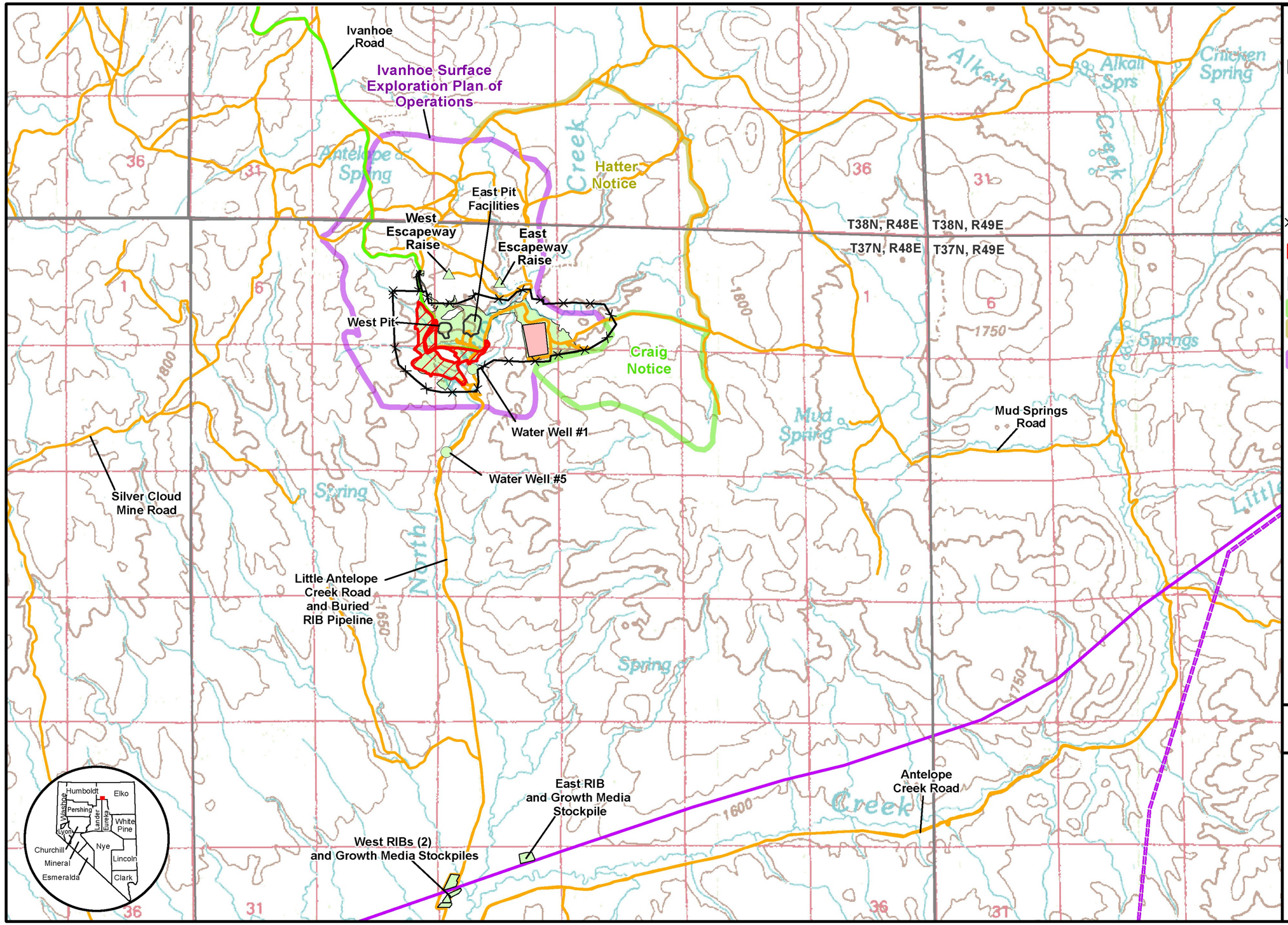
For exploration drilling, existing drill sites are used when possible. Existing “two-track” roads and overland (cross-country) travel are used wherever possible to access drill sites. New temporary access roads are constructed to include a maximum width of 20 feet, of which 12 feet is roadbed surface. Exploration roads are not routinely maintained, and the roads are included within the disturbance acreages. New access roads and road maintenance must be approved by the BLM. Maintenance activities, when necessary, consist of grading and/or gravelling and are conducted within the existing roadbed disturbance. Drainage crossings may be graveled to prevent deepening or widening. If necessary, a culvert would be placed in a drainage crossing temporarily to provide access and to minimize blading disturbance.

2.2.3.2 Surface Exploration Drill Site Construction

Drill sites are approximately 50 feet by 85 feet (about 0.1 acre in size) and must be approved by the BLM. RCG erects a temporary perimeter fence around each drill site prior to mobilization of the drill rig. Each drill site may be utilized to drill one or more exploration holes. Blading drill sites is rare and must be authorized by the BLM.

2.2.3.3 Surface Exploration Drilling

Approximately 30 to 40 surface drill sites with associated exploration drilling activities per year are permitted. New drill sites are established concurrently while previous drill sites are reclaimed. RCG is currently permitted for up to 25 acres of unreclaimed surface disturbance for exploration activities at any given time. Reclaimed areas released by BLM are not included in calculating the 25 acres. The three acres of surface disturbance associated with water well #5 are not included in surface exploration acreages. Permits allow up to four drill rigs on-site at any time, but RCG currently only uses one drill rig which has been voluntarily customized for use in this area. Drilling support equipment includes water trucks, crew trucks, tanks, pipe trucks or skids, portable toilets, light plants, and product storage pallets, all contained within the 50-foot by 85-foot permitted drill site.



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line
- Fenceline
- Newmont Reclaimed Waste Rock Storage Facilities
- Reclaimed Heap Leach Pad
- Craig Notice Boundary
- Hatter Notice Boundary
- Ivanhoe Surface Exploration Plan of Operations Boundary

Source:BLM 2010a; RCG 2009a.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 2-3

Exploration Plan and Notice Boundaries

2/27/2012

RCG has established a 150-foot by 150-foot (0.52-acre) storage area to support exploration drilling (**Figure 2-1**). The bulk of the material stored in this area consists of non-hazardous types of drilling additives such as bentonite clay, biodegradable detergents, viscosity modifiers, biodegradable polymers, and cement. Drill pipe, mobile equipment, and driller supply trailers also are kept at the storage area.

The average drill hole depth ranges from approximately 900 to 1,000 feet. Maximum depths reach 3,000 feet or more. In areas where the depth of the mineralized zones are known, RCG uses reverse-circulation drilling to access the area above the known mineralized zones before switching to core drilling. The depths of reverse-circulation drill holes average from 500 to 1,500 feet, but may reach beyond 1,500 feet.

Currently RCG recycles drill fluids back to the drill rig using portable sumps, or collects drill cuttings in straw bale catchment basins, thus meeting BLM standards to achieve zero discharge.

2.2.4 Underground Exploration and Bulk Sampling

2.2.4.1 Underground Access and Development

RCG accesses the underground workings with a ramp (also called a decline or decline ramp). The ramp begins at the portal at an elevation of 5,500 feet above mean sea level (amsl) and travels underground at a grade of 12 percent to the underground workings at an elevation of 5,060 feet amsl (RCG 2011b). These ramps are designed to be 16 feet wide by 17 feet high and provide access to different elevations or levels within the mine. RCG establishes the main services (e.g., air, water, ventilation, ore/waste rock haulage, and water discharge) along the ramps.

Main haulage drifts are approximately 16 feet wide by 17 feet high. These drifts are essentially parallel to the strike of the vein or stope system and serve as haulage ways for ore, waste rock, equipment and supplies, and personnel.

Crosscuts typically branch from the main haulage drifts to access the veins (or stopes). Vertical or inclined sections into the crosscuts, called slots, are approximately 15 feet wide by 15 feet high. The slots target veins through non-mineralized rock. After removal, the non-mineralized rock is waste rock that is either transported to the surface and placed in a surface WRSF or used underground as stope (excavated area produced during extraction of ore-bearing rock) backfill material.

2.2.4.2 Exploration and Development Drilling

Drilling is currently being accomplished with the use of jumbo, long hole, or jackleg drills, depending on the underground conditions. The holes are loaded with an ammonium nitrate fuel oil mixture or an emulsion blend and subsequently detonated. Blasting is performed under safety procedures required by the Mine Safety and Health Administration (MSHA).

2.2.4.3 Ore Sampling

Bulk samples are extracted daily and assayed to determine gold and silver values. Bulk sampling tonnages vary based on the grade of ore. Currently, bulk samples range from 280 to 400 tons per day (tpd).

2.2.4.4 Loading, Hauling, and Ore Storage

Ore removed from the underground operation is hauled to the surface by truck and temporarily stored on leveled areas (approximately 200 feet by 200 feet) on top of the existing RCG WRSF (an engineered and fully lined facility) (**Figure 2-1**).

2.2.4.5 Underground Test Mining Techniques

The main factors that influence the selection of underground mining methods, which currently are still being tested, for the Hollister operation bulk sampling program include:

- Width of vein;
- General geometry of the deposit;
- Physical (rock mechanic) characteristics of the veins and wall rock;
- Equipment productivities;
- Ability to use waste rock or backfill in the mine stopes; and
- Economic viability.

The Hollister deposit is composed of relatively high-grade narrow veins. RCG engineers selected narrow vein test methods of underground mining (**Figure 2-4**) based on experience gained from actual bulk sampling and test mining at the Hollister operation in combination with rock mechanics analyses and detailed mine feasibility studies. The vein systems at the Hollister Site are steeply dipping and range in thickness from a few inches to over 10 feet, but they typically average between 2 and 4 feet in thickness. The vein systems at the Hollister Site generally begin at the unconformity between the Tertiary- and Ordovician-age formations that lie approximately 250 to 500 feet below the surface (RCG 2009a).

Exploration drilling and test mining at the Hollister operation occurs from approximately 500 to 2,000 feet below the surface. The primary access from the surface for personnel and equipment to the underground workings is via the existing decline that is approximately 16 feet wide and 17 feet high.

A typical Hollister stope (excavated area produced during extraction of ore-bearing rock), is approximately 300 feet in length. Stope mining width varies depending on vein width; a nominal 3- to 5-foot width is typical, but the stope width may increase to 10 feet depending upon actual vein width. An average vertical height for a typical stope is approximately 110 feet (RCG 2009a).

RCG has tested up to four narrow vein mining methods to extract the ore depending on the factors mentioned at the beginning of Section 2.2.4.5. These methods include:

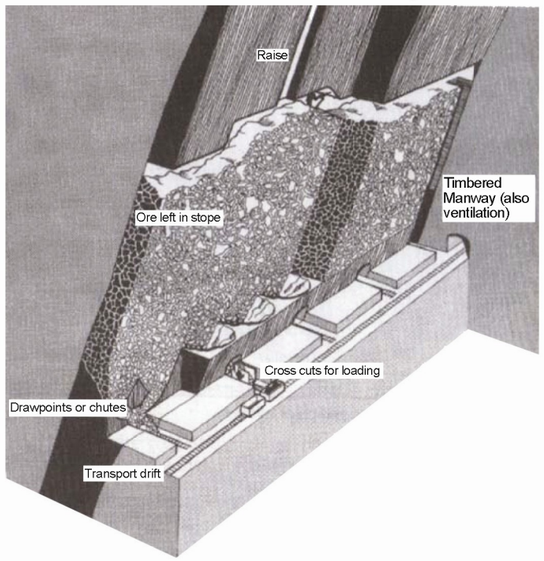
- Shrinkage stoping;
- Cut and fill stoping;
- Long hole stoping; and
- Thermal fragmentation.

Shrinkage Stoping

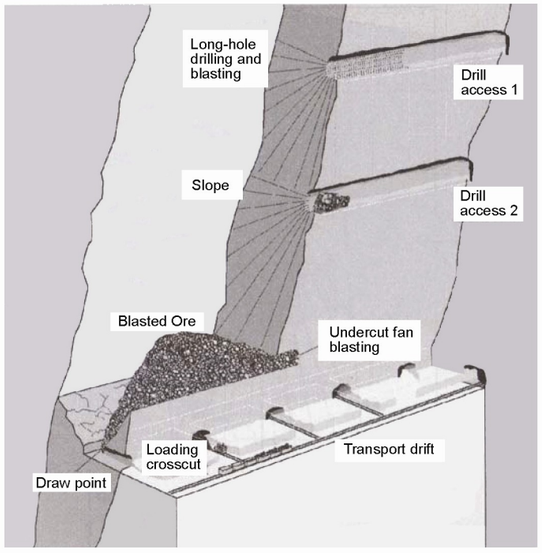
During shrinkage stoping, ore is excavated in horizontal slices, starting at the bottom of the stope and advancing upward (**Figure 2-4**). Part of the broken ore is left in the mined-out stope, and that broken ore serves as a “working platform” for mining the ore above and to support the stope walls. Shrinkage stoping is typically used in steeply dipping veins that exceed the angle of repose, with firm ore that has regular ore boundaries, or with a comparatively stable hanging wall and footwall.

Through blasting, rock increases its occupied space (swell factor). Therefore, blasted rock must be removed during mining to maintain suitable clearance between the back and the top of the blasted ore. When the stope has advanced to the upper border of the planned stope (top of the economic vein), mining is stopped, and the remaining ore is drawn down in the stope and recovered in the mineralized vein, also known as the drawpoint.

Shrinkage Stoping with Cross-cut Loading

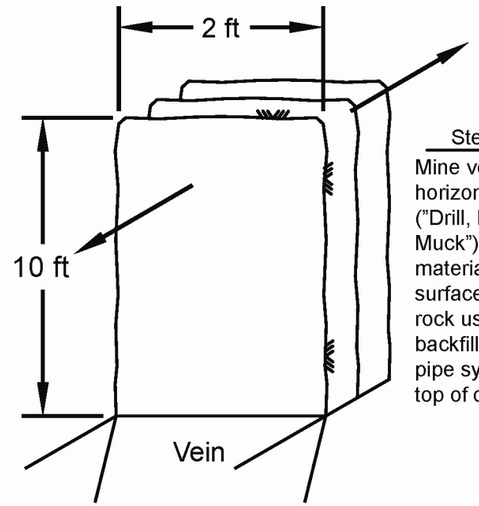


Long-Hole Stoping



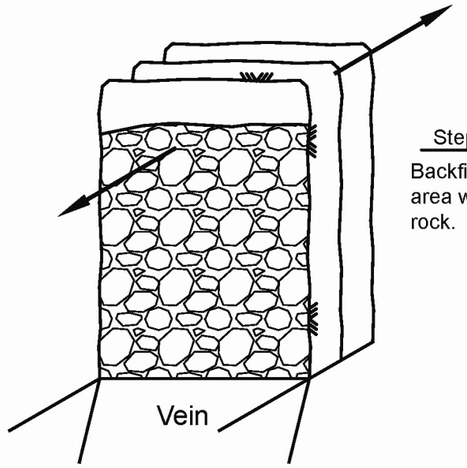
Images from "Underground Mining Methods - Engineering Fundamentals and International Case Studies", Edited by William A. Hustrulid and Richard L. Bullock 2001.

Typical Cut & Fill Mining and Backfill Sequence



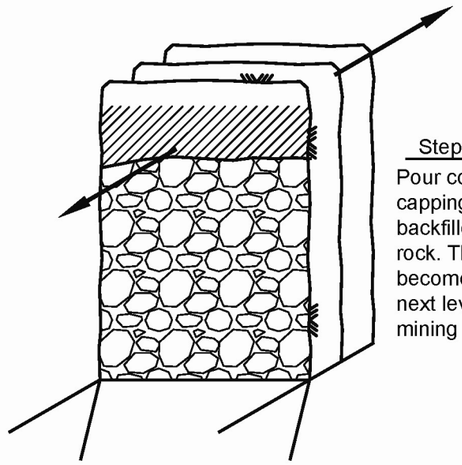
Step 1

Mine vein out in horizontal drift ("Drill, Blast & Muck"); ore material taken to surface. Waste rock used for backfill; install pipe system along top of drift.



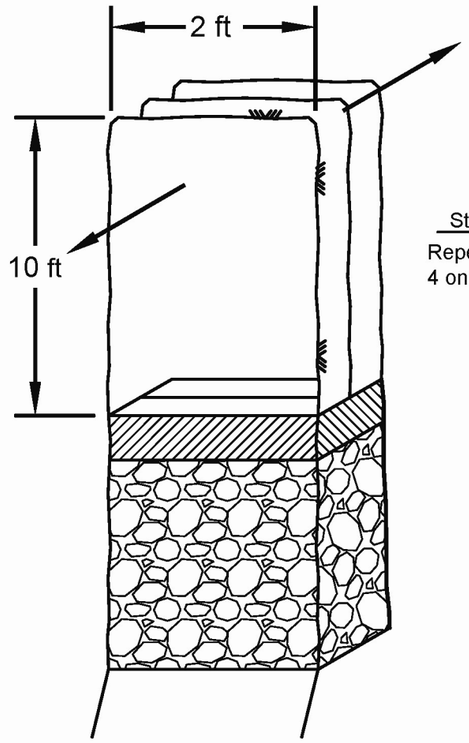
Step 2

Backfill mined-out area with waste rock.



Step 3

Pour concrete capping on top of backfilled waste rock. This capping becomes floor for next level of mining in vein.



Step 4

Repeat steps 1, 2 3, & 4 on next (upper) lift.

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Figure 2-4

Typical Narrow Vein Underground Mining Techniques

Note: All dimensions shown are approximate and not to scale.

08/16/11

The development of shrinkage stoping involves the following steps: 1) haulage drift is driven parallel to the vein; 2) crosscuts are driven at right angles to the haulage drift to intersect the drawpoint; 3) an undercut or complete bottom slice of the stope is taken out at the sill (bottom of the stoping block); and if accessible 4) a raise from the undercut is excavated to the level above for ventilation and backfill.

The development of the bottom section of the stope can be simplified with finger raises deleted and replaced by crosscuts that are used for drawpoint loading of ore material. Drilling and blasting are conducted as overhead stoping, using air-leg rock drills, known as stopers. The rough pile of ore in the stope prevents the use of mechanized equipment.

Cut and Fill Stoping

This mining method uses waste rock as backfill material in the mined-out area (**Figure 2-4**). Actual mining occurs along the strike of the vein in a horizontal slice. After ore is drilled, blasted, and removed from the horizontal slice length of the stope, manways and mill holes are raised and waste rock material is backfilled into the mined-out area. A concrete cap is then poured on top of the backfilled rock. This concrete cap serves as the floor for the subsequent slice of the vein and provides a smooth working surface for mining equipment. Ore losses are minimized because the concrete floor eliminates the rocky voids that would occur if mining were conducted on a floor of backfilled waste rock.

A typical slice is 3 to 4 feet wide by 6 to 8 feet high. Horizontal mining in the vein occurs by drilling to a depth of approximately 6 to 8 feet in the current working back of stope. Drill holes are loaded with explosives and blasted. Once blasted, ore is removed by an air-operated slusher.

Long Hole Stoping

In this mining method, ore is recovered in open stopes that can be backfilled after the stope is mined (**Figure 2-4**). Between stopes, ore sections are set aside for pillars to support the hanging wall. Pillars are normally shaped as vertical beams across the ore body. Horizontal sections of ore, known as crown pillars, also are left to support mine workings above the producing stope.

Long hole stoping is used for mining veins with: 1) a steep dip, 2) stable rock in the hanging wall and footwall, 3) competent ore and non-mineralized rock, 4) regular ore boundaries, and 5) vein width is between 3 and 10 feet wide.

Drifts for long hole drilling are created inside the vein between main levels. These are strategically located because these are the points from which the long hole rigs drill the blast pattern. The drill pattern specifies where blast holes are to be collared and the depth and the angle of each hole, all of which must be set with precision to achieve a successful cut.

Drawpoints are excavated below the stope bottom for safe removal (mucking) of ore from long hole methods, which would be loaded into trucks for haulage to the surface.

Thermal Fragmentation

Two lateral drifts are driven approximately 50 feet apart through a mineralized block of ore to be mined. Thermal holes are drilled approximately 10 feet apart along the mineralized length of the block to be mined. Heat in excess of 1,800 degrees Fahrenheit (°F) is utilized in these thermal holes to fragment the ore. Blast holes are drilled then shot between the thermal holes. The blasted muck is then loaded into trucks and hauled to the surface.

2.2.5 Waste Rock Management

Waste rock removed during bulk sampling varies from 350 to 500 tpd and is transported and placed in the existing RCG WRSF. Any draindown water from material placed on the existing RCG WRSF is collected in the synthetically lined wet well sumps beneath the existing RCG WRSF. The collected

draindown water, if any, is then pumped and treated in the water treatment facilities (described in Section 2.2.6, Water Management) located in the East Pit. After treatment, clean water is routed via buried pipeline to the existing RIBs located near the confluence of Little Antelope Creek and Antelope Creek (**Figure 2-2**). Material used as backfill is occasionally stored temporarily in the underground workings.

The existing RCG WRSF, as currently permitted (**Figure 2-1**), has an approved design capacity of 612,000 cubic yards (yd^3) with a surface disturbance of 7.2 acres. Approximately 307,000 tons of waste rock has been placed in the WRSF. The available capacity of the existing RCG WRSF is approximately 786,800 tons with a permitted height of 120 feet. On average 612,000 yd^3 is equal to approximately 1,100,000 tons at 0.0662 tons per cubic foot density (RCG 2011b). This WRSF was permitted and approved without a stability analysis because it is located in the bottom of an existing open pit.

Because most of the rock placed within the WRSF is potentially acid generating (PAG), the facility is fully lined and managed in accordance with the approved Nevada Division of Environmental Protection (NDEP) Water Pollution Control Permit (WPCP) (WPCP #NEV-2003107) as follows:

1. The area beneath the WRSF was lined with a low permeability barrier and synthetically lined wet well sumps;
2. A layer of dolomite was placed on top of the layer of filter sand. Dolomite also is layered within the waste rock at intervals and at the mixing ratio of 1.2:1. This ratio was previously approved by the NDEP for the existing RCG WRSF at the Hollister Site. However, BLM requires that neutralizing agents be applied in a 3:1 buffering capacity ratio;
3. Any draindown water in the WRSF is collected and contained in wet well sumps and sent to water treatment facilities in the East Pit;
4. Any standing water in the wet well sump is sampled, collected, and treated in the Hollister RO plant or the de-silting facility as needed so that this water does not adversely affect Waters of the State; and
5. Treated water is discharged in accordance with NDEP WPCP Permit NEV-2003114 into the existing RIBs.

Past acid-base accounting (ABA) test results for the Hollister waste rock have consistently indicated that the estimated average total pyritic sulfur content of the Hollister waste rock would be 1.26 percent. Therefore, ABA calculations predict approximately 118 tons of calcium carbonate ($CaCO_3$) (1.26% of pyritic sulfur x 31.25 tons of $CaCO_3$ x 3 for a 3:1 ratio = 118.13 tons of $CaCO_3$) would be required to effectively neutralize 1,000 tons of waste rock from the Hollister Site.

Quarterly samples of waste rock are collected and subjected to meteoric water mobility procedure (MWMP) and ABA tests; HCT tests typically are conducted for initial characterization rather than on a routine, periodic basis. RCG also has established groundwater monitoring wells downgradient of the WRSF. RCG submits quarterly WPCP reports to the NDEP and the BLM that includes this information.

Waste rock characterization is performed utilizing ABA, MWMP, and humidity cell test (HCT) methods. Test protocols are summarized below (Walker and Associates 2003).

ABA testing is performed to identify rock types with potential for acid generation. ABA testing in 2003 followed the methods described in the British Columbia Research Initial Test. Waste rock samples were ground to minus 100 mesh, dried to 60 degrees Celsius (°C), and then used for the sulfur assays and titration tests. Total sulfur and sulfate were analyzed in the sulfur assays. The acid production potential of the sample, expressed as kilograms (kg) of $CaCO_3$ per ton of sample, is calculated on the basis of the sulfide content of the sample, which is the total sulfur minus the sulfur in sulfate form. In the titration test, 10 grams of ground waste rock sample is suspended in 100 milliliters (ml) of distilled water and stirred for

15 minutes during which time the natural pH of the sample is recorded. The sample is titrated to pH 3.5 with 1.0 Normal sulfuric acid. The total volume of acid added is recorded and converted to kg of $CaCO_3$ per ton of sample. This is the acid consuming ability of the material. An estimate of the potential for excess acid production is obtained by comparing the acid production potential and the acid consumption ability. A ratio smaller than one indicates the material may potentially be acid producing, while a number above two may suggest that acid generation is unlikely (Walker 2011; Walker and Associates 2003).

Kinetic testing was performed based on the British Columbia HCT for assessing the rates of acid generation from the different waste rock types. The HCT consisted of adding distilled water to 200 grams of waste rock ground to a particle size of less than 2 millimeters. The sample was spread evenly across the bottom of a column 30 centimeters (cm) in length and 11.5 cm in diameter. Each week, 200 ml of water was added to the sample and the drainage water was collected in a beaker; the pH was measured and plotted on a graph over time. Kinetic tests were run for a minimum of 10 weeks and a maximum of 20 weeks; samples that reach a steady state at 10 weeks were terminated (Walker and Associates 2003). Each week, sample solutions were analyzed for iron, pH, oxidation-reduction potential, and sulfate. Every 4 weeks, the sample solutions were analyzed for Nevada Profile I chemical constituents. The rates of sulfide oxidation and metals dissolution were determined from the results of the British Columbia HCT. The British Columbia HCT tests conducted in 2003 are not in conformance with current BLM Instruction Memorandum (IM) No. NV 2010-14 guidelines (BLM 2010b) due to the testing periods being shorter than currently required. However, at the Hollister Site, all waste rock is and would continue to be treated as PAG. The MWMP tests are used to evaluate the potential for dissolution and mobility of certain constituents from mine rock samples by meteoric water.

MWMP tests are conducted to assess release of chemical constituents from waste rock under expected meteorological conditions in northern Nevada. The procedure consists of a single-pass column leach over a 24-hour period using a crushed mine rock sample to extract fluid to a ratio of 1:1. The extraction fluid is Type II reagent grade water at a pH of 5.5. Extracts are analyzed for Nevada Profile I constituents. Test protocols follow NDEP–Bureau of Mining Regulation and Reclamation (BMRR) MWMP guidelines (Walker and Associates 2003).

Currently, waste rock characterization tests are conducted quarterly, pursuant to WPCP NEV2003107, which is in compliance with the BLM IM NV-2010-014 2010 requirements (RCG 2011b). The BLM IM NV-2010-014 procedures include the following analyses for waste rock:

- ABA testing including the NDEP Modified Sobek Procedure;
- Net acid/alkaline production (Acid Potential [AP], Neutralizing Potential [NP], and Net Neutralizing Potential [NNP]);
- MWMP following American Society for Testing and Materials (ASTM) E-2242-02 procedures that include analysis and report on metal mobility, attenuation, and accumulation potential;
- Humidity Cell/Column Leach tests following ASTM D5744-07 protocols with a minimum test period of 20 weeks (only initial testing; not conducted quarterly);
- NDEP – BMRR Profile II analysis with total recoverable metals; and
- Other additional tests may be required at the discretion of BLM and NDEP.

2.2.6 Water Management

The current mine water handling facilities and operations associated with exploration, as well as the proposed underground mining operations water management system, including how the water at the Hollister Site is used and discharged back into the environment, are illustrated in **Figure 2-5**. Water inflow into the underground workings currently is removed from the underground workings at a rate of approximately 400 gallons per minute (gpm) with capacity up to 700 gpm.

The current water management system (4.7 miles of pipeline, 3 RIBs, 2 tanks, and associated wells) is self-contained and designed to remove water from the underground workings. A grouting study conducted by Phillips Mining, Geotechnical and Grouting, Inc. (Phillips 2003) indicated that grouting in the decline would reduce the average steady state inflows more than 50 percent. Grouting is the method used to force cement into the bedrock fractures and the groundwater conduits to prevent or reduce water flow through the fractures into the decline.

Water inflow to the underground workings is routed to underground sumps through dedicated pipelines and then pumped from the underground workings to the surface. Upon reaching the surface, this water is gravity-fed in a pipeline to the existing East Pit water treatment facilities. After treatment, the water is discharged to the RIBs located near the confluence of Little Antelope Creek and Antelope Creek (**Figure 2-2**). The existing Hollister operation RIBs were designed for and have operated at a capacity of 700 gpm.

RCG uses between 100 and 150 gpm of the discharge water to support surface facilities and underground drilling activities. There are monitoring wells located at the RIBs and around the East Pit. The water streams in the water management facilities at the Hollister operations are illustrated in **Figure 2-5**. The facilities include storage, treatment/management, and discharge components. The storage component includes a mine service water tank and two evaporation ponds. The water is managed in the de-silting plant, the water treatment/RO facility, and the potable water plant. When present, water from the WRSF collection sump is pumped to the treatment plants and then to the RIBs. Depending on water quality, water obtained from the underground workings is treated and the water not utilized in operations is released to the RIBs. Fresh water is collected and stored in the potable water plant and tank before use in the office buildings, dry, and in-pit uses. Storm water is collected as runoff in a lined storm water pond and pumped to the recycle water pond for evaporation.

There are no additional water handling activities associated with exploration drilling in the Hatter or Craig Notice areas or the Ivanhoe Surface Exploration area.

2.2.7 Existing Hollister Operations Infrastructure

2.2.7.1 Power and Fuel

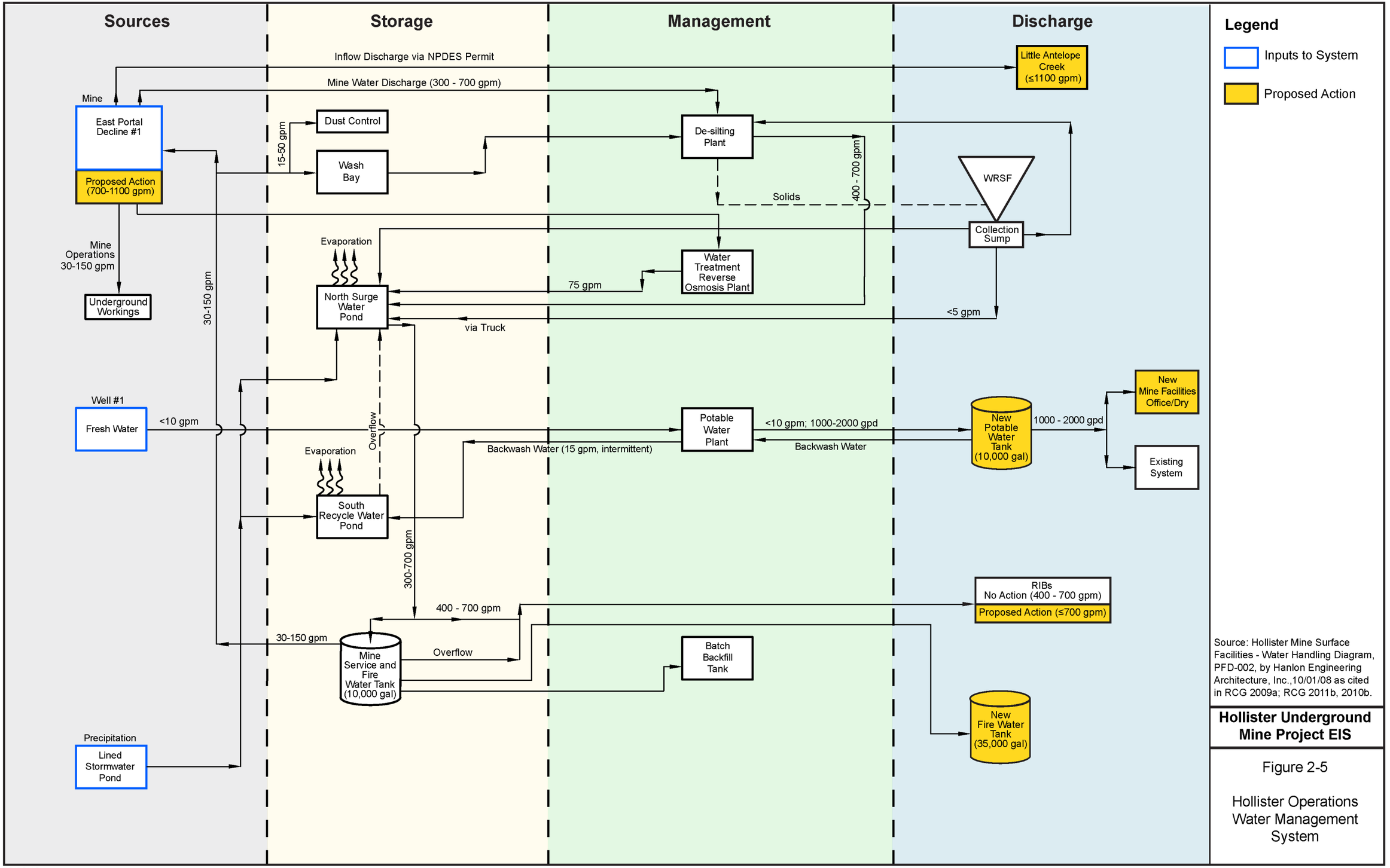
Two diesel generators at the Hollister Site provide electric power. Generator #1 produces approximately 2,922 horsepower (hp), and Generator #2 produces 2,333 hp (RCG 2011b). The two generators and accompanying fuel storage tanks are located on the southwest side of the East Pit (**Figure 2-1**). The generators supply the necessary power for all permitted Hollister operations.

On-site fuel storage includes aboveground gasoline and diesel tanks. A 5,000-gallon capacity gasoline tank fuels the light vehicles. Three 10,000-gallon tanks store diesel fuel for the diesel generators and underground mobile equipment.

2.2.7.2 Water Supply

Potable water is currently used at a rate of approximately 3 gpm at the Hollister Site, and is extracted from water well #1. The existing potable water treatment facility (**Figure 2-1**) includes a green sand filter to treat iron and manganese with arsenic filtration through a media and chlorination.

Water well #5 is a backup water supply for water well #1 (**Figure 2-2**). RCG used water well #5 for past surface exploration activities.



Source: Hollister Mine Surface Facilities - Water Handling Diagram, PFD-002, by Hanlon Engineering Architecture, Inc.,10/01/08 as cited in RCG 2009a; RCG 2011b, 2010b.

Hollister Underground Mine Project EIS

Figure 2-5

Hollister Operations Water Management System

03/20/12

2.2.7.3 Ancillary Surface Support Facilities

Existing ancillary facilities located at the Hollister Site are used to support the bulk sampling activities. These existing facilities include offices, men's and women's dry facilities, maintenance facilities, monitoring wells, potable water treatment plant, air compressors, fuel stations, diesel and gas storage facilities, haul roads, communications equipment, and other facilities (**Figure 2-1**).

2.2.7.4 Sanitary and Solid Waste Disposal

The East Pit area septic system tanks are emptied on a weekly basis. Sewage is hauled by a contractor to an approved sewage disposal site. All other non-toxic, non-hazardous solid waste materials generated at the Hollister Site are removed from the site and disposed of in the Humboldt County Regional Landfill in Winnemucca.

2.2.7.5 Site Security, Signs, and Fencing

RCG provides security at the Hollister Site that includes patrols, access control, and asset protection. Signs are in place to direct traffic to the Hollister Site.

RCG maintains the existing four-strand (three top wires barbed and one bottom wire smooth) perimeter fence with gates as shown in **Figure 2-2**. Other existing fences include a wildlife fence around the water management ponds and the evaporation pond in the East Pit, a fence around the RIBs, and temporary fences used around exploration drill sites.

2.2.8 Hazardous Materials and Hazardous Waste Management

Procedures for hazardous material transportation, storage, waste management, spill prevention, and emergency response programs currently are in place and implemented for the existing exploration and underground testing program, as described in the Hollister Development Block EA (BLM 2004a) and other cited RCG plans. A summary of the regulatory requirements on which these procedures and programs are based is provided below.

2.2.8.1 Hazardous Materials

The chemicals and fuel used and stored at the Hollister Site are provided in **Table 2-2**. Hazardous materials storage information is updated on an annual basis at the Hollister Site as required by the Hollister Fire Marshal Hazardous Materials Permit. RCG reports chemical use volumes under the U.S. Environmental Protection Agency (USEPA) Toxic Release Inventory (TRI). Explosives are stored underground.

Table 2-2 Chemicals Currently Used at Hollister Site

Chemical Name	Common Name/Other Name	Quantity	Location	Area Used	Rate of Use Per Year	Shipment Quantities
Acetylene	Acetylene	900 cu ft	Maintenance Shop	Maintenance Shop	variable	10 cyl
Alum	Alum	1,600 gal	Water Treatment/ Desilting Plant	Water Treatment/ Desilting Plant	3,200 gal	400 gal
Amino Trimethylene	Delvo Stabilizer	110 gal	Surface	UG Bulk Sampling	variable	variable
Ammonium Nitrate	Unigel	*	Explosive Magazine	Bulk Sampling	*	*
Ammonium Nitrate	Magnasplit	*	UG Explosive Magazine	Bulk Sampling	*	*

Table 2-2 Chemicals Currently Used at Hollister Site

Chemical Name	Common Name/Other Name	Quantity	Location	Area Used	Rate of Use Per Year	Shipment Quantities
Ammonium Nitrate	Magnafrac	*	UG Explosive Magazine	Bulk Sampling	*	*
Ammonium Nitrate/Fuel Oil	ANFO	*	UG Explosive Magazine	Bulk Sampling	*	*
Anionic Polyacrylamide	Poly-plus 2000	80 gal	Laydown Area at Main Gate	Surface & UG Drilling	10,920 gal	160 gal, two pallets
Calcium Hydroxide	Hydrated Lime	47,000 lbs	Water Treatment/ Desilting Plant	Water Treatment/ Desilting Plant	20,000 lbs	20,000 lbs
Chemco #1	Cleaner Degreaser	55 gal	Maintenance Shop	Mobile Equip.	55 gal	55 gal
Choline Chloride	Kla Gard	490 gal	Laydown Area at Main Gate	Surface & UG Drilling	21,840 gal	240 gal, two pallets
Copolymer of Sodium Acrylate	Insta-vis	250 gal	Laydown Area at Main Gate	Surface & UG Drilling	10,920 gal	160 gal, one pallet
Copolymer of Sodium Acrylate	Insta-pac	200 gal	Laydown Area at Main Gate	Surface Drilling	10,920 gal	160 gal, one pallet
CS-141	Concrete Stripper	55 gal	Surface Containment Area	Bulk Sampling	55 gal	55 gal
Ethylene Glycol	Anti-freeze	220 gal	Maintenance Shop	Mobile Equipment	3,600 gal	300 gal/mo
Flocculent	Flocculent	800 gal	Water Treatment/ Desilting Plant	Water Treatment/ Desilting Plant	7,300 gal	800 gal
Hydrochloric Acid	Hydrochloric Acid	300 gal	Water Treatment/ Desilting Plant	Water Treatment/ Desilting Plant	800 gal	400 gal
Hydrogen Sulfate (20%)	Sulfuric Acid	1,650 gal	Water Treatment/ Desilting Plant	Water Treatment/ Desilting Plant	38,400 gal	4,000 gal
Mineral Oil	Rod Coat B 700	70 gal	Laydown Area at Main Gate	Surface Drilling	5,460 gal	240 gal, two pallets
Oxygen	Oxygen	2,490 cu ft	Maintenance Shop	Maintenance Shop	variable	6 cyl
Pentaerythritol	Cordex Detonation Cord	*	UG Explosive Magazine	Test Mining	*	*
Pentaerythritol Tetranitrate	Non-electric Detonator	*	UG Explosive Magazine	Test Mining	*	*
Petroleum Hydrocarbon Mixture	Gasoline	5,000 gal	Fuel Storage Area (surface)	Surface Mobile Equipment	7,100 gal	4,000 gal
Petroleum Hydrocarbon Mixture	Diesel	30,000 gal	Fuel Storage Area (surface)	Surface & UG Equipment	510,000 gal	7,400 gal
Petroleum Naphtha	Solvent/ Degreaser	55 gal	Maintenance Shop	Maintenance Shop	500 gal	55 gal
Propane	Odorized LPG	575 gal	Office Complex	Office Complex	500 gal	200 gal

Table 2-2 Chemicals Currently Used at Hollister Site

Chemical Name	Common Name/Other Name	Quantity	Location	Area Used	Rate of Use Per Year	Shipment Quantities
Sodium Hydroxide	Caustic Soda	2,400 gal	Water Treatment Plant	Water Treatment Plant	800 gal	800 gal
Sodium Hypochlorate	Same	55 gal	Water Treatment Plant	Water Treatment Plant	55 gal	55 gal
Vegetable Oil	Rod Ease	475 gal	Laydown Area at Main Gate	Surface & UG Drilling	21,840 gal	240 gal, two pallets

*Note: U.S. Office of Homeland Security regulations do not allow mine operators to report explosive quantities.

cu ft = cubic feet
cyl = cylinder
gal = gallon
lbs = pounds
LPG = liquidfied petroleum gas
mo = month
UG = underground

Source: RCG 2009a.

2.2.8.2 Spill Prevention and Response

RCG maintains a Spill Prevention, Control, and Countermeasures (SPCC) Plan for the Hollister Site (RCG 2008a). The plan describes: 1) the prevention, response, containment, and safe cleanup of any spills or discharges of substances that potentially may degrade the environment; 2) the systems and procedures to prevent and contain spills of petroleum fuels, lubrication oil, and used oil; and 3) the spill discovery, notification, and general cleanup procedures.

RCG is responsible for clean-up of releases of hazardous substances or oil associated with bulk sampling activities in accordance with the National Oil and Hazardous Substances Contingency Plan (40 Code of Federal Regulations [CFR] 300). If a release were to occur, RCG would notify the BLM Authorized Officer (AO), the NDEP, and the National Response Center of all reportable quantities of hazardous substances or oil released on public land, as required. Spills would be cleaned up in accordance with local, state, and federal regulations.

2.2.8.3 Hazardous Waste Management

The Resource Conservation and Recovery Act (RCRA) hazardous wastes generated at the Hollister Site are “universal wastes,” which generally include florescent bulbs and lights, as well as NiCad and lithium batteries. The Hollister operation is a Conditionally Exempt Small Quantity Generator (defined by federal regulations as a facility generating less than 200 pounds of hazardous waste per month). Materials that are not spent or consumed (e.g., petroleum oils, antifreeze, etc.) are recycled to the extent possible or disposed of off-site in an approved depository in accordance with RCG’s Solid and Hazardous Waste Management Plan (RCG 2010a) and all applicable federal and state regulations.

2.2.9 Safety and Fire Protection

RCG’s existing fire protection plan procedures are in accordance with MSHA and applicable state and county fire code regulations. Adequate fire protection equipment is maintained on site during operations.

2.2.10 Reclamation of Existing Facilities

Existing permits call for reclamation and revegetation of disturbed areas to reduce the potential for wind and water erosion. Following initial construction, cut and fill embankments and growth media stockpiles were seeded. Concurrent reclamation of surface exploration activities would be conducted to the extent possible to accelerate revegetation of disturbed areas.

All mineral exploration and development drill holes and monitoring or observation wells would be properly plugged and abandoned following completion of their functions to prevent contamination of groundwater resources.

All disturbed surfaces would be revegetated to control runoff, reduce erosion, reduce visual impacts, and provide forage for wildlife and livestock. Compacted surfaces would be ripped to loosen the soil. Accessible surfaces not composed of soil would then be covered with growth media. Seedbed preparation would be performed immediately prior to seeding to allow seed placement prior to soil re-compaction. Seedbed preparation and seeding generally would take place in the fall after grading and topsoiling of reclaimed areas.

The reclamation seed mixture and application rate has been developed based on BLM requirements and is developed from the plant species listed in **Table 2-3**. The species used would be dependent on availability and cost, and would be applied at a rate of approximately 11 to 15 pounds pure live seed (PLS) per acre. Modifications in the seed mixture, application rates, cultivation methods, and techniques could occur based on success of concurrent reclamation. Changes and/or adjustments to seed mixtures and application rates would be developed through consultation with, and approval by, the BLM and NDEP. Seedlings may be substituted for seeds. The seed mix selected would represent a reclaimed desired plant community, and the mix would be appropriate for each ecological site in the project area. This mixture would provide forage and cover species similar to the pre-disturbance conditions, facilitating the post-mining land uses of livestock grazing and wildlife habitat. In addition, the seed mix has been determined based on the species' effectiveness in providing erosion protection, the ability to grow within the constraints of the low annual precipitation experienced in the region, and its suitability for the site aspect, elevation, and soil type.

Compacted roads would be ripped to a depth of 6 inches to 2 feet. Any road or drill site not requiring re-contouring or ripping would be scarified to a depth of 6 inches or less, then seeded and harrowed to provide soil cover for the seeds. Because of the cultural resource sensitivity of the area, prior to ripping any road outside of the immediate disturbance areas (WRSF, pit, main access roads, etc.), RCG would consult with BLM to verify that ripping is an acceptable activity.

Table 2-3 Reclamation Plant List

Common Name	Species Name
Grasses	
Bluebunch wheatgrass	*Pseudoroegneria spicatum*
Thickspike wheatgrass	*Elymus lanceolatus*
Western wheatgrass	*Pascopyrum smithii*
Crested wheatgrass	*Agropyron cristatum*
Slender wheatgrass	*Elymus trachycaulus*
Sandberg bluegrass	*Poa sandbergii*
Canby bluegrass	*Poa canbyi*
Big bluegrass	*Poa ampla*

Table 2-3 Reclamation Plant List

Common Name	Species Name
Great Basin wild rye	*Leymus cinereus*
Indian ricegrass	*Oryzopsis hymenoides*
Webber ricegrass	*Oryzopsis webberi*
Idaho fescue	*Festuca idahoensis*
Sheep fescue	*Festuca ovina*
Green needlegrass	*Stipa viridula*
Bottlebrush squirreltail	*Elymus elymoides*
Sand dropseed	*Sporobolus cryptandrus*
Alkali sacaton	*Sporobolus airoides*
Forbs	
Cicer milkvetch	*Astragalus cicer*
Northern sweetvetch	*Hedysarum boreale*
Buckwheat	*Eriogonum* spp.
Common sainfoin	*Onobrychis viciaefolia*
Annual ryegrass	*Lolium perenne* spp. *multiflorum*
Western yarrow	*Achillea millefolium*
Blue flax	*Linum lewisii*
Small burnet	*Sanguisorba minor*
Gooseberry leaf globemallow	*Sphaeralcea grossulariaefolia*
Scarlet globemallow	*Sphaeralcea coccinea*
Desert globemallow	*Sphaeralcea ambigua*
Arrowleaf balsamroot	*Balsamhoriza saggitata*
Palmer penstemon	*Penstemon palmeri*
White sweetclover	*Melilotus alba*
Alfalfa	*Medicago sativa*
Shrubs	
Wyoming big sagebrush	*Artemisia tridentata* ssp. *wyomingensis*
Big sagebrush	*Artemisia tridentata*
Black sagebrush	*Artemisia nova*
Antelope bitterbrush	*Purshia tridentata*
Serviceberry	*Amelanchier (ainifolia) utahensis*
Winterfat	*Ceratoides lanata*
Chokecherry	*Prunus virginiana*

Table 2-3 Reclamation Plant List

Common Name	Species Name
Snowbrush	*Ceanothus* spp.
Fourwing saltbush	*Atriplex canescens*
Prostrate kochia	*Kochia prostrate*
Rubber rabbitbrush	*Chrysothamnus nauseosus*
Currant	*Ribes* spp.
Wood rose	*Rosa woodsii*
Snowberry	*Symphoricarpos* spp.

Source: BLM 2004a.

2.2.10.1 Drill Hole and Water Well Abandonment

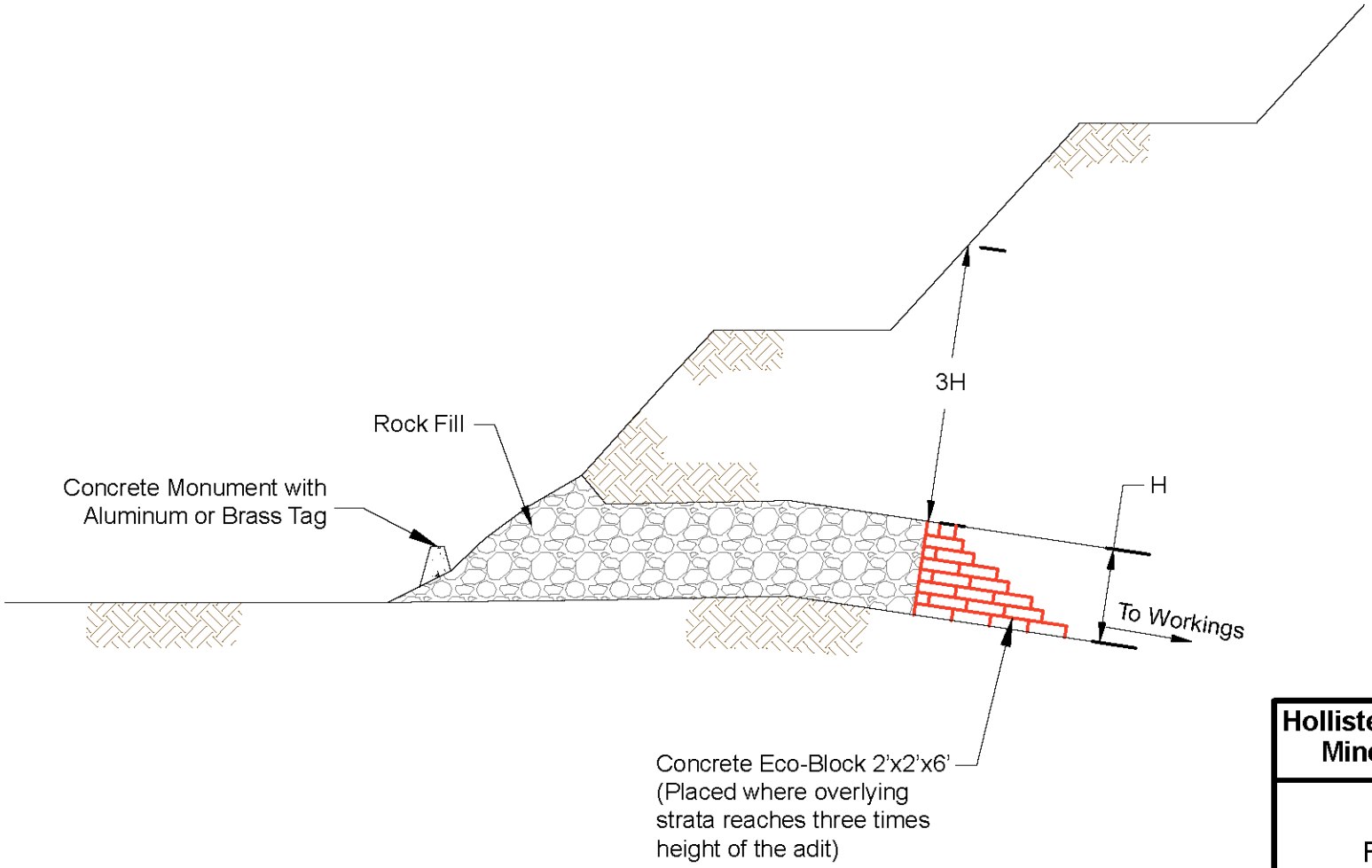
RCG would abandon and plug existing exploration drill holes, water wells, and water monitoring wells in accordance with the Nevada Administrative Code (NAC) 534 regulations. As appropriate to prevent possible contamination between different water zones in the drill holes, RCG would seal water-bearing zones to comply with requirements of the Nevada Division of Water Resources (NDWR). In addition, each drill hole, water well, and monitoring well collar would be plugged or sealed to prevent surface water or foreign objects from entering the drill hole.

2.2.10.2 Closure of Underground Operations

Underground facilities would be closed in phases starting at the lowest point of the underground facilities/structure working up to the surface. The closure procedures are summarized below.

In general, removal of water management equipment would consist of the following steps in accordance with applicable rules and regulations. Water monitoring and production well holes and core holes would be cemented. Underground and surface piping, pumps, tanks and pumping equipment would be removed and salvaged or disposed of in an approved waste disposal facility. Piping that cannot be salvaged for reuse would be dismantled as required for backfill placement and left underground. Fans, motors, pumps, compressors, power supply, electrical distribution equipment, ventilation curtains and ducts, and other equipment would be removed and salvaged for use at another facility or disposed of in an approved waste disposal facility. Non-reactive equipment (e.g., high-density polyethylene [HDPE] pipe) may be left underground. All remaining fuels, lubricants, and explosives would be removed from the underground workings and disposed of as described in Section 2.2.10.5, Demolition and Disposition of Buildings and Ancillary Facilities.

To prevent access to underground workings, the Hollister Site portal, production shaft, and escape raises would be closed and sealed upon permanent cessation of exploration operations in a manner similar to the detail shown in **Figures 2-6** and **2-7**. A concrete, cemented cinder block or similarly constructed bulkhead would be installed inside the portal. The portal area would be backfilled with waste rock material, extending from the portal bulkhead to outside the actual portal. A permanent informational plaque would be erected at the portal to identify the site.



Hollister Underground Mine Project EIS

Figure 2-6

Mine Portal
Closure Cross-section

Source: RCG 2009a.

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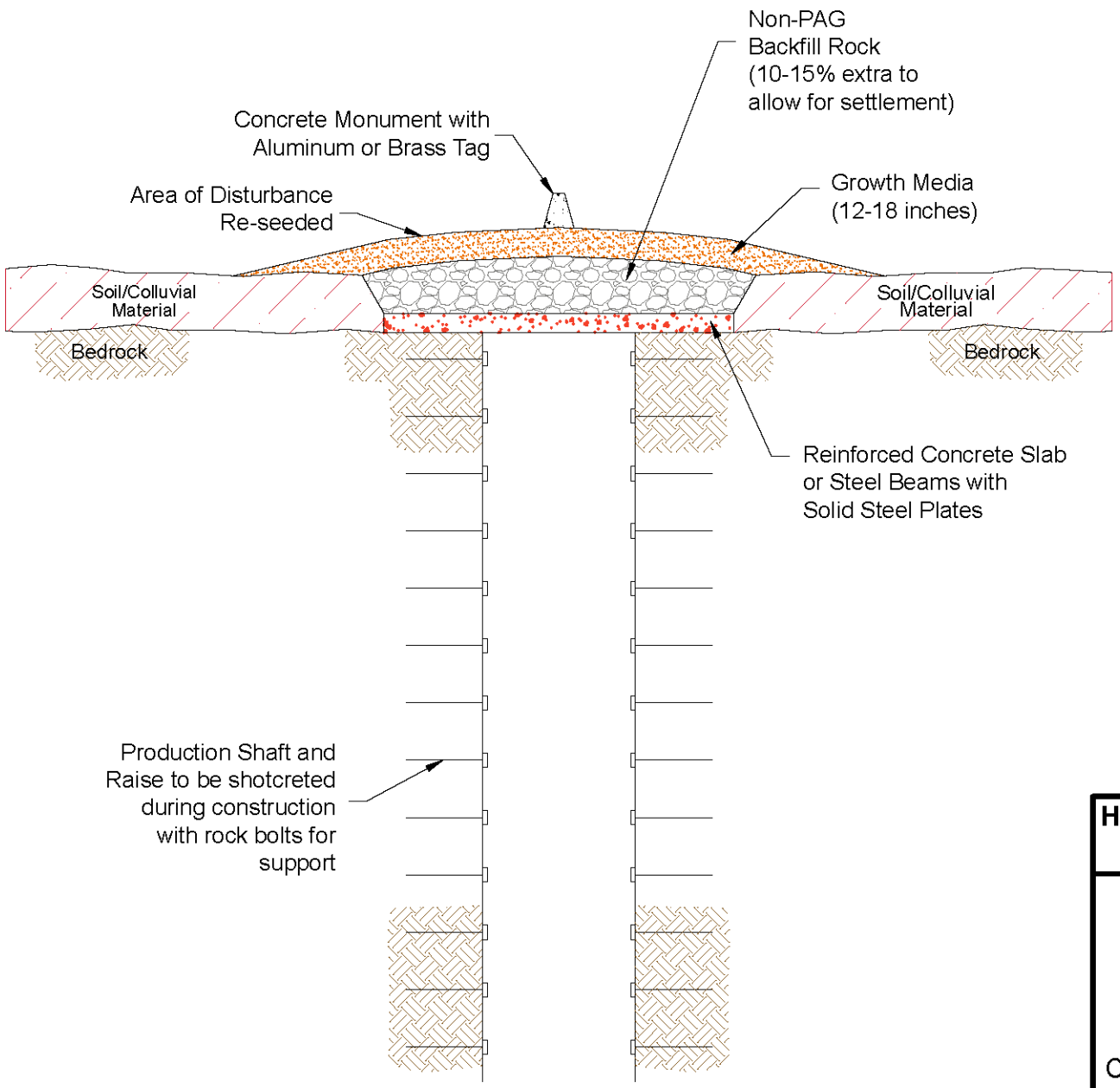

Hollister Underground Mine Project EIS

Figure 2-7

Escapeway Raise and Shaft Closure Cross-section

Source: RCG 2009a.

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The production shaft and escape raises would be closed and sealed with engineered concrete plugs, consisting of reinforced concrete slabs placed on firm ground over the opening and anchored into solid bedrock. The production shaft and escape raises would be sealed and reclaimed as follows: 1) an I-beam would be placed over the raise opening; 2) a 0.5-inch-thick steel plating would be welded to framework; 3) a concrete plug (6 inches thick) would be poured on top of the steel plate and reinforced with rebar; 4) 4 to 5 feet of non-PAG rock would be placed on top of the concrete and graded to provide for drainage away from the covered opening; and 5) 12 to 18 inches of growth media would be placed on top of the non-PAG rock, and the site would be seeded with a seed mixture developed from **Table 2-3**. These concrete plug structures would be constructed for permanence and to sustain the expected weight of the rock material that would be placed on top of the structure.

2.2.10.3 Reclamation of Existing RCG Waste Rock Storage Facility

The reclamation goals for the existing RCG WRSF include stabilizing slopes, ensuring mass stability, shaping the edges to minimize visual impacts, revegetating surfaces, and erosion control. Reclamation of the WRSF would entail the following:

1. Lime or dolomite amendments to the PAG material in a ratio approved by BLM;
2. Use of an appropriate soil evapotranspiration (ET) cover of 36 inches of non-PAG cover material over the PAG waste rock material to reduce or eliminate infiltration of water and oxygen;
3. Use of 6 to 12 inches of cover consisting of growth media would be placed over the 36 inches of ET cover material; and
4. Shaping the entire area to a geomorphically stable configuration to ensure that no ponding occurs on, behind, or around the WRSF.

The total amount of cover material would be 42 to 48 inches, thus providing an adequate barrier between the PAG waste rock material and water or oxygen infiltration.

As areas of the WRSF reach their ultimate configuration and become inactive, the waste rock facility face would be regraded. After regrading, the surface and sides of the WRSF would be covered with growth media as described above, and seeded with a seed mixture developed from **Table 2-3** to meet post-mining land use objectives. Toe and transition crest areas would maintain positive drainage off the WRSF with grades of 2 percent or greater. To minimize erosion until vegetation has re-established, silt fences, sediment traps, or other appropriate Best Management Practices (BMPs) would be implemented.

2.2.10.4 Reclamation of Roads, Parking Lots, Washbay, and Other Compacted Areas

Compacted areas such as roads, parking lots, and the East Pit facilities area would be ripped or disked or otherwise left in a roughened condition prior to growth media material replacement and revegetation. Typically, a motor grader, with a scarifier unit, would be used to rip the compacted areas. Given the cultural sensitivity of the area, RCG would consult with, and get approval from, the BLM prior to ripping any road outside of the areas disturbed by the past surface mining operations.

Upon permanent closure, the Ivanhoe and Little Antelope Creek roads would remain but would no longer be maintained by RCG and could revert to two-track roads. Mile markers, fences, and signs would be removed.

2.2.10.5 Demolition and Disposition of Buildings and Ancillary Facilities

During final mine closure, salvageable equipment, instrumentation, and personal property would first be removed from the site prior to actual removal of structures and facilities. The temporary trailers and structures would be dismantled, and materials would be salvaged or disposed of in a permitted landfill off

site. After demolition and salvage operations have been completed, the associated disturbance areas would be regraded, scarified, and covered with growth media and revegetated.

Unless ongoing post-mining use is authorized by BLM at the close of reclamation, project site structures and other facilities would be demolished and/or dismantled and removed from the site at the time of permanent closure. This would include office and maintenance structures, the compressor facility, water and fuel storage tanks, generators, temporary trailers, and ancillary and storage facilities.

With facility closure, the sewage system and associated tanks would be decommissioned. Sewage remaining in the septic tanks would be pumped out by a licensed contractor and hauled to an approved site for disposal. Exposed components of the sewage system would be dismantled and buried at a minimum depth of 5 feet in the existing RCG WRSF or removed and disposed of in an approved site. Decommissioned buried pipelines and septic tanks would be removed and disposed of in an appropriate landfill.

Upon permanent mine closure, pumping of water from the underground operation would cease, and water would be allowed to fill the workings. Given that the pre-exploration groundwater potentiometric surface was beneath the portal level, post-mining groundwater levels would not reach the portal; thus, there would be no discharge of groundwater to the surface. Section 3.5, Groundwater Resources and Geochemistry, describes predicted post-mining groundwater levels and groundwater chemistry.

2.2.10.6 Reclamation of Storm Water and Surge Ponds

All equipment and surface piping associated with the storm water, RIBs, and surge ponds would be removed. The pond liners would be folded into the pond bottom and overlain with concrete from building foundations to prevent liners from floating to the surface. Any sludge remaining in the ponds would be sampled, analyzed, and disposed of appropriately. The ponds would be backfilled and regraded to prevent ponding of water. Growth media would be redistributed prior to seeding.

The RIBs near Little Antelope Creek would be reclaimed. Reclamation activities would include backfilling the RIBs with the existing stockpiled material, grading the area to blend with the surrounding topography, placing 12 inches of growth media, and then revegetation with a seed mixture developed from **Table 2-3**. The buried pipeline between the mine and the RIBs would be plugged and abandoned in place. Any above-surface pipelines and valve boxes would be removed and properly disposed of on or off site.

2.2.10.7 Reclamation and Closure Monitoring

Following site closure, berm and sign maintenance, site inspections, and any other necessary monitoring for the period of reclamation responsibility would be conducted. NDEP can require monitoring for up to 30 years and the BLM has no limitations on duration of monitoring requirements per the current regulations.

Post-mining groundwater quality would be monitored according to the requirements established by NDEP-BMRR, and included in the WPCP. Monitoring would consist of quarterly groundwater and surface water sampling, analysis, and reporting to BMRR. After the post-reclamation monitoring period is complete, monitoring wells constructed during the project would be closed and abandoned in accordance with NDWR regulations.

Revegetation monitoring would be conducted for a minimum of 3 years following implementation and completion of revegetation activities, or until revegetation successes have been achieved. Revegetation monitoring would occur based on seasonal growth patterns, precipitation, and weather conditions (RCG 2008b).

2.3 Third-party Processing Facilities

RCG does not process the bulk samples of ore from the Hollister Site, but rather ore is processed off-site by third-parties. While the ore processing itself is not part of the existing Hollister operations or the Proposed Action, this EIS describes certain relevant aspects of the existing mills at Esmeralda and Midas.

Previous open-pit mining operators processed ore on-site using cyanide heap leach methods. Because there are no milling and processing facilities at the Hollister Site, RCG ships bulk sample ore offsite for processing at area mills operated by third parties. RCG entered into agreements for processing bulk samples of ore at facilities owned by Queenstake Resources USA, Inc., Newmont, and Antler Peak Gold Inc (APGI). APGI is a subsidiary of Great Basin Gold Ltd (GBG) (the parent company of RCG). RCG has most recently entered into arrangements for ore processing with APGI at the Esmeralda Mill in Mineral County, and with Newmont at the Midas Mill in Elko County. The Midas Mill is located at the Midas Mine, also known as the Ken Snyder Mine.

2.3.1 Transport of Ore Bulk Samples

Bulk samples of ore have been transported to the Esmeralda Mill or Midas Mill for processing by third-parties. The ore is hauled to the Esmeralda Mill in trucks with an approximate capacity of 38 tons. Trucks and trailers are highway-legal with side-dumping tubs. An estimated 12 truck trips are made per day, 5 days per week, from the Hollister Site. Ore is occasionally hauled in campaigns (3 to 15 trucks traveling together) to account for adverse weather that temporarily increases the roundtrips per day but lowers the number of ore haulage days per month and increases highway and truck driver safety. The current ore haulage requires two, 10-hour shifts per day, 5 days per week.

Ore is hauled a distance of approximately 297 miles along the route shown in **Figure 2-8**, from the Hollister Site to the Esmeralda Mill. Ore is transported in trucks from the Hollister Site for a distance of 9 miles north on the Ivanhoe Road and then west approximately 31 miles on the Midas-Tuscarora Road. The ore trucks travel southwest on Nevada State Route (SR) 789 for 16 miles and 111 miles southwest on Interstate 80 (I-80) to the junction of United States Highway 95 (U.S. 95). The trucks travel south on U.S. 95 for 104 miles and then at the Town of Hawthorne proceed south on SR 359 for 4 miles to the junction of the Lucky Boy Pass Road. The ore trucks travel along the Lucky Boy Pass Road a distance of approximately 22 miles to the Esmeralda Mill.

Alternatively, ore has been hauled to the Midas Mill at a distance of 20 miles from the Hollister Site via the Ivanhoe Road for 9 miles, then west on the Midas-Tuscarora Road for approximately 9 miles, and approximately 2 miles on a gravel road to the Midas Mill located about 2 miles southeast of the Town of Midas (**Figure 2-8**).

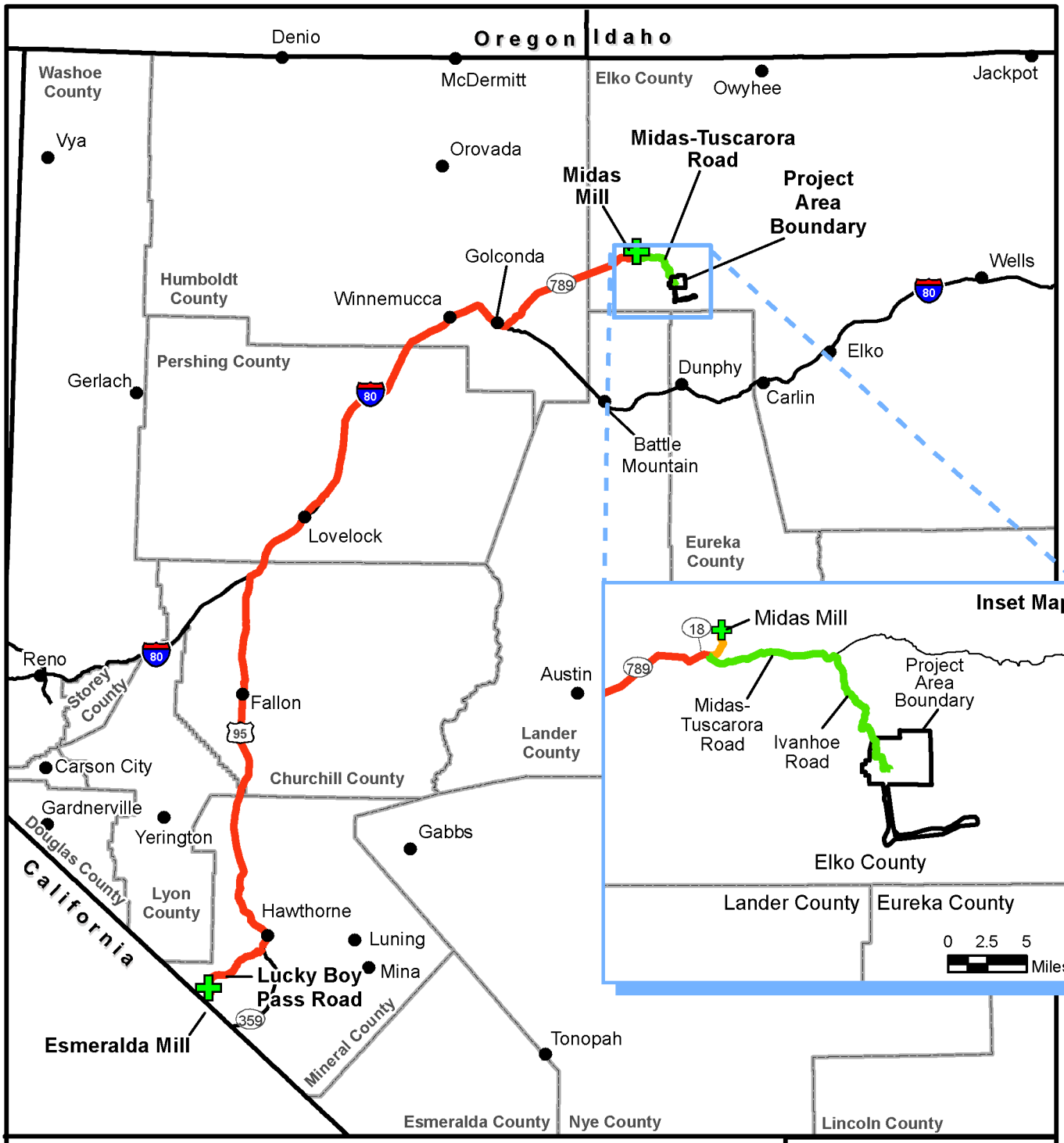
2.3.2 Processing Bulk Samples of Ore

As described above, bulk samples of ore have been sent to the Esmeralda and/or Midas mills. Ore processed at each mill varies and is managed according to grade and metallurgy.

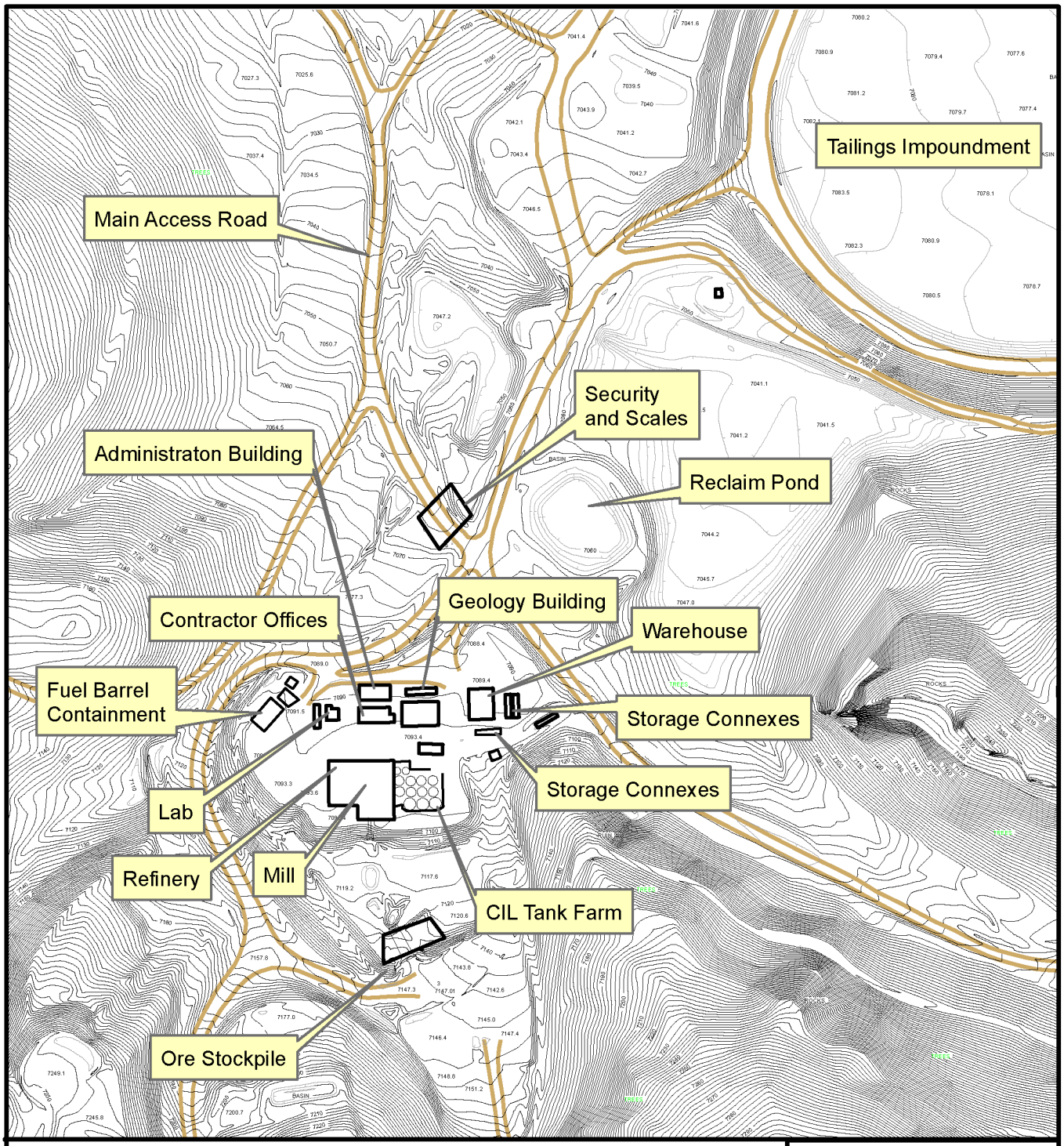
2.3.2.1 Existing Esmeralda Mill Facilities

APGI owns the Esmeralda Mine and Mill in Mineral County, Nevada, and has refurbished the mill facilities to accept and process ore from third-parties (**Figure 2-9**). The Esmeralda Mill is located on both private lands owned and controlled by APGI and federal land administered by the U.S. Forest Service (USFS).

The Esmeralda Mill includes administrative buildings; a warehouse and ancillary portable storage containers; a milling facility (ore pad with ore stockpile, crushing system, and mill building); tailings facility; and a Class III landfill (APGI 2009). Approximately 45 employees currently work at the Esmeralda Mill.


Oregon
Idaho
Denio
McDermitt
Jackpot
Owyhee
Elko County
Washoe County
Vya
Orovada
Midas-Tuscarora Road
Midas Mill
Project Area Boundary
Golconda
Wells
Humboldt County
Winnemucca
789
80
Pershing County
Gerlach
Dunphy
Elko
Carlin
Battle Mountain
Lovelock
Eureka County
Inset Map
Midas Mill
18
789
Midas-Tuscarora Road
Ivanhoe Road
Project Area Boundary
Elko County
Lander County
Eureka County
0 2.5 5
Miles
Reno
Storey County
Austin
Fallon
95
Lander County
Carson City
Churchill County
Gardnerville
Douglas County
Yerington
Gabbs
California
Lyon County
Hawthorne
Luning
Mina
Lucky Boy Pass Road
359
Esmeralda Mill
Mineral County
Tonopah
Esmeralda County
Nye County
Lincoln County
Legend
Project Area Boundary
Esmeralda Mill Route
Midas Mill Route
Esmeralda Mill and Midas Mill Routes
Mill Site
Nevada State Route
U.S. Federal Highway
U.S. Interstate Highway
Source: RCG 2010b.
N
0 20 40
Miles
Hollister Underground Mine Project EIS
Figure 2-8
Ore Transportation Route

3/20/2012



Legend

Dirt Road

N

0 500 1,000 Feet

Note: Contour interval is 2 feet.
Source: RCG 2011b; 2010b.

Hollister Underground Mine Project EIS

Figure 2-9

Esmeralda Mill Facilities Overview

3/23/2012

The Esmeralda Mill is operated by APGI under permits approved by the USFS and NDEP, and occupies approximately 43.5 acres (7.8 acres of federal land, 35.7 acres of private land) for the tailings impoundment and reclaim pond, the mill area, the office, and ancillary buildings (USFS 1997). The chemicals and fuel used and stored at Esmeralda Mill are identified in **Table 2-4** (RCG 2010b).

Ore Processing at Esmeralda Mill

The Esmeralda Mill is permitted to process up to 127,700 tons of gold- and silver-bearing ore annually. High grade metallic ore initially is stockpiled in the ore storage area. A front-end loader feeds the ore into a grizzly, which in turn feeds the primary crusher. Undersized material bypasses the primary crusher, and oversized material is reduced to 6 inches minus. The ore stream is collected and conveyed to the secondary crusher for reduction to 5/8 inch minus. Following secondary crushing, the ore is stored in a fine ore stockpile (APGI 2009).

The ore is reclaimed from the fine ore stockpile via underground slot feeds and a conveyor system. Lime is added to the ore for pH adjustment prior to the ore entering the grinding circuit. The grinding circuit consists of a semi-autogeneous mill followed by final grinding through two conventional ball mills. Gold and silver values are recovered from the ground ore utilizing conventional carbon-in-leach (CIL) technology with sodium cyanide the primary lixiviant for metal dissolution. After the gold and silver are dissolved and subsequently adsorbed (loaded) onto activated carbon, the metals are stripped (removed under high pressure and temperature) from the carbon in the form of a high grade pregnant solution. This solution is then further processed and precious metal precipitate is collected. Concentrate from the processing is then smelted to produce gold and silver doré. The doré bars are then shipped to a refinery (APGI 2009).

APGI applied for and, on October 21, 2010, was issued, a Mercury Operating Permit to Construct Phase 2. The permit allows for the construction of mercury control systems. Construction must be initiated within 18 months of approval and completed within 24 months of approval.

Esmeralda Mill Tailings Facility

Tailings slurry is pumped from the mill to the tailings impoundment through 1,700 feet of buried 4-inch-diameter, HDPE pipe coupled with high pressure flange fittings. The tailings slurry is discharged on a planned rotational basis along the perimeter of the tailings impoundment, thereby creating a relatively uniform tailings surface, both in terms of elevation and deposition. This method results in a stronger and more impermeable dam face and allows for easier water recycling. This practice also minimizes potential seepage by sealing off the inner embankment slope of the impoundment with settled tailings. Seepage water is piped from the internal drain to the seepage collection facility and then recycled back into the tailings facility (APGI 2009).

The seepage containment facility south of the access ramp is an HDPE-lined pond that provides secondary containment to an HDPE storage tank that is the primary collection receptacle. The tank is equipped with a submersible pump to move solution to the tailings facility. Water is piped from the internal drain to the seepage collection facility and then to the tailings facility (APGI 2009).

Excess water from the tailings impoundment is pumped to the reclaim pond, via a buried 4-inch-diameter HDPE pipe that parallels the tailings discharge line. A drainage net between the two liners provides leak detection (APGI 2009). Tailings material is treated in a cyanide destruction circuit located at the mill prior to being pumped to the tailings impoundment. A perimeter fence prevents access by wildlife.

A perimeter road and storm water diversion channel were constructed around the tailings impoundment. As required by the State of Nevada regulations governing facility design, the tailings impoundment was designed for a 100-year, 24-hour storm event (APGI 2009).

Table 2-4 Chemicals Currently Used at Esmeralda Mill

Chemical Name	Common Name/Other Name	Quantity	Location Stored on Site	Area Used	Rate of Use Per Year	Shipment Quantities
Caustic Soda Pellets	Caustic Soda	4,000 lbs	Mill Building	CIL Tank Farm	8,000 lbs	4,000 lbs
Cyanide Solution (20 to 30%)	Same	10,000 gal	Esmeralda Mill Site Storage Tank	CIL Tank Farm	40,000 gal	10,000 gal per quarter
Hydrogen Peroxide (40 to 60%)	Same	8 x 400 gal totes	CIL Tank Farm	CIL Tank Farm	12,800 gal	8 x 400 gal totes every 3 months
Lead Nitrate	Same	15,000 lbs	Mill Building	CIL Tank Farm	35,000 lbs	15,000 lbs
Propane	Odorized LPG	5,000 gal	Mill Building, Office Complex	Mill/Office Building Complex	180,000 gals	15,000 gal per month
Zinc	Zinc Dust	800 lbs	Mill Building, Warehouse	Mill Building	10,000 lbs	800 lbs

lbs = pounds.

gal = gallons.

Source: RCG 2010b.

2.3.2.2 Existing Midas Mill Facility

The Midas Mill (**Figure 2-10**) is located entirely on private land in western Elko County, approximately 1.5 miles southeast of the Town of Midas, Nevada.

NDEP-BMRR approved processing of ore from the Hollister Site at the Midas Mill. The recent contractual arrangement with the Midas Mill has been an ore purchase agreement where title to the ore passes to Newmont prior to processing. The Hollister ore is stored on a containment pad located adjacent to the Midas Mill prior to processing in batches. Hollister ore is not blended with other ore for processing. It is estimated that approximately 10,000 tons of Hollister ore could be processed on a monthly basis under existing permits. All procedures, facilities, and chemicals used at the Midas Mill meet NDEP permit requirements (Newmont 2007).

Ore Processing at Midas Mill

The mill process building and perimeter areas contain crushing, grinding, gravity separation, cyanide leaching, Merrill-Crowe gold recovery, retorting, and precious metal refining facilities. The mill is equipped with sumps and evacuation pumps to return solution to process components and to the tailings impoundment. Permitted annual throughput is 450,000 tons per year (tpy) (NDEP 2008a). The Midas Mill employs 30 employees (Newmont 2007).

The mill processing includes crushing the ore in a two-stage crushing plant in a closed circuit to 3/8-inch size at a throughput rate of 108 tons per hour (tph). The ore is then fed by conveyor to a single-stage ball mill for grinding before being routed to cyclones. Slurry solids are then washed from the gold-bearing solution. The rinse water from this process becomes the gold- and silver-bearing pregnant solution. Gold and silver are recovered from the pregnant solution in a conventional Merrill-Crowe plant that produces a precious metals-bearing precipitate filter cake. The concentrates are then treated in a propane-fired pressure retort to volatilize the mercury. Mercury is recovered by condensing the mercury vapor, collecting it as a liquid, and capturing it in a carbon column. The retort product is then fed to the refinery where it is loaded into a propane-fired melting furnace to produce a molten gold/silver doré. The doré bullion is shipped off-site for smelting.

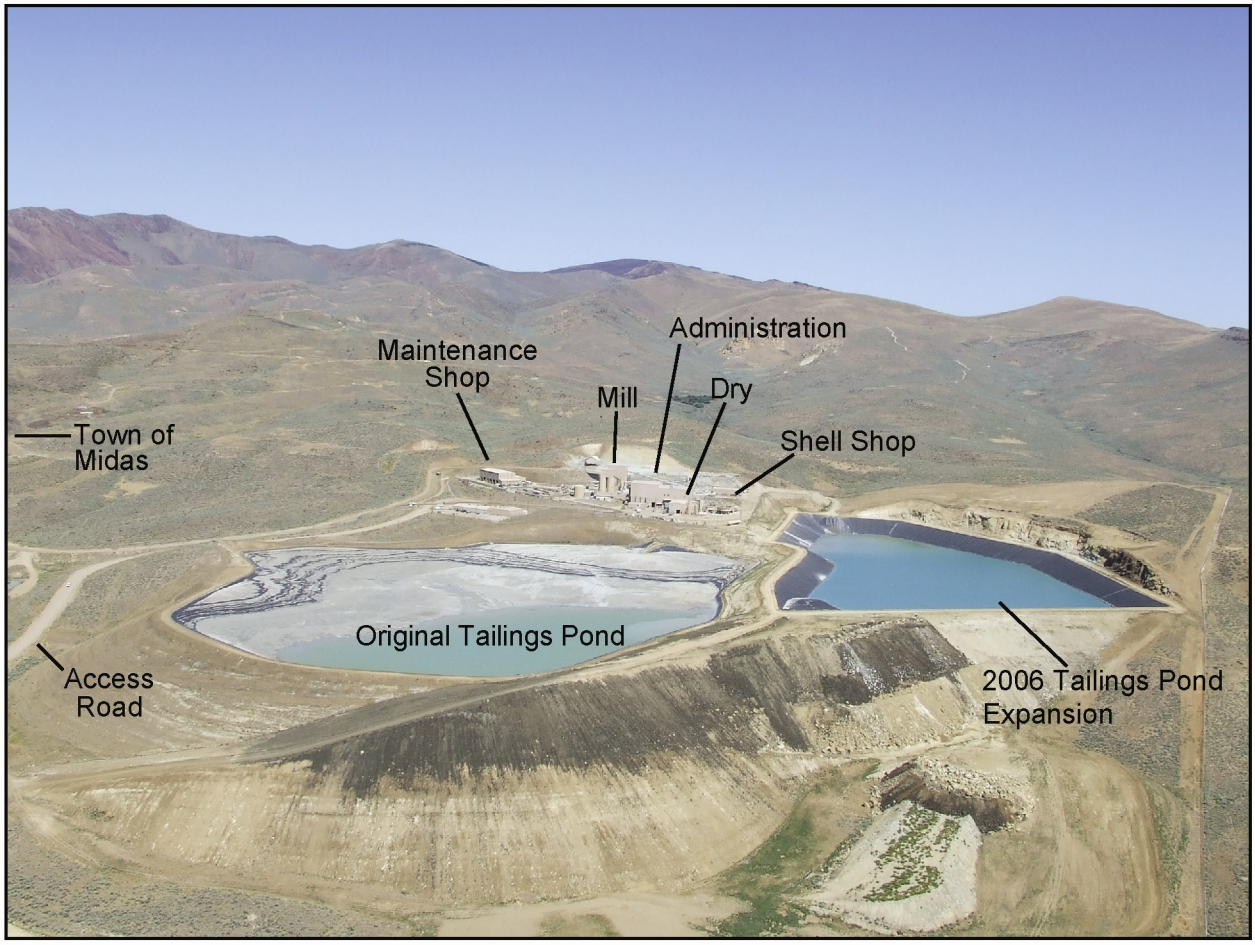
Midas Tailings Facility

The tailings impoundment is located south and downgradient of the mill process building (**Figure 2-10**). Both the surface of the impoundment basin and the upstream face of the embankment are lined with textured 80-mil HDPE. The impoundment storage capacity at final buildout would be approximately 5.67 million tons (Newmont 2007).

Tailings material is distributed from a single-point discharge pipeline that can be moved to promote drying and consolidation of the tailings fines. An underdrain collection system was constructed with a network of 6-inch-diameter corrugated polyethylene collector pipes placed on the HDPE liner, wrapped with 16-ounce geotextile, and covered with a minimum 12-inch layer of drain rock. The underdrain solution is pumped for secondary containment before being reclaimed for use in the mill (Newmont 2007).

Tailings solution is recycled from the impoundment to the mill. The tailings impoundment is designed to store the incident precipitation from a 100-year, 24-hour storm event, plus operational volumes, with 3 feet of freeboard. A runoff diversion channel on the upgradient perimeter of the tailings impoundment is designed to divert surface runoff from a 100-year, 24-hour storm event to an adjacent catchment basin (Newmont 2007).

The tailings material is treated in a cyanide destruction circuit located at the mill; a layer of bird balls and a propane cannon provide wildlife protection at the supernatant pools and the underdrain solution collection pond. A fence encompasses both the tailings impoundment and the underdrain solution collection pond (Newmont 2007).



Hollister Underground Mine Project EIS

Figure 2-10

Midas Mill Facilities Overview

Source: BLM 2010c (photo date unknown); RCG 2010b.

2.4 Proposed Action

2.4.1 Project Overview

RCG is proposing an expansion of its existing surface and underground exploration activities at the Hollister Site and the transition to full-scale underground mine production and associated support facilities. An amendment to the PoO (NVN-076802) for the proposed project was submitted to the BLM in March 2008 in compliance with BLM regulations (43 CFR Subpart 3809) and NDEP regulations governing the reclamation of mined lands (NAC 519A.010-635). A revised PoO amendment was submitted to the BLM based on comments RCG received. The PoO amendment is available at the BLM office.

The Proposed Action (also called proposed project or the Hollister Underground Mine Project) would contain the following major components (**Figures 2-11** and **2-12**):

- Continued and expanded surface and underground exploration activities;
- Transition from underground exploration and bulk sampling activities to full-scale production of gold and silver (underground mining operation);
- Installation of the Hatter production shaft, raise, or ramp (collectively referred to as the HPS), as the geology of the area dictates;
- Continued maintenance of the existing Ivanhoe access road and Little Antelope Creek Road;
- Construction of road(s) within the existing mining disturbance areas and to the Hatter production shaft;
- Construction of a new 11.6-mile-long electric power transmission and distribution line (collectively referred to as 'transmission line') and substation, including access routes;
- Mine water management including installation of a National Pollutant Discharge Elimination System (NPDES) permitted outfall for discharge to Little Antelope Creek and surface monitoring and underground wells, as needed;
- Continued waste rock disposal in the existing permitted and lined WRSF, in underground mined-out areas as backfill, and in a new WRSF located on previously disturbed and unreclaimed land in an existing open pit;
- Construction of ancillary support facilities; and
- Continued and increased transport of ore by truck to off-site existing third-party owned mineral processing facilities located on private land at the Esmeralda Mill in Mineral County, Nevada, and/or the Midas Mill in Elko County, Nevada.

Descriptions of Proposed Action facilities in Section 2.4 pertain only to the Hollister Underground Mine, unless specifically noted as the Esmeralda or Midas mills. The proposed project facilities are shown in **Figures 2-11** and **2-12**.

The project area is defined as the approximately 10,168-acre region within the black line designating the project area boundary depicted on **Figure 2-11**. The Proposed Action would result in a total of approximately 117 acres of proposed surface disturbance for mining, transmission line construction, and exploration activities in addition to the previously authorized 105 acres of surface disturbance. A total of 92 acres of surface disturbance would occur within the project area for the Proposed Action, of which 51.5 acres are new disturbance, 32.4 acres are located on reclaimed lands disturbed by previous mining activities, and 8.1 acres of previously disturbed but not reclaimed lands (**Table 2-5**). Approximately 34.7 of the 92 acres of proposed disturbance would be for construction of the transmission line and associated components. The Proposed Action also includes an additional 25 acres of new disturbance from surface exploration activities for a total of up to 50 acres of surface exploration disturbance (**Table 2-6**).

Ivanhoe Road

INSET MAP

Proposed Mine Office Complex

West Pit

East Pit Facilities

Surface Exploration Storage

Proposed HPS

West

East

South

Proposed NPDES Surface Discharge

0 0.25 0.5 Miles

T38N, R48E

T37N, R48E

Transmission Line Analysis Corridor

Mud Springs Road

Coyote Creek Substation

Little Antelope Creek Road and Buried RIB Pipeline

Proposed 24.9-kV Transmission Line

Baroid-Rossi Mine

Antelope Creek Road

East RIB

West RIBs (2)

Proposed 120-kV Transmission Line

Proposed Rodeo Creek Substation

T37N, R48E T37N, R49E

Humboldt Elko Washoe Pershing Lander Eureka White Pine Lyon Churchill Nye Mineral Lincoln Esmeralda Clark

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line
- Storm Water Diversion Channel
- East Pit Facilities
- Newmont Reclaimed Waste Rock Storage Facilities

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 10,000-gallon Potable Tank and 35,000-gallon Fire Water Tank
- Rodeo Creek Substation
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Proposed Storm Water Diversion Channel
- East Pit Spur Road
- Surface Exploration Storage

Sources: BLM 2010a; RCG 2009a.

N

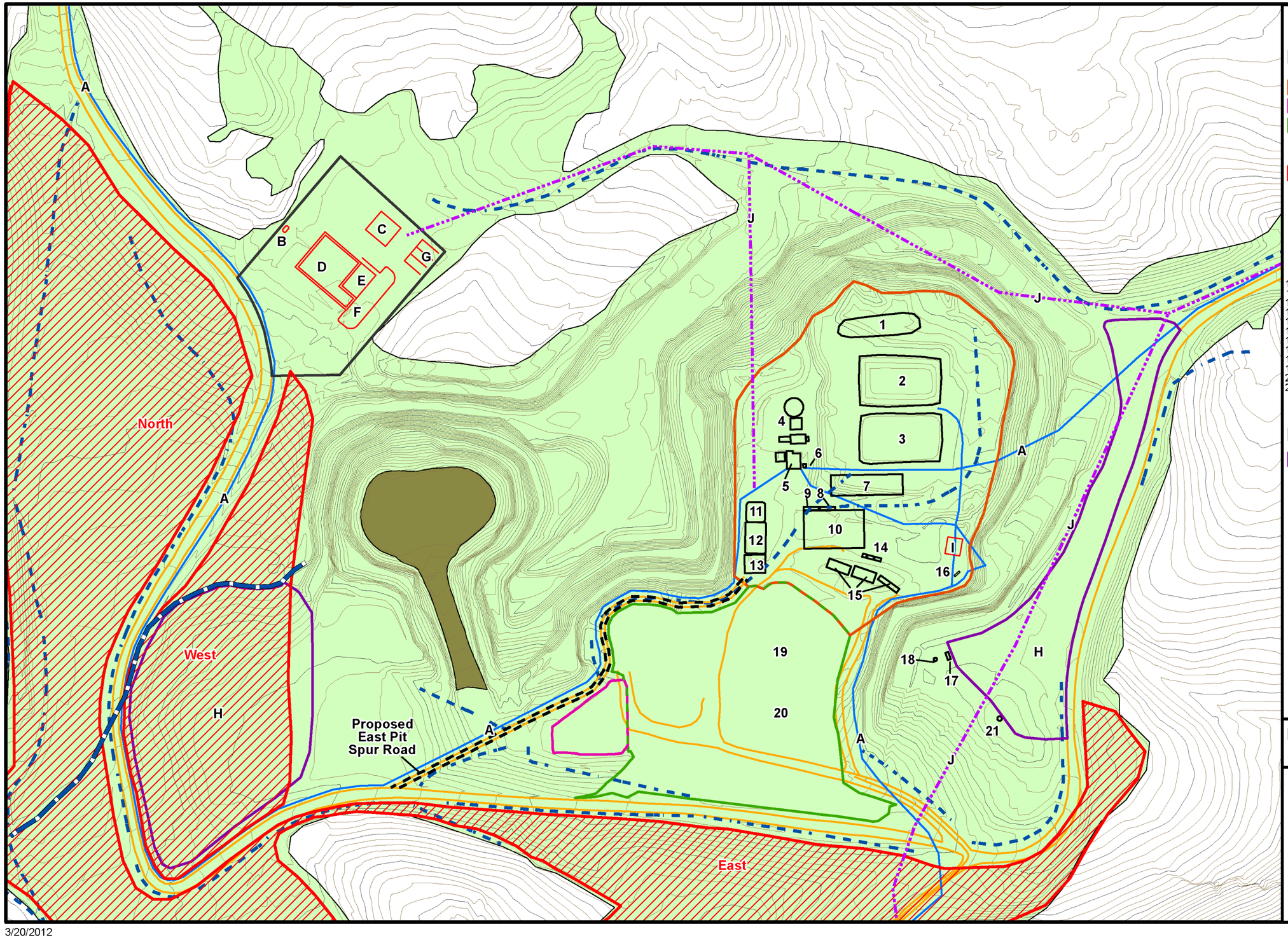
0 0.75 1.5 Miles

Hollister Underground Mine Project EIS

Figure 2-11

Overview of Proposed Action Facilities

3/19/2012



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Road
- East Pit Facilities
- Storm Water Basin Pond
- Waste Rock Storage Facility
- Storm Water Diversion Channel
- Newmont Reclaimed Waste Rock Storage Facility

1) Growth Media Stockpile
2) North Surge Pond
3) South Recycle Pond
4) De-silting System
5) Oil Contaminated Soil Pad
6) Wash Bay/Steam Cleaner
7) Reverse Osmosis Water Treatment Plant
8) Connex Storage
9) Lube Oil Storage
10) Maintenance Shop
11) Fuel Storage
12) Generators (2)
13) Compressor Building
14) Septic Holding Tanks
15) Office Trailers
16) Portal
17) Potable Water Treatment Plant
18) Potable Water Tank (5,000-gal) (4)
19) RCG Existing Waste Rock Storage Facility
20) Ore Stockpile and Storage
21) Utility Water Tank (10,000-gal)

Proposed Surface Disturbance or Facilities

- West Pit Waste Rock Storage Facility
- Laydown Area
- Buried Pipelines
- Proposed Storm Water Diversion Channel
- 24.9-kV Transmission Line
- East Pit Spur Road

A) Buried Water Pipelines
B) Propane Tank
C) Mine Rescue Building
D) Mine Office Complex
E) Fenced Outside Storage Area
F) Outside Storage Area
G) Septic Tank and Leach Field
H) Laydown Area
I) Batch Plant
J) Powerline

Note: Contour interval 5 feet.
Source: MWH Americas Inc. 2007; RCG 2009a.

N

0 200 400 Feet

Hollister Underground Mine Project EIS

Figure 2-12

Detail of Proposed Action Facilities

3/20/2012

Table 2-5 Currently Authorized and Proposed Action Disturbance

Component	No Action Alternative Authorized Disturbance			Proposed Action Disturbance			Total Disturbance
	Public Acres	Private Acres	Total Existing Acres	Public Acres	Private Acres	Total Proposed Acres	
Mining Facilities							
Existing RCG WRSF and Ore Stockpile Storage	7.2	-	7.2	-	-	-	7.2
West Pit WRSF	-	-	-	8.0	-	8.0	8.0
Hatter Production Shaft	-	-	-	5.0	-	5.0	5.0
East Raise	0.4	-	0.4	-	-	-	0.4
West Raise	0.4	-	0.4	-	-	-	0.4
Laydown Areas	10.0	-	10.0	10.0	-	10.0	20.0
Mining Facilities Disturbance Totals[1]	**18.0**	**-**	**18.0**	**23.0**	**-**	**23.0**	**41.0**
Transmission Line and Associated Components							
Rodeo Creek Substation[2]	-	-	-	-	2.0	2.0	2.0
East Pit Switchgear Facility				0.1	-	0.1	0.1
Transmission Line Pads: 24.9-kilovolt (kV)[3]	-	-	-	0.1	0.1	0.2	0.2
Transmission Line Pads: 120-kV[4]	-	-	-	0.1	0.1	0.2	0.2
Temporary Access Roads: 24.9-kV[5]	-	-	-	13.7	1.5	15.2	15.2
Temporary Access Roads: 120-kV[5]	-	-	-	7.9	7.1	15.0	15.0
Laydown Areas: 24.9-kV	-	-	-	1.0	-	1.0	1.0
Laydown Areas: 120-kV	-	-	-	1.0	-	1.0	1.0
Transmission Line and Associated Components Disturbance Totals[6]	**-**	**-**	**-**	**23.9**	**10.8**	**34.7**	**34.7**
Water Management Facilities							
Water Management Ponds[7]	2.0	-	2.0	-	-	-	2.0
Water Tanks/Treatment[8]	2.0	-	2.0	-	-	-	2.0
New Water Tanks	-	-	-	0.3	-	0.3	0.3
Water Well #1	0.5	-	0.5	-	-	-	0.5
Rapid Infiltration Basins	3.0	5.0	8.0	-	-	-	8.0

Table 2-5 Currently Authorized and Proposed Action Disturbance

Component	No Action Alternative Authorized Disturbance			Proposed Action Disturbance			Total Disturbance
	Public Acres	Private Acres	Total Existing Acres	Public Acres	Private Acres	Total Proposed Acres	
RIB Monitoring Wells	6.5	0.1	6.6	-	-	-	6.6
Proposed Buried Pipelines[9]	-	-	-	20.4	-	20.4	20.4
Proposed NPDES Discharge Outfall	-	-	-	0.5	-	0.5	0.5
Proposed Storm Water Diversion Channel[10]	-	-	-	0.4	-	0.4	0.4
Monitoring Wells for Mine Site	2.0	-	2.0	1.0	-	1.0	3.0
Overburden Stockpile for RIBs	6.0	1.8	7.8	-	-	-	7.8
Growth Media Stockpiles for RIBs	0.5	1.5	2.0	-	-	-	2.0
Water Management Facilities Disturbance Totals	**22.5**	**8.4**	**30.9**	**22.6**	**-**	**22.6**	**53.5**
Roads							
Misc. Roads and Parking	3.1	-	3.1	-	-	-	3.1
East Pit Spur Road (1,215-foot length)	-	-	-	0.7	-	0.7	0.7
Little Antelope Creek Road	6.0	1.1	7.1	-	-	-	7.1
Access Road Upgrade to HPS [11]				6.0		6.0	6.0
Miscellaneous[12]	6.7	-	6.7	1.0	-	1.0	7.7
Roads Disturbance Totals	**15.8**	**1.1**	**16.9**	**7.7**	**-**	**7.7**	**24.6**
Ancillary Facilities							
De-silting Facilities	0.4	-	0.4	-	-	-	0.4
Wash Bay	0.1	-	0.1	-	-	-	0.1
Explosives Yard[13]	0.0	-	0.0	-	-	-	0.0
East Pit Offices[14]	1.0	-	1.0	-	-	-	1.0
Mine Office Complex	-	-	-	4.0	-	4.0	4.0
Misc. East Pit Facilities[15]	10.1	-	10.1	-	-	-	10.1

Table 2-5 Currently Authorized and Proposed Action Disturbance

Component	No Action Alternative Authorized Disturbance			Proposed Action Disturbance			Total Disturbance
	Public Acres	Private Acres	Total Existing Acres	Public Acres	Private Acres	Total Proposed Acres	
Ancillary Facilities Disturbance Totals	**11.6**	**-**	**11.6**	**4.0**	**-**	**4.0**	**15.6**
Total[16]	**67.9**	**9.5**	**77.4**	**81.2**	**10.8**	**92.0**	**169.4**

[1] The proposed disturbance associated with mining facilities would all be on existing disturbance.

[2] Includes temporary laydown area that would be reclaimed after facility construction.

[3] Transmission line pad acreage estimates for 24.9-kV transmission line were less than 0.1 acre, but were rounded up to better buffer disturbances.

[4] Transmission line pad acreage estimates for 120-kV transmission line were less than 0.1 acre, but were rounded up to better buffer disturbances.

[5] Transmission line temporary access roads assume 20-foot width, following the transmission line directly with spur roads at a maximum of one every mile for access to transmission line where topography or existing road would be difficult to access.

[6] The proposed disturbance associated with the transmission line would be mostly on previously undisturbed land.

[7] North surge pond, south recycle pond, and storm water basin pond.

[8] Septic holding tank, potable water tank, utility water tank, RO water treatment plant, de-silting system, and potable water treatment plant.

[9] Includes a 20-foot-wide temporary disturbance from: 1) the West Raise to the RIBs (15.9 acres), 2) the water treatment facility to the HPS (2.5 acres), and 3) from underground groundwater pumping to the NPDES discharge outfall via water treatment plant (2.0 acres).

[10] Assumes a 15-foot-wide permanent disturbance for the diversion channel.

[11] Assumes a 18-foot running width with 5-foot shoulders and 1.0 acre extra for turnouts.

[12] Includes service roads, main gate, guard shack, storage areas, diversion channels, and other authorized disturbance.

[13] Explosives storage was moved underground.

[14] Includes connex storage, lube/oil storage, maintenance shop, office trailer, foreman trailer, and shifter trailer.

[15] Walkways among East Pit facilities, laydowns, storage, parking, etc.

[16] Of the total 92 acres of disturbance associated with the Proposed Action, 32.4 acres would be on reclaimed lands disturbed by previous mine and mineral exploration activities, 51.5 acres would be on new disturbance, and 8.1 acres would be on existing disturbed and non-reclaimed land.

Source: BLM 2011a, 2010c; RCG 2010b, 2009a.

Approximately 106 acres would involve lands administered by the BLM, and approximately 11 acres are owned by private parties (**Figure 1-2**). Total surface disturbance at the Hollister Site for previously authorized and proposed actions would be approximately 222 acres.

Table 2-6 Surface Exploration Disturbance for Existing Authorized Actions and the Proposed Action

Component	Disturbance from Existing Authorized Actions			Disturbance from Proposed Action			Total Disturbance
	Public Land (acres)	Private Land (acres)	Total Existing Disturbance (acres)[1]	Public Land (acres)	Private Land (acres)	Total Proposed Disturbance (acres)	
Exploration including roads and drill sites	28[1]	0	28	25	0	25	53

[1] Includes 3 acres for water well #5 and associated water system facilities (i.e., pipeline, pump house, water tank, and roads).

Note: The proposed disturbance associated with surface exploration may be mostly on previously undisturbed land.

Source: Ivanhoe Surface Exploration Plan of Operations NVN-071014 (BLM 1993a).

The designated analysis corridor includes the transmission line route, a segment of Little Antelope Creek, the RIB area, and Little Antelope Creek Road. The analysis corridor contains 1,121 federally owned and 867 privately owned acres. **Tables 2-5** and **2-6** present a summary of surface disturbance associated with the proposed project and authorized disturbance for currently permitted activities (i.e., the No Action Alternative).

The transition to full-scale mine production, described in Section 2.4.3.2, Ore Production, would require minor additions to the existing project infrastructure. Most of the existing on-site surface infrastructure described in Section 2.2, Existing Hollister Operations, used to facilitate the underground exploration activities would remain in place for the Proposed Action. Most of the existing infrastructure required for the Proposed Action is located within disturbance created by open-pit mining operations namely, the East Pit, undertaken in the early 1990s by previous operators. Most of the new and upgraded surface infrastructure would be placed on previously disturbed and reclaimed areas outside of the East Pit.

RCG is currently authorized to disturb approximately 80 acres (70.9 acres of public land and 9.5 acres of private land) associated with the facilities located in the East Pit, including the existing RCG WRSF, roads, growth media stockpiles, cement batch plant, offices, dry facilities, some water treatment facilities, portal, and the water well #5 associated water system. Some of the existing water treatment facilities are located outside of the East Pit, such as water wells, water tanks, and RIBs (**Figures 2-1** and **2-2**).

2.4.1.1 Project Area Description

The project area (**Figures 2-11** and **2-12**) includes all the areas for the three general categories of activities under the Proposed Action. These activities are: transition to full-scale underground mining, construction of a transmission line, and surface exploration. The project area is the region within the project area boundary black line (**Figure 2-11**).

The proposed milling operations would be conducted at the Esmeralda Mill in Mineral County, and/or the Midas Mill in Elko County.

2.4.1.2 Schedule and Work Force

Pending authorization of required permits and approvals, construction and operation of the proposed project is anticipated to be initiated in 2012. The mine would be active year-round for approximately 20 years. Concurrent reclamation would be conducted during this period as areas are no longer utilized. Up to an additional 3 years would be required for final reclamation and site closure.

Currently, approximately 160 people work at the Hollister Site. It is anticipated that the Proposed Action would require up to 60 additional workers for full production and construction of facilities and other site preparation activities. Approximately 45 of the additional 60 workers would be temporary hires to construct new facilities; 15 workers would be permanent new hires to support full-scale mine production. The majority of the work force has been hired from the local communities. It is anticipated that the proposed project would provide employment opportunities for the 20-year mine life, plus the reclamation period.

2.4.2 Access Roads

2.4.2.1 Project Area Access Road – Ivanhoe Road

Under the Proposed Action, the 9-mile Ivanhoe Road to the Hollister Site would continue to be maintained as needed to enhance safety, reduce the risk of accidents, minimize sediment in drainages, and reduce dust generation from the road. Maintenance activities would be in accordance with the terms and conditions of the ROW, including grading (blading), snow removal, and use of dust suppressants, depending on the time of year and road conditions. In the vicinity of the mine and new office complex areas, a turnout from the Ivanhoe Road would be required to access the truck scales.

2.4.2.2 RIBs and Transmission Line Access – Little Antelope Creek Road

The existing Little Antelope Creek Road would be maintained as in the past. Blading would not widen the road; its purpose would be to maintain safe access to the RIBs and transmission line under the Proposed Action. The buried water pipeline from the mine site to the RIBs, is located in the center of the Little Antelope Creek Road. Gravel would be placed on the Little Antelope Creek Road as needed.

2.4.2.3 East Pit Access – Spur Road Within East Pit

RCG would continue to access the East Pit via the existing Ivanhoe Road, but a second short spur road, with a length of approximately 1,215 feet and a width of approximately 30 feet, would be constructed on the west side of the East Pit to provide for “loop” traffic into the pit area (**Figure 2-12**). It would be constructed in an area above the existing storm water pond, and it would connect to the top of the existing RCG WRSF. This road would allow RCG to maintain right-hand traffic with a safer and more efficient traffic flow for ore and supply trucks entering and exiting the East Pit.

Prior to construction of this 0.2 mile stretch of road known as the East Pit spur, RCG would investigate the nature and extent of the underlying material to determine if it is natural ground, waste rock, or low grade ore and the PAG nature of the material. If the waste rock or low grade ore in this area is determined to be PAG, one of the following preventative measures (or a combination of the two measures) would be used to construct this spur road to prevent acid generation:

1. The waste rock or ore material would be excavated to a depth of 3 feet and non-PAG rock would be used to fill the area of excavation for the spur road. The excavated material would be placed in the existing RCG WRSF.
2. Three feet of non-PAG material would be used as fill to construct the East Pit spur road. Regardless of the construction technique selected, RCG would place a gravel overlay on a crowned running surface of the road and route any drainage off the road and into the existing storm water pond via diversion channels. Gravel and clean fill material would be hauled from an existing gravel pit located on private property near the Town of Midas.

2.4.2.4 East and West Raise Access Roads

Minimal maintenance such as blading and or graveling on an as-needed basis would be done on the East and West Raise access roads.

2.4.2.5 Surface Exploration Access

Access to the project area for surface exploration would utilize the Ivanhoe Road described above. Within the project area surface exploration access would utilize existing roads and two-track roads and may include overland travel where possible. Any new constructed access roads must be approved by BLM.

2.4.3 Underground Mining Operations

Underground mining operations would consist of the facilities in the East Pit at an approximate elevation of 5,550 feet amsl, or 170 feet below the natural ground surface; the existing and new WRSFs; transmission line additions; laydown areas; access roads; Hatter production shaft, ramp, or raise; water treatment facilities; and other ancillary facilities (**Figure 2-12**). The total surface disturbance footprint to support the Proposed Action is comprised of 8.1 acres of existing, non-reclaimed land, 32.4 acres of new disturbance on previously reclaimed mining disturbance, and 51.5 acres of new disturbance (**Table 2-5**).

Under the Proposed Action, bulk sampling and testing operations would transition to full-scale underground mine production. Narrow vein mining methods (**Figure 2-4**) are proposed to extract the ore, as described in Section 2.2.4.5, Underground Test Mining Techniques.

Under the Proposed Action, RCG would use the same type of equipment that has been utilized at the site for bulk sampling activities. Some current equipment would be replaced during the life of the mine as equipment reaches the end of its useful life, and the equipment may be modified during the mine life depending on site-specific conditions and needs, and, depending on mining methods, more of the same type of equipment may be required.

2.4.3.1 Hatter Production Shaft, Raise, or Access Ramp

Under the Proposed Action, a new vertical production shaft (**Figure 2-13**) or alternatively a raise (**Figure 2-14**) or access ramp, would be constructed to a depth of approximately 2,000 feet below the surface (RCG 2012) (the HPS). This facility would be constructed to minimize underground truck haulage and to provide for future ore and waste rock haulage from the mine. The decision whether to sink a shaft or drive a ramp or raise would be made based on the geology, location of the ore body, and engineering requirements. For the purposes of this EIS, the proposed shaft was quantitatively assessed for potential impacts because it is taller and would cause the most visual impact and greatest surface disturbance. Alternatively the construction of either a raise or ramp would be less visible and would create less surface disturbance. Initial indications are that the shaft, raise, or ramp would be located near an old topsoil stockpile and old drillsite (“drillsite MT”) in a previously disturbed area. However, depending on future delineation of the ore body, it may be necessary to move this proposed location for better alignment with the ore body. A shaft would be approximately 2,000 feet deep and rectangular in cross section (approximately 8 feet by 24 feet). The topsoil currently stored in the proposed shaft location (**Figure 2-11**) would be stripped and stored near the proposed shaft on existing disturbance. All activities and facilities associated with the proposed shaft would be contained within a 5-acre area.

The shaft, raise, or ramp would be placed using conventional drill and blast techniques, with the waste rock excavated during construction hauled and placed in the existing RCG WRSF or the West Pit. A shaft would be lined with concrete or shotcrete with rock bolts and steel mesh, and would contain various compartments to be used for ore/waste rock hoisting, ventilation, and mine services, and supply movement into and out of the mine. Although the proposed shaft would be available for an emergency personnel escapeway from the mine, the existing decline in the East Pit would continue to serve as the primary personnel ingress/egress.

The production shaft would be supported by surface facilities, principally a hoist house and headframe. The proposed shaft hoist house would be a steel-sided building constructed on a concrete foundation. The color of the siding would be selected to blend in with the surrounding landscape. The headframe would be approximately 100 to 120 feet tall placed over the shaft (**Figure 2-13**). Additional facilities associated with the proposed shaft would include a small laydown area, office space in the hoist house, and temporary waste rock and ore stockpiles. All facilities would be located within the 5 acres of disturbance identified in **Table 2-5** (RCG 2010b).

Alternatively, a raise (**Figure 2-14**) or ramp may be constructed. Either facility also would be supported by shotcrete, with rock bolts and steel mesh. Additional facilities associated with a raise or ramp would include a small laydown area, a small building with office space not to exceed the height and dimensions of a hoist house (average size of 75 feet by 130 feet), and temporary waste rock and ore stockpiles (200 feet by 200 feet). If a ramp or a raise is chosen as the preferred method of access, it would be similarly located.

Ventilation, drainage, power, and communications with underground areas would be provided via the shaft or ramp to the underground working areas. Power would be supplied through a new overhead transmission line, described in Section 2.4.6.1, Electrical Power, and shown in **Figure 2-11**.

Waste rock removed from the HPS would be transported and placed in the existing RCG WRSF, in the proposed West Pit WRSF, or backfilled in the underground workings. Material used as backfill may be stored temporarily in the underground workings. Section 2.4.4, Waste Rock Management, describes the WRSF options and waste rock management procedures.

Access to the HPS would be via a 30-foot-wide road, (20-foot-wide running width and 5-foot-wide shoulders on each side) shown on **Figure 2-11**. Ore and waste rock would be hauled from the HPS to the WRSFs or ore stockpile for transport to the mill for processing.

2.4.3.2 Ore Production

As of September 2010, RCG reported approximately 1.6 million ounces of gold equivalent measured, indicated, and inferred resources for underground deposits associated with the Hollister operations. Targeted ore production would average 750 tpd for a total of up to 275,000 tpy. Daily ore production could vary based on the geometry and grade of the deposit and may reach 1,000 tpd. All ore produced would be mill grade. The ore and waste rock tonnages (based on current economic factors) for the proposed project are summarized in **Table 2-7**. All waste rock would be expected to be PAG.

Table 2-7 Proposed Action Ore and Waste Rock Tonnages

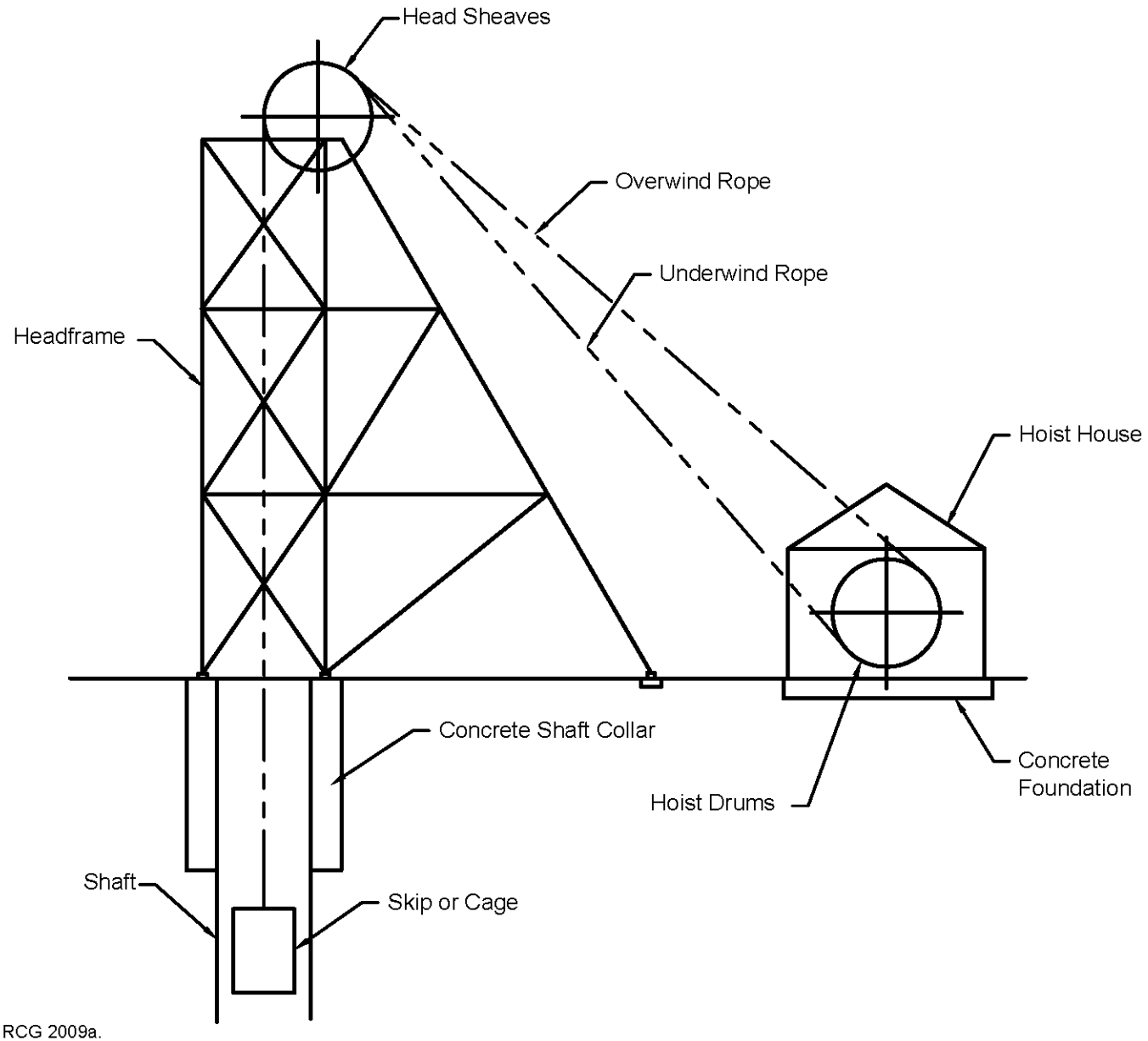
Source of Ore and Waste Rock	Total Ore (tpd)	Waste Rock (tpd)
Underground Operations	750 to 1,000	935 to 1,250

Source: RCG 2010b.

2.4.3.3 Loading, Hauling, and Ore Storage

Ore material removed from the underground mine would be hauled by truck and temporarily stored on a concrete pad on top of the approved and existing RCG WRSF, or on a concrete pad adjacent to the proposed HPS. Any draindown water from ore stockpiled on the existing RCG WRSF would continue to be collected, treated, and routed via buried pipeline to the existing RIBs, as described in Section 2.2.6, Water Management. The on-site ore storage area would include a small portable crusher. The crusher could accommodate approximately 100 tph and would be used as needed.

Typical Shaft Hoisting System



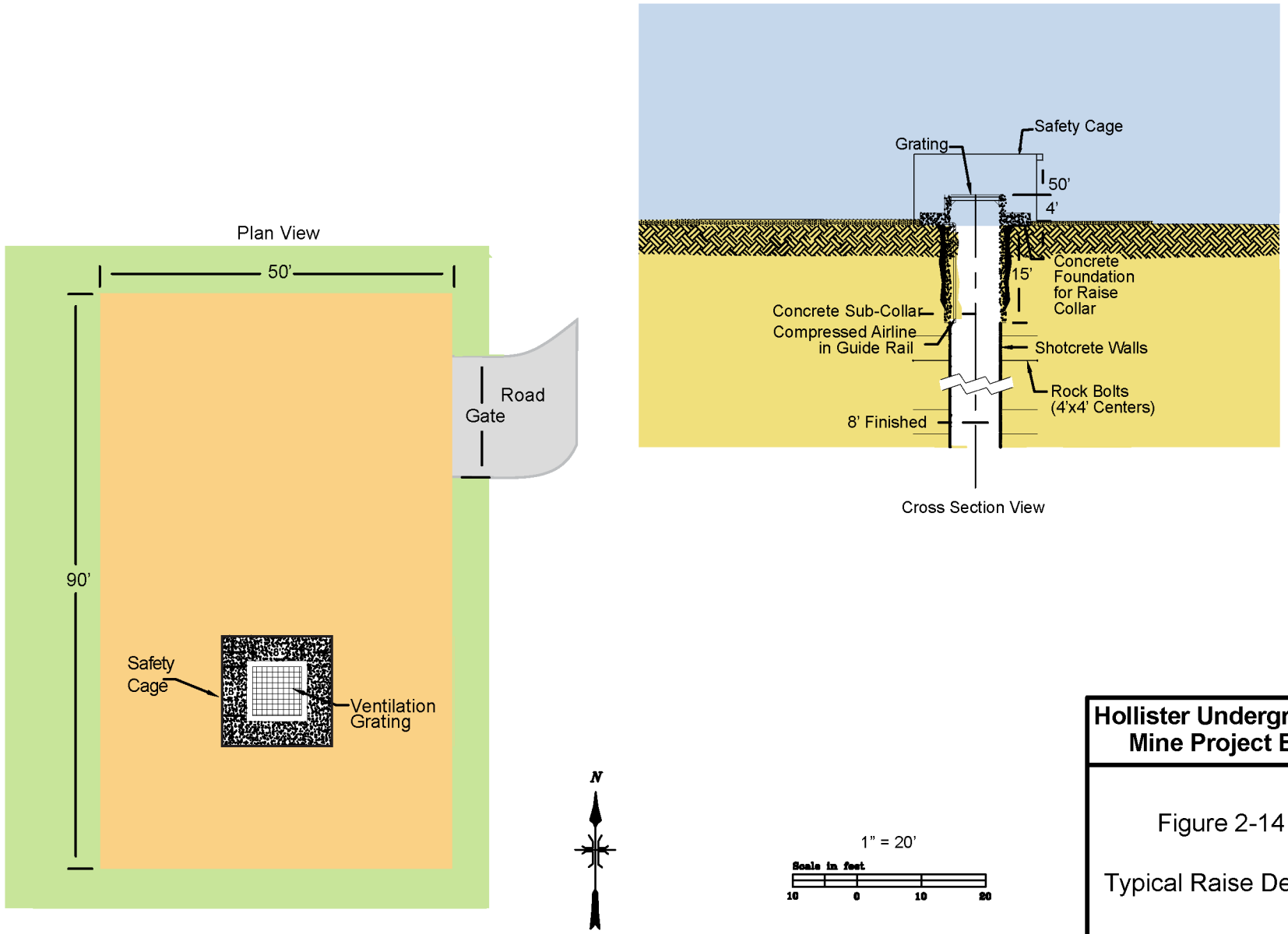
Source: RCG 2009a.

Hollister Underground Mine Project EIS

Figure 2-13

Typical Hoist House and Hoist Headframe Design

03/20/12



Source: RCG 2011b, 2010b.

Hollister Underground Mine Project EIS

Figure 2-14

Typical Raise Design

03/23/2012

2.4.3.4 Water Management

Water management under the Proposed Action consists of two separate systems, a new groundwater pumping system and continuation of the current mine water management system. To differentiate between the two, the new system is referred to as the groundwater pumping system and the existing system is referred to as the water management system. The existing water management system would continue to be utilized for the Proposed Action (see Section 2.2.6).

Pumping System

To supplement the existing water management system for the Proposed Action, 8 to 12 underground wells may be installed within the underground mine workings as necessary to improve water handling (**Figure 2-15**).Water would be removed from the underground workings up to a maximum rate of approximately 1,100 gpm on a continuous basis for the 20-year mine life. The groundwater pumping system (wells, pumps, pipelines, and tanks) would prevent groundwater from contact with the underground workings or from commingling with mine water that is handled by the existing water management system. The deepest working would be at a depth of approximately 4,000 feet amsl at the Hatter Expansion area or approximately 2,000 feet below ground surface (bgs). However, pumping water out to that depth may not be necessary because water is only pumped out when encountered. Section 3.5, Groundwater Resources and Geochemistry, describes the current groundwater elevations and expected pumping requirements for mining.

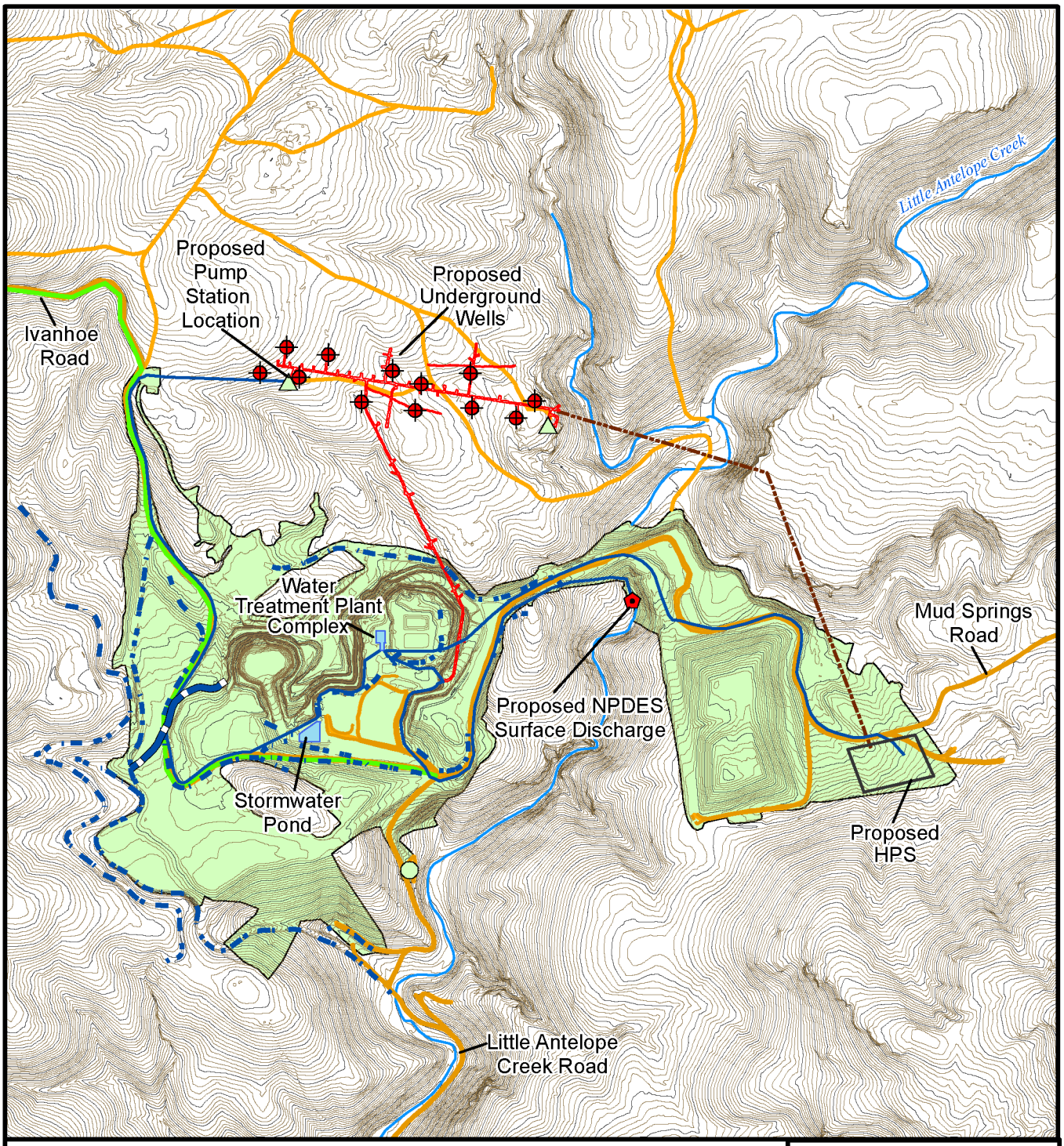
Water produced from the underground wells would be routed to underground pumping stations through dedicated pipelines. Water then would be pumped from the mine to the surface. Upon reaching the surface, this water would be gravity-fed in an existing buried pipeline to the RIBs or to the proposed NPDES discharge outfall on Little Antelope Creek (**Figure 2-15**). Pipeline diameters would vary from 6 to 8 inches.

The proposed discharge rate to Little Antelope Creek and the RIBs would be approximately equal to the groundwater pumping rate. In addition, RCG may use between 100 and 150 gpm from the underground wells to support Hollister Mine operations. **Figure 2-15** illustrates the conceptual location of underground groundwater pumping wells. RCG would obtain a NPDES permit from NDEP-Bureau of Water Pollution Control (BWPC) to allow surface discharge into Little Antelope Creek. Water discharged into Little Antelope Creek via the NPDES location would be treated, if necessary, to attain NDEP water quality standards for Rock Creek.

The Proposed Action conceptual underground expansion areas are shown in **Figure 2-16**. There are two primary areas: the Hollister expansion and the Hatter expansion. The Hollister expansion is located where RCG is currently conducting underground exploration and would be mined for the Proposed Action. The proposed Hatter expansion area is east of the Hollister expansion.

The NPDES outfall would be NDEP-approved and would disturb less than 0.5 acre of previously undisturbed land. An 18-inch-diameter water pipeline would be anchored to prevent movement and would discharge water onto bedrock to prevent splash-over flow (**Figure 2-17**).

Natural rock materials already existing in the Little Antelope Creek channel bottom and sideslopes have size gradations ranging from approximately 6 inches to 48 inches, and are expected to be adequate to ensure channel stability at the proposed NPDES outfall location at the maximum anticipated discharge rate of 1,100 gpm. Routine monitoring of the outfall would ensure continued stability. If monitoring identifies any erosion concerns at the outfall location and/or downstream of the outfall, additional rip rap material would be placed in the channel to provide additional energy dissipation.



Legend

Existing/Authorized Disturbance or Facilities

- Mining Disturbance
- Water Well
- Escapeway Raise
- Surface Water Diversion Channel
- Road
- Ivanhoe Road
- Creek

Note: Contour interval 5 feet.
Source: RCG 2009a.

Proposed Disturbance or Facilities

- Underground Well Conceptual Locations
- Proposed NPDES Surface Discharge
- Buried Pipeline
- Existing Underground Exploration Workings
- Proposed Storm Water Diversion Channel
- Proposed Conceptual Underground Workings

N

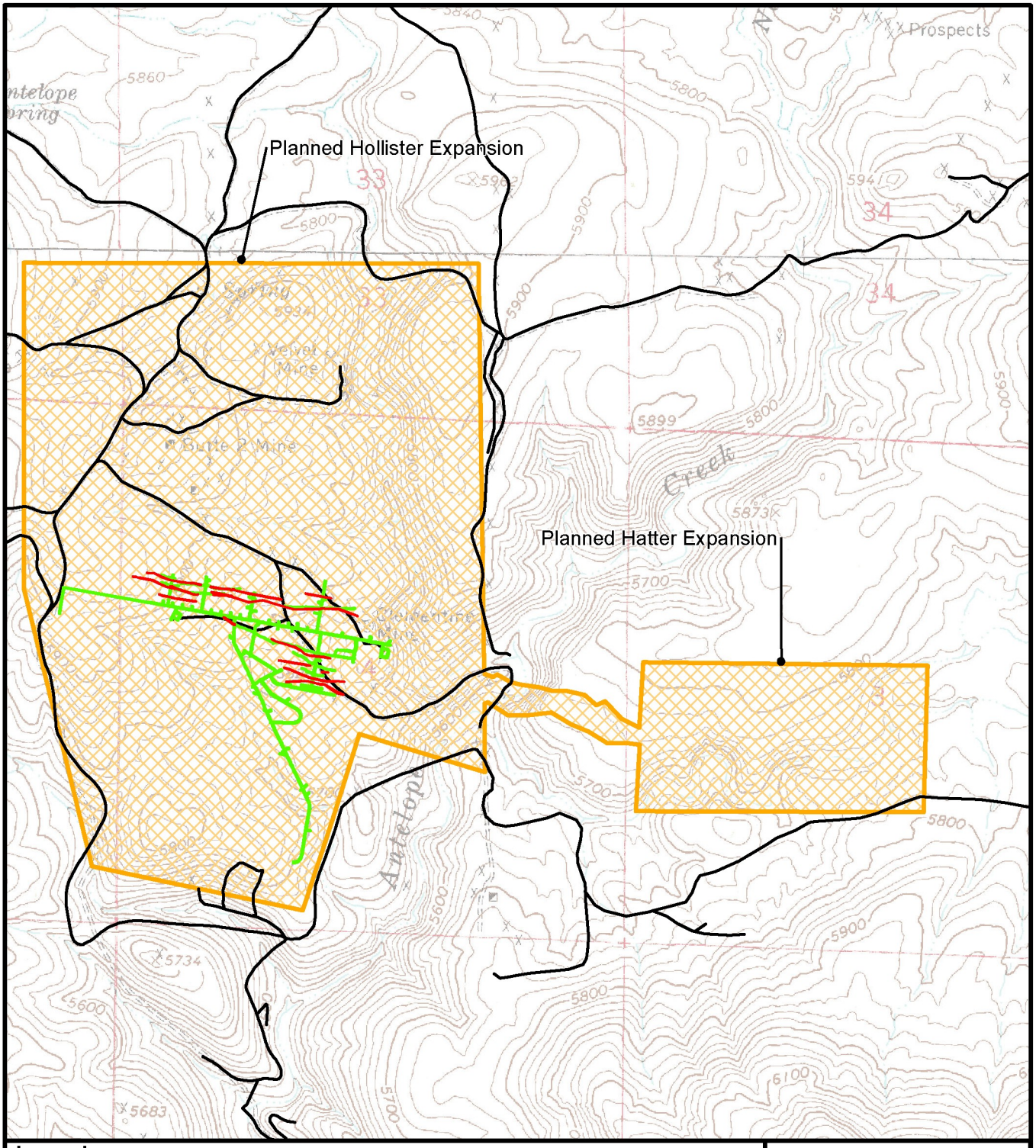
0 0.1 0.2 Miles

Hollister Underground Mine Project EIS

Figure 2-15

Proposed Underground Well Locations

3/20/2012



Legend

- Access Road to Escapeway Raise
- Existing Underground Exploration Workings
- Vein
- Proposed Action Conceptual Underground Expansion Area

N

0 0.1 0.2 Miles

Source: Brown and Caldwell 2010a; Montgomery and Associates 2010a; RCG 2011b.

Hollister Underground Mine Project EIS

Figure 2-16

Proposed Action Conceptual Underground Expansion Area

3/20/2012

Hollister Underground Mine Project EIS

Figure 2-17

Approximate Location of the Proposed NPDES Outfall

Source: RCG 2011b.

03/20/12

2.4.4 Waste Rock Management

Under the Proposed Action, waste rock would be disposed of in the existing approved RCG WRSF, in a new WRSF located in the West Pit, and/or as backfill in underground mined-out areas.

2.4.4.1 Existing RCG Waste Rock Storage Facility

The existing RCG WRSF is described in Section 2.2.5, Waste Rock Management. As currently permitted, the existing RCG WRSF would be used to accommodate a portion of the waste rock generated under the Proposed Action described in Section 2.4.3, Underground Mining Operations. The design capacity of the approved WRSF is approximately 612,000 yd^3 (1,100,000 tons), with a surface disturbance of 7.2 acres. Under the Proposed Action, waste rock would be added to the existing RCG WRSF until its capacity is reached and reclamation is initiated. RCG has no current plans to expand the approved height or footprint of the facility.

Walker and Associates (2003) completed static ABA tests, Nevada MWMP tests, and HCTs on lithologies from the Vinini Formation that would be expected to be involved in the proposed expansion of the underground workings. Section 2.2.5, Waste Rock Management, describes the ABA, MWMP, and HCT test procedures for waste rock. Waste rock characterization tests would follow BLM IM NV-2010-014 protocols (RCG 2011b). More details regarding waste rock geochemistry can be found in Section 3.5, Groundwater Resources and Geochemistry.

2.4.4.2 West Pit Waste Rock Storage Facility

Under the Proposed Action, a new WRSF would be constructed within the West Pit (**Figure 2-12**). The West Pit was excavated by previous operators during surface mining operations in the early 1990s and is in an ideal location for a WRSF for the following reasons:

- There would be no new disturbance as a result of the proposed WRSF construction;
- The pit walls provide natural containment;
- Waste rock from the Hollister Mine would partially backfill the existing West Pit, which would reduce visual impacts from the pit when the WRSF is reclaimed; and
- A properly designed WRSF could mitigate pre existing water quality impacts to groundwater in the vicinity of the West Pit.

All waste rock from the Hollister Mine is characterized as PAG based on past and ongoing geochemical analyses. Waste rock characterization would be in conformance with BLM IM NV-2010-014 protocols (RCG 2011b). Waste rock characterization methods for the West Pit WRSF are the same as current procedures used for the Existing RCG WRSF. Specialized design and construction techniques would be implemented for the proposed West Pit WRSF to control and prevent acid rock drainage (ARD). These techniques would include the use of a wet well, a liner system beneath the disposal area, and intermixing of dolomite rock into the waste rock during construction of the WRSF. The West Pit WRSF would be engineered, constructed, and reclaimed in a similar manner as the existing RCG WRSF to ensure long-term stability, provide for effective reclamation, and reduce the overall visual impact.

Design and Construction

The West Pit WRSF would be designed and constructed as follows (**Figure 2-18**).

1. A 10- to 12-inch polyvinyl chloride (PVC) underliner pipe would be placed along the existing access road into the West Pit to the approximate lowest point within the pit. The pipe would be wrapped in geotextile filter blanket and would be located on compacted subgrade or native material. It would be bedded in filter sand. The purpose of this underliner pipe would be to gather samples of water (if present) beneath the wet well. The piping would extend beyond the area of proposed waste rock disposal. An inclined submersible pump would be placed at the bottom of

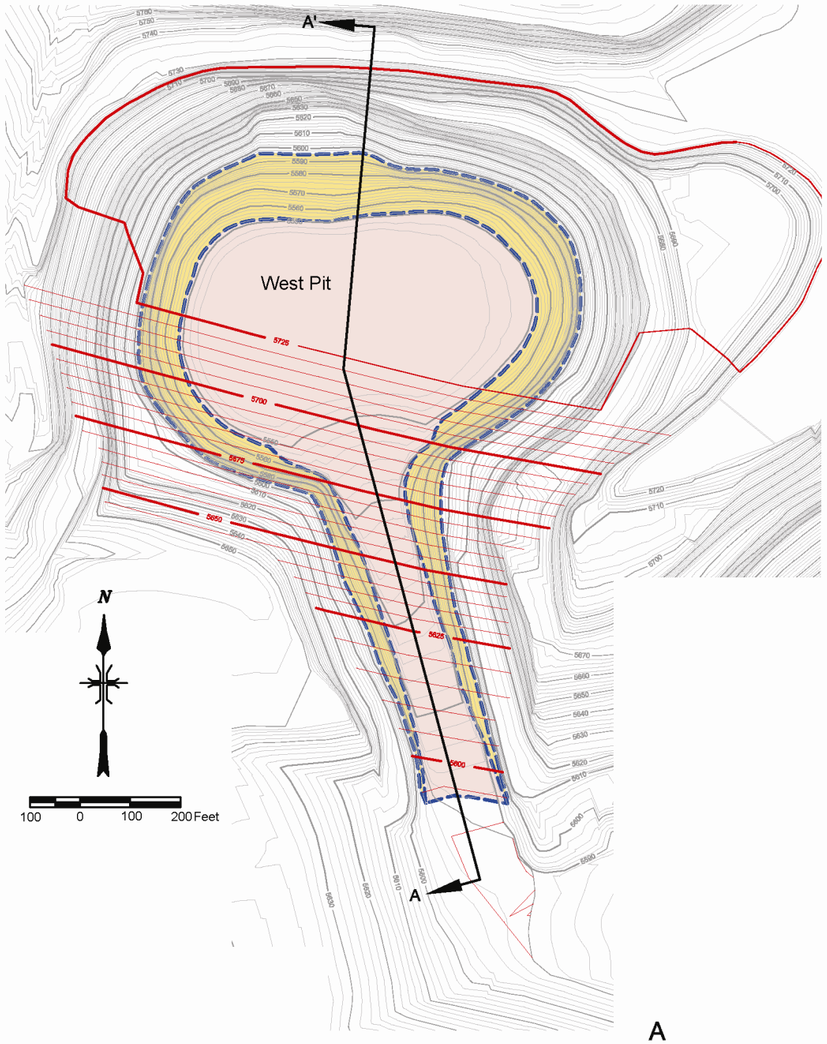
this pipe for water removal and sampling purposes. This pump would be situated such that it can be removed from the pipe if necessary for maintenance or replacement.

2. Approximately 5 to 6 feet of compacted (non-PAG) aggregate material would be placed in the bottom of the West Pit. The total amount would be adjusted to be sufficient to cover water (if present) in the pit. If necessary to facilitate the placement of the underliner pipe and aggregate material, any water present would be pumped from the West Pit into the existing surge ponds and processed through the on-site water treatment facility.
3. A layer of silt material would be placed on top of the aggregate. This layer would form the base for a geotextile blanket and the synthetic liner that would cover the bottom of the pit. The aggregate material would be shaped upward on the outer edges of the pit (i.e., the toe of the existing highwall) so that liner anchor trenches can be installed to secure the synthetic liner in place.
4. Similar to the underliner pipe, another 10- to 12-inch PVC pipe would be placed on top of the synthetic liner to serve as the sample mechanism for the actual wet well. Another inclined submersible pump would be placed at the bottom of this pipe. The pipe would be wrapped in geotextile filter blanket and bedded in filter sand. This pump would serve to sample water from the wet well for testing purposes.
5. A layer of dolomite, crushed to 3/8-inch minus, would be placed on top of the layer of filter sand. Dolomite also would be layered within the waste rock at intervals and at the mixing percentage for a 3:1 buffering capacity as required by the BLM for the waste rock disposal at the Hollister Site. Mixing methods are described below in PAG Waste Rock Neutralization. The source of dolomite would be off-site.
6. The highwall would be coated (sprayed) with shotcrete in horizontal layers of approximately 8 to 12 feet around the pit walls. As waste rock is disposed of in the West Pit, shotcrete would continue to be sprayed on the walls prior to each subsequent lift of waste rock. It is expected that approximately 40 to 50 feet of shotcrete would be required to form a sufficient seal in the disposal site to create a bowl-shaped protection area. Given the clayey nature of the waste rock, it is expected that waste rock would compact such that long-term permeability through the waste rock would be very low.
7. After mining is completed, the waste rock in the West Pit would be shaped to allow drainage off the facility and would be capped according to BLM- and NDEP-approved waste rock disposal capping and reclamation protocols. Capping and reclamation of the West Pit WRSF would follow the same protocols as described in Section 2.2.10.3, Reclamation of Existing RCG Waste Rock Storage Facility.

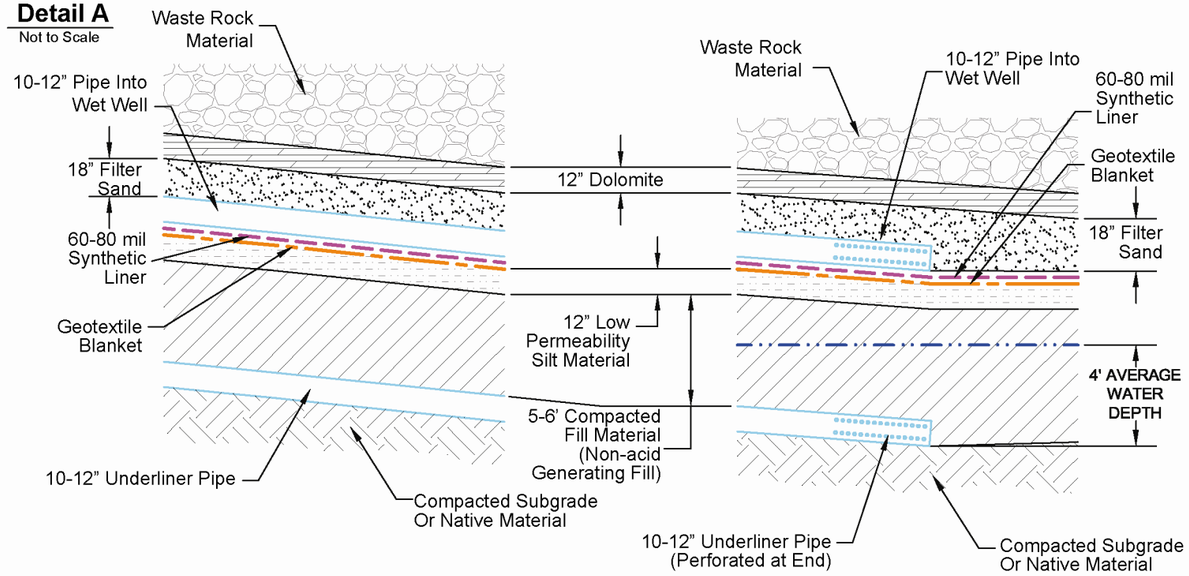
Mined waste rock would be hauled into the West Pit via an existing surface mine ramp within the pit. The WRSF would be constructed in a series of lifts within the interior of the existing West Pit. Waste rock would be placed by end-dumped lifts, progressing horizontally across the waste rock disposal site. During construction, working dump faces would be maintained at an overall angle of repose.

An access ramp would be constructed on the west side of the pit, and would wrap around to the north as subsequent waste rock lifts are added to the facility. This road would remain in place until the dump reaches the approximate 5,726-foot elevation amsl and contains a volume of slightly more than 900,000 yd^3 (1,617,647 tons). The existing ramp would then be closed, and the final filling of the West Pit would be completed from the top of the WRSF, accessed from a road external to the West Pit. Another 200,000 yd^3 (359,477 tons) of waste rock would be required to completely fill the West Pit WRSF.

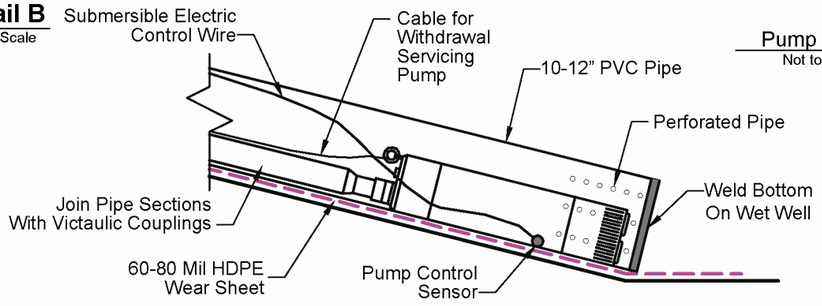
The West Pit WRSF would accommodate up to 1.1 million yd^3 (1,977,124 tons) of waste rock and cover approximately 8 acres when full. The maximum height of waste rock above the floor of the West Pit would be approximately 175 feet, and the maximum crest elevation of the facility would be approximately 5,726 feet amsl. The maximum height of the facility would be below the rim of the West Pit.



Detail A
Not to Scale



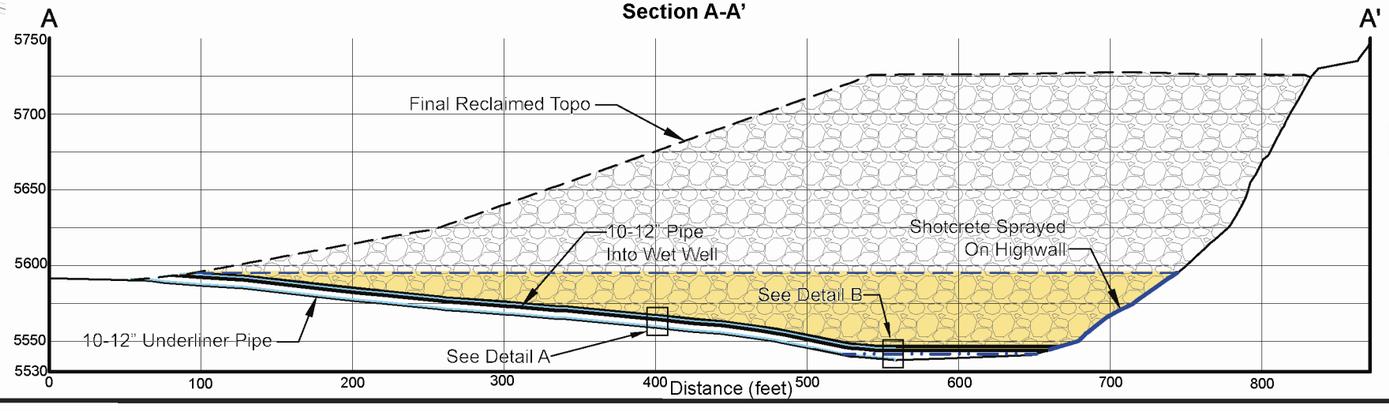
Detail B
Not to Scale



Pump Details
Not to Scale

5-6' COMPACTED FILL MATERIAL (NON-ACID GENERATING FILL)

Section A-A'



Legend
- Existing Contours
- Final Waste Rock Contours
- Waste Rock Fill
- Dolomite
- Filter Sand
- Synthetic Liner
- Geotextile Blanket
- Bedding Material
- Compacted Fill (Non-acid Generating)
- Approximate Extent of Highwall Shotcrete
- Approximate Extent of Synthetic Liner System

Source: Czarnowsky 2010a.

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Figure 2-18

West Pit Backfill WRSF Conceptual Design

To control erosion and for long-term stability of the West Pit WRSF, appropriate storm water controls would be constructed. The waste rock pile also would be appropriately graded to control storm water runoff and runon. Storm water would be routed to the existing storm water facility south of the West Pit.

PAG Waste Rock Neutralization

Dolomite or similar material would be added to the waste rock for in-situ neutralization of ARD at a buffering capacity of 3:1. Such material would be mixed with PAG waste rock upon placement in the West Pit. Smith et al. (1974) and Sobek et al. (1978) found that for every 1 percent of sulfur in the form of pyrite, 31.25 tons of limestone ($CaCO_3$) is required to neutralize the potential acidity in 1,000 tons of materials.

Past ABA test results for the Hollister waste rock have consistently indicated that the estimated average total pyritic sulfur content of the Hollister waste rock would be 1.26 percent. Therefore, ABA calculations predict approximately 118 tons of $CaCO_3$ (1.26% of pyritic sulfur x 31.25 tons of $CaCO_3$ x 3 for a 3:1 ratio = 118.13 tons of $CaCO_3$) would be required to effectively neutralize 1,000 tons of waste rock from the Hollister Site.

2.4.4.3 Groundwater Monitoring Plan

Groundwater monitoring and reporting currently is conducted in accordance with existing permit requirements to measure the effects of groundwater pumping and discharge on groundwater quantity and quality. RCG's Groundwater Monitoring Plan would be reviewed and updated every 2 years to include additional monitoring locations if required.

The groundwater monitoring wells previously permitted under the Ivanhoe Surface Exploration PoO would be incorporated into the full-scale mine operations, including the wells permitted under the surface exploration PoO. RCG may add up to 11 total new groundwater monitoring wells and piezometers as needed to monitor the hydrogeological characteristics of the site. These include proposed installation of:

- Two separate wells (one shallow and one deep) immediately downgradient from the southernmost stream sample location GBG-04. If needed, RCG also may install a pair of shallow and deep wells approximately 1 mile downgradient of the above described wells to measure the extent of potential migration, if any, of contaminants from the historic mining operations;
- A shallow water monitoring well north of the reclaimed heap leach facility to better measure the downstream effects, if any, of water entering Little Antelope Creek; and
- Four to six piezometers in the Hatter Notice area to expand the hydrologic information base in the Hollister Mine area.

2.4.4.4 Ore Transport

Under the Proposed Action, the ore would continue to be transported off-site to third-party mills, which may include the Esmeralda Mill for processing by APGI, and/or the Midas Mill for processing by Newmont. The majority of the ore would continue to be processed at the Esmeralda Mill. As described in Section 2.3.1, Transport of Ore Bulk Samples, the ore would likely continue to be hauled in trucks with an approximate capacity of 38 tons. At an estimated 750 to 1,000 tpd of ore production, ore hauling would increase to 7 days per week and there could be an increase of between 6 and 13 truck trips on each of the four segments of the ore hauling route, resulting in a maximum total of 18 to 25 truck trips for each travel segment each day. The four segments are Golconda to the Hollister Site; Hollister Site to Golconda; Golconda to Esmeralda Mill; and Esmeralda Mill to Golconda. Ore may be hauled in campaigns (12 to 15 trucks traveling together) to account for adverse weather that would temporarily increase the roundtrips per day but would lower the number of ore haulage days per month and increase highway and truck driver safety. The ore haulage would require two, 10-hour shifts per day, up to 7 days per week.

2.4.4.5 Ore Processing

Ore processing would continue to be managed according to grade and metallurgy, and processed under contractual toll-milling or ore purchase arrangements with third parties, which include but are not limited to APGI at the Esmeralda Mill and/or Newmont at the Midas Mill, as described in Section 2.3.1, Transport of Ore Bulk Samples.

2.4.5 Surface Exploration Drilling Program

The Proposed Action also includes 25 additional acres of disturbance for surface exploration dispersed throughout the project area over the course of the 20-year mine life, for a total of up to 50 acres of authorized exploration disturbance (**Table 2-6**).

Surface exploration under the Proposed Action would continue as described in Section 2.2.3, Surface Exploration, and would occur on the previously approved areas identified as the Craig Notice, Hatter Notice, and Ivanhoe Surface Exploration PoO areas (**Figure 2-3** and **Table 2-6**). RCG proposes to consolidate the surface exploration plan and two notices into this PoO within the project area under the Proposed Action. These project areas would be replaced by the new project boundary (black line). **Table 2-6** lists the disturbance acreages associated with exploration activities. Although 50 acres is being proposed for surface exploration, disturbance could occur anywhere within the project area defined by the new project boundary (black line and does not include the transmission line analysis corridor on **Figure 2-11**). Therefore, the entire project area needs to be considered for exploration disturbance to occur.

Approximately 30 to 40 surface drill sites per year are currently permitted. This could continue under the Proposed Action for a potential total of 600 to 800 new drill sites through the life of the mine. No more than 50 total acres of unreclaimed exploration surface disturbance would be allowed at any one time in the project area.

2.4.6 Infrastructure

2.4.6.1 Electrical Power

Within the project area is a 1,988-acre analysis corridor for the proposed transmission line route (**Figure 2-11**). The analysis corridor is a 0.25-mile-wide buffer surrounding the proposed transmission line route along Antelope Creek Road, Little Antelope Creek Road, some sections of Little Antelope and Antelope creeks, and the RIB areas. The analysis corridor contains 1,121 publically owned and 867 privately owned acres.

Under the Proposed Action, electric power would be provided by NVEnergy through a proposed transmission and distribution line (collectively called ‘transmission line’) to replace the existing diesel generators. The proposed transmission line to distribute electric power to the Hollister Mine would be approximately 11.6 miles in length, originating from an existing 120-kV transmission line at the existing Coyote Creek substation north of the Rossi Mine (**Figure 2-11**).

At the Coyote Creek substation, electric power currently is reduced from the main 345-kV transmission line to 120-kV power. From the existing 120-kV transmission line southwest of the Coyote Creek substation, a new 120-kV overhead transmission line would be routed approximately 5.4 miles to a new substation identified as the Rodeo Creek substation located on private property near the existing east RIB (**Figure 2-11**). Electric power would be reduced from 120 kV to 24.9 kV at the proposed Rodeo Creek substation, and a new 24.9-kV overhead transmission line would be constructed in a northward direction parallel to Little Antelope Creek Road. This 4.5-mile line would transmit electric power to an updated switchgear facility (20 feet by 40 feet) located in the East Pit, where the lines would be routed to various surface facilities and underground mine workings for 1.7 miles.

Transmission line poles would be wooden with wooden cross-arms. The 120-kV line would be an H-frame (two poles with one-wooden cross bar). The 24.9-kV transmission line would have single wooden poles with double support crossbars. RCG would use Avian Power Line Interaction Committee (APLIC) raptor-deterring design measures, which may include, but are not limited to, a 60-inch separation between conductors and/or grounded hardware in eagle-use areas as well as the use of insulating or cover up materials for perch management (APLIC 2006).

A temporary construction lay-down area (equipment storage) of approximately 1 acre would be established on private property adjacent to the proposed Rodeo Creek substation to facilitate temporary storage of pole structures, line spools, and miscellaneous transmission line supplies and equipment. This temporary laydown yard would be reclaimed upon completion of transmission line construction. **Table 2-5** lists disturbance associated with the transmission line and associated components.

New transmission line construction would disturb an approximate 4-foot by 4-foot area for each pole on the 24.9-kV line with an estimated 20 poles per mile. Construction of the proposed 120-kV line segment would disturb approximately a 6-foot by 6-foot area for each pole with an estimated 14 poles per mile. Disturbance acreage for the transmission line pads along the 24.9-kV and 120-kV lines was calculated to be less than 0.05 acre. However, proposed disturbance was increased to 0.1 acre to provide a construction buffer. Roads used for construction were estimated at 20 feet wide and follow the transmission lines directly. Spur roads connecting to established roads were estimated at a maximum of one every mile to access the transmission line where topography or existing roads would be difficult to drive. Total surface disturbance for construction of the proposed transmission lines, Rodeo Creek substation, temporary access roads, switch gear facility, and laydown areas is estimated at 34.7 acres (23.9 public and 10.8 private) (**Table 2-5**). Of this disturbance, 30.2 acres are for temporary access roads and would be reclaimed upon completion of the transmission line.

The transmission line and substation designs would be based on Rural Utilities Services (RUS) electrical standards for material and construction. The final transmission line design would be dependent on the final route selection and approval by NVEnergy, which would be responsible for the ownership and maintenance of the transmission lines and substations as well as obtaining the necessary right-of-way (ROW) approvals for the transmission line. RCG would assume responsibility for the electric power from NVEnergy at either the Rodeo Creek substation or the East Pit switchgear facility, either of which would serve as the NVEnergy metering location (**Figures 2-11** and **2-12**).

The existing diesel generators at the Hollister Site would remain on-site to serve as emergency electric power back-up in the case of a transmission line or substation power failure.

2.4.6.2 Water Supply

Potable water demands would increase under the Proposed Action from current use of approximately 3 gpm under current conditions to an average use of 12 gpm under the Proposed Action. The existing potable water treatment facility (**Figure 2-12**) has the capacity to treat this increased volume of water. The water treatment facility includes a green sand filter to treat iron and manganese with arsenic filtration through a media followed by chlorination. Any sludge resulting from water treatment would be sampled, analyzed, and disposed of appropriately.

Water from water well #1 would be pumped to the existing potable water plant for treatment and then would be pumped to a new 10,000-gallon potable water holding tank located above the proposed mine office complex (**Figure 2-11**). Tank dimensions would be approximately 10 feet in diameter by 16 feet high. The concrete foundation for this new tank would be approximately 14 feet square and 2 feet thick. From this new tank, potable water would be gravity fed to the mine office, dry, warehouse, and foreman/safety trailers.

Under the Proposed Action, RCG also would install a 35,000-gallon fire-water storage tank to meet local and state fire protection codes. This tank would be located adjacent to the potable water storage tank

above the proposed mine office complex (**Figure 2-11**). The fire-water tank dimensions would be approximately 22 feet in diameter by 16 feet tall. The foundation dimensions of the fire-water tank would be approximately 26 feet square by 2 feet thick. In case of a fire, water from this tank would be gravity fed to a series of fire hydrants located at the mine office complex and adjacent to facilities within the East Pit. Fire hydrants and water pipelines would not be installed at the HPS.

Water pipelines from the East Pit area to the potable and fire water tanks would be buried adjacent to the existing main access road, at a minimum depth of 4 feet. A 4-inch HDPE pipeline would supply the potable water, and a 6-inch HDPE pipeline would supply the firewater tanks. There would be one valve box for each pipeline located at the upper end of the pipelines. The valve boxes would be constructed of concrete with steel covers. They would be installed belowground and covered with approximately 1 foot of gravel. No new actions are planned for the existing water well #5.

2.4.6.3 Ancillary Support Facilities

Existing ancillary support facilities at the Hollister Mine would be used to support the Proposed Action. Additional support facilities would be constructed in the East Pit and at the proposed location of the new mine office complex north of the West Pit (**Figure 2-12**). The additional facilities that would be needed to support the Proposed Action are described below.

East Pit Maintenance Shop

Additional maintenance shop capacity would be created within the East Pit, at the site of the existing shop to provide suitable capability and space for on-site equipment maintenance work. The existing “tent” maintenance facility would be replaced by a new structure. The proposed maintenance facility would consist of a building (approximately 100 feet by 160 feet), with a wash bay (approximately 50 feet by 60 feet), a drain sump (approximately 20 feet by 80 feet), and a truck pad/storage area (approximately 30 feet by 70 feet) (**Figure 2-12**). The maintenance building would be of steel frame construction with metal siding and roofing. Concrete footings and slabs would be reinforced with rebar. The building would have external concrete slabs and ramps. Any sludge resulting from the maintenance shop operations would be sampled, analyzed, and disposed of appropriately.

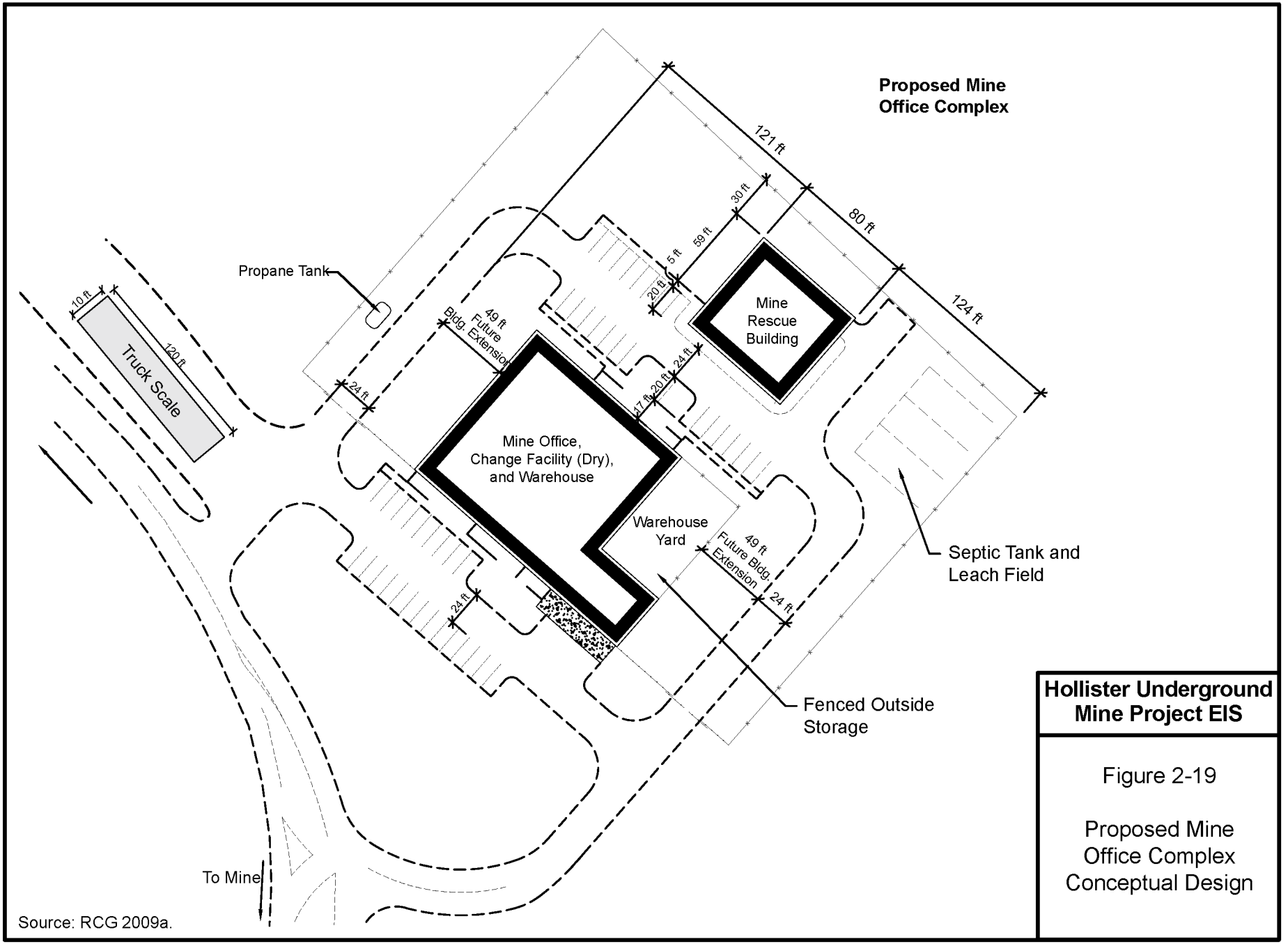
New Mine Office Complex

Under the Proposed Action, a new main office, miner change facility (dry), mine rescue building, and receiving warehouse would be constructed in an area of previous disturbance created by previous open-pit mining activities (**Figures 2-12** and **2-19**). The area proposed for the new Hollister Mine office complex was utilized during past surface mining activities as an office and storage area. This site was reclaimed. Prior to any facility installation, RCG would remove the growth media and place this material in a stockpile. The material would be seeded with a BLM-approved seed mixture to prevent the establishment of noxious weeds and non-native invasive plant species (e.g., cheatgrass) and to keep the soil micro-organisms viable.

The mine office and mine rescue buildings would be constructed on permanent concrete foundations and slabs, reinforced with rebar. The one-story buildings would be constructed from metal siding and roofing, be up to 20 feet tall, and would be coated (painted) with an earth-tone color, such as desert beige, to blend with the general surrounding color shade and hue of the existing terrain. The approximate dimensions of the new mine office and mine rescue buildings are shown in **Figure 2-19**.

The parking area at the mine office complex would be graveled. The gravel would come from an independently operated gravel pit located on private property near the Town of Midas. The mine office complex would accommodate supply trucks. The outside warehouse yard would be fenced (**Figure 2-19**).

Propane would be used at the mine office complex to heat hot water and provide heating. Propane tanks would be located adjacent to these buildings and structures. Propane would be delivered to the buildings via buried pipelines from the propane tank located northwest of the mine office building.



Source: RCG 2009a.

Hollister Underground Mine Project EIS

Figure 2-19

Proposed Mine Office Complex Conceptual Design

03/19/2012

Electricity would be supplied to the mine office complex via the proposed overhead transmission line routed around the north rim of the East Pit (Section 2.4.6.1, Electrical Power). The existing telephone system would be expanded to include the mine office complex. An additional micro-wave receiver would be erected near the mine office complex to receive signals from the existing receivers located above the East Pit near the present water system tanks. The components would include a 2-foot receiver antenna rod and a possible 12- to 15-foot-high mast. The actual installation location would depend on signal strength and line-of-sight from the existing antenna.

Mine Office

The mine office would be a one-story building of modular or steel construction placed on a concrete slab. The building would contain approximately 5,000 square feet, with offices, reception area, conference room, utility room, bathrooms, and a training room. Parking would be adjacent to the mine office for company, supplier, and visitor vehicles.

Miner Change Facility (Dry)

The miner change facility (dry) would be located in the same building as the receiving warehouse. The dry would contain approximately 7,500 square feet of space, with lockers and baskets, showers, and lavatory facilities. The dry would be a steel-constructed building with ample ceiling height (15 to 20 feet) to accommodate drying capabilities for the baskets and miners' gear. Buses and/or vans would transport miners and employees to the dry from Winnemucca. Vans would transport workers from the dry to the portal area for each shift.

Warehouse

The warehouse would be part of the same building that houses the dry. The warehouse floor space would contain approximately 4,000 square feet of interior space for parts storage. The warehouse would be configured for ease of delivery with a loading dock and an adjacent outdoor, fenced storage area.

Mine Rescue Building

The mine rescue building would be located northeast of the mine office and would contain emergency equipment and supplies. It would be approximately 80 feet by 80 feet in size.

Contractor Trailers and Lay-down Storage Area

Contractors would construct the office, dry, and warehouse facilities. Temporary contractor office trailers with adjacent equipment laydown areas would be located on the same pad planned for use for the mine office complex with a separate but adjacent laydown area located within the mine office complex.

Four to six new temporary construction trailers would be placed in the mine office complex on temporary wood-cribbed foundations and sided with sheeting. Electricity would be supplied by a temporary portable 200-kilowatt (kW) generator. A 500-gallon diesel fuel tank would be used to power the generator, and this tank would be contained in a HDPE-lined facility; a lined containment area would be constructed that would contain 110 percent of the volume contained in the tank. A propane tank also may be placed central to the trailers to facilitate the heating systems for wintertime operations. Temporary portable sanitary facilities would be located throughout the area.

The contractor trailers would be removed when construction is completed and the permanent facilities are commissioned, which is estimated to be approximately 1 year. Upon removal, the area on which the temporary contractor trailers were placed could be used for permanent mine supply storage.

Truck Scale

A truck scale would be installed in the mine office complex to weigh ore truck shipments from the mine. The scale would be approximately 120 feet long by 10 feet wide (**Figure 2-19**).

Guard Shack

As needed, a small portable guard shack(s) (15 feet by 25 feet) would be placed on the road at the entrance to the mining area.

2.4.6.4 Storm Water Drainage Control

Engineered storm water diversions would be designed and constructed to divert runoff away from project facilities as needed based on anticipated storm water runoff calculations. BMPs for reducing erosion and sediment transport that would be implemented for the Proposed Action are described in Sections 2.4.9, Applicant-committed Environmental Protection Measures.

Under the Proposed Action, a 1,200-foot diversion channel would be constructed to direct storm water runoff along the main access road near the 90 degree turn west to the secondary diversion channel (**Figure 2-12**). This short section would redirect storm water runoff from approximately 28 acres of watershed and away from the West Pit. The proposed storm water drainage channel around the west side of the project area would most likely be a trapezoidal cross-section and would not be lined. In accordance with NDEP guidelines (McGoff 2010), it would be designed to accommodate the peak flow from a 25-year, 24-hour runoff event with freeboard. No water exchange is expected with the Newmont Reclaimed South WRSF. All storm water management practices, including diversion channels and other program features, would be implemented in accordance with the current Storm Water Pollution Prevention Plan (SWPPP) approved by the NDEP-BWPC. BMPs would be employed.

A second temporary storm water diversion around the mine office complex also would be installed for the life of the project to manage storm water. This channel would drain into an existing storm water channel along the East Pit Spur Road. The proposed mine office complex would be situated within the 28-acre watershed.

Temporary diversions would be constructed as needed to manage storm water runoff (**Figure 2-12**). All channels would be constructed in accordance with NDEP requirements and periodically would be inspected and maintained as part of the ongoing storm water management plan.

2.4.6.5 Sanitary and Solid Waste Disposal

A new sewage disposal system would be installed to service the proposed mine office complex (**Figure 2-12**). This system would consist of a 10,000-gallon septic tank, associated dosing tanks, and a leach field (80 feet by 90 feet). RCG would obtain NDEP approval for the engineering designs and specifications prior to construction.

The existing septic system within the East Pit area would continue to be used during mine operations. With the relocation of the dry to the mine office complex, the need to regularly pump from the East Pit area septic system tanks for haulage to the Winnemucca sewage treatment system would be reduced from its present weekly basis to once every 8 to 10 weeks.

All non-toxic, non-hazardous solid waste materials generated at the Hollister Site currently are, and would continue to be, removed from the site, transported to, and disposed of in accordance with existing authorizations.

2.4.6.6 Site Security, Fencing, and Signs

Site security, fencing, and signs at the Hollister Mine would remain the responsibility of RCG and would not change from existing procedures described in Section 2.2.7.5, Site Security, Signs, and Fencing. Temporary fences would continue to be used around exploration drill sites. Except for temporary exploration fencing and a new chainlink fence around the HPS, no new fencing is proposed for the project area. All fences would have access gates. Signs may be revised or added to reflect new facility locations or safety information.

2.4.7 Hazardous Materials Management

Procedures for hazardous materials transportation, storage, waste management, and spill prevention and emergency response programs currently are in place and implemented for the existing surface and underground exploration program as described in the Hollister Development Block Project Environmental Assessment (BLM 2004a) and the Solid and Hazardous Waste Management Plan (RCG 2010a). A summary of the regulatory requirements on which these procedures and programs are based is provided in Chapter 3.0, Section 3.24, Hazardous Materials and Solid Waste. RCG's existing procedures and programs would be updated, as needed, to incorporate the proposed project.

The Hollister Mine would continue to be a Conditionally Exempt Small Quantity Generator (defined by federal regulations as a facility generating less than 200 pounds of hazardous waste per month). The program of recycling (used oil, used batteries, used antifreeze, etc.) and transportation of hazardous waste to approved licensed facilities for disposal would continue under the Proposed Action.

Under the Proposed Action, there would be no change in the current production consumption rate as the operations transition from underground exploration and bulk sample testing to full-scale mine production at the Hollister Mine site with two exceptions. Diesel fuel consumption would decrease to approximately 60 percent of current volumes because the two existing diesel generators would be replaced by electricity supplied by the proposed new transmission line (RCG 2011b). In addition, due to increased ore extraction, blasting agents consumed on site would increase to approximately 1.5 times current levels. On-site product storage and use at the existing facilities would continue to be covered under existing plans and permits. New fuel and lubricant storage facilities would be constructed at the Hollister Mine. The types and quantities of materials that would be stored at these new storage facilities are presented in **Table 2-2**.

2.4.7.1 Product Transport and Storage

The chemicals and fuel used and stored at the Hollister Mine is provided in **Table 2-2**. This information is updated on an annual basis as required by the Hollister Fire Marshal Hazardous Materials Permit.

Diesel fuel use would decrease (by approximately 40 percent) with installation of the proposed transmission line into the proposed Hollister Mine site due to additional diesel fuel use associated with ore transport. Gasoline usage at the site would remain approximately the same. Hollister vans and light trucks would continue to be fueled on site and at Winnemucca gas stations. The amount of lubricating oil, propane, antifreeze, and miscellaneous solvents would increase slightly at the proposed Hollister Mine, but no extra storage capacity would be needed. The same handling and environmental protection safeguards now employed by RCG would continue at the site. RCG reports chemical use volumes under the USEPA TRI program.

RCG would be responsible for clean-up of releases of hazardous substances and oil associated with the Proposed Action as required by the National Oil and Hazardous Substances Contingency Plan (40 CFR 300). RCG would notify the BLM AO, the NDEP, and the National Response Center of all reportable quantities of hazardous substances and/or oil released on public land, as required. Spills would be cleaned up in accordance with local, state, and federal regulations.

2.4.7.2 Spill Prevention and Response

RCG maintains a SPCC Plan for the Hollister Mine (RCG 2008a). Prior to initiation of the proposed project, the existing plan would be amended, as necessary, to encompass the proposed facilities. The plan would be maintained and implemented, as needed, throughout the life of the project. This plan describes the prevention, response, containment, and safe cleanup of any spills or discharges of substances that potentially may degrade the environment, in addition to discovery, notification, and general cleanup procedures.

2.4.7.3 Waste Management

The only RCRA hazardous waste anticipated to be generated at the Hollister Mine would be "universal wastes," which generally includes florescent bulbs, and batteries. As shown in **Table 2-2** the majority of the hazardous materials used on site would be spent or consumed during operations. Materials that are not spent or consumed (e.g., petroleum oils, antifreeze, etc.) would be recycled, to the extent possible, or disposed of off-site in an approved depository in accordance with RCG's Solid and Hazardous Waste Management Plan (RCG 2010a) and all applicable federal and state regulations.

2.4.8 Fire Protection

RCG's existing fire protection plan would continue to be implemented for the proposed project. The procedures outlined in the fire protection plan are in accordance with MSHA and applicable state and county fire code regulations. Adequate fire protection equipment needed to implement the plan would be maintained on site at the Hollister Mine during operations. A fire water reserve would be maintained in the facility fire water tank located adjacent to the potable water storage tank above the mine office complex.

2.4.9 Applicant-committed Environmental Protection Measures

During construction and operation of the Proposed Action, RCG would implement applicant-committed environmental protection measures to mitigate potential impacts to air, land, water, wildlife, cultural resources, and human resources and to prevent undue or unnecessary degradation of the environment as part of the proposed project's standard operating procedures. Pre-development planning, pollution prevention measures, and pollution control measures and equipment would be used to reduce potential project-generated environmental impacts. Some of these measures stated below are regulations, which must be followed and do not substitute as applicant-committed environmental protection measures or mitigation measures.

Proposed environmental protection measures applicable to the Proposed Action have been adopted from the PoO (RCG 2010b, 2009a) and the Hollister Development Block Project EA (BLM 2004a). These measures are identified below.

2.4.9.1 Geology

- RCG would perform geotechnical monitoring, including geologic structure, mapping, and groundwater monitoring.

2.4.9.2 Water Resources

- Placement of waste rock in engineered, lined WRSF facilities with limestone, dolomite, or other acid neutralizing rock, and routine monitoring of the waste rock disposal facilities during operations would be implemented to reduce the potential for acid rock drainage, per 43 CFR 3809.420 regulations.
- To abide by 43 CFR 3809.420 regulations and to limit erosion and reduce sediment transport from project disturbance areas, erosion control measures, as outlined in the project's SWPPP (Brown and Caldwell 2007) and Reclamation Plan, would be installed as needed and maintained. To further reduce erosion potential, storm water diversions would be installed upgradient and around project facilities, as needed, to divert storm water runoff around disturbance areas. Facilities would be graded appropriately and monitored following spring snowmelt and intense rain events to ensure that drainage and sediment control measures are effective and operating properly. Implementation of concurrent reclamation, if possible, would further reduce erosion potential.
- Groundwater monitoring would be conducted to ensure compliance with permit criteria and to provide for early identification of unanticipated potential impacts.

- All mineral exploration and development drill holes and monitoring and observation wells would be properly plugged and abandoned in accordance with NAC 534 regulation requirements to prevent contamination of groundwater resources.
- Limestone or dolomite would be used as needed on the mine site should ARD issues arise.

2.4.9.3 Soils, Vegetation, and Non-native Invasive Plant Species

- To minimize impacts to soils and provide for re-establishment of vegetation, suitable growth media would be salvaged and stockpiled during project construction for subsequent use in reclamation, where possible, per 43 CFR 3809.420 regulations. The growth media also would be transported to, and redistributed on, mine and mineral exploration surface disturbance areas undergoing concurrent reclamation.

  In addition, the Newmont Reclaimed WRSF may contain extra growth media. RCG would test this material to determine suitability. If it is found to be suitable growth media, it would be extracted and used as a supplement to currently existing growth media stockpiles. The Newmont Reclaimed WRSF would be regraded and re-seeded so that it also would support revegetation efforts.

  Growth media could be imported to the mine site if existing stockpiles on-site are not sufficient to complete reclamation. Growth media stockpiles would be seeded with a BLM-approved interim seed mix. During reclamation, if growth media is imported from off-site public lands, it would be BLM-approved. Growth media stockpiles would be seeded with a BLM-approved interim seed mix (**Table 2-3**).
- BMPs, as described in RCG's SWPPP (Brown and Caldwell 2007), and conditions specified in the storm water permit would be implemented to limit erosion from project facilities and disturbance areas during and following construction, operations, and initial stages of reclamation, per 43 CFR 3809.420 regulations. These practices may include, but would not be limited to, installation of storm water diversions to route water around disturbance areas and project facilities using accepted engineering practices, and the placement of erosion control devices (e.g., silt fences, staked weed-free straw bales, riprap, sediment traps, etc.). To ensure long-term erosion control, all sediment and erosion control measures would be inspected quarterly and after large precipitation events, and repairs would be performed as needed.
- Waste rock facilities would be contoured to provide for the most stable reclamation landform to simulate surrounding topography.
- Per 43 CFR 3809.420 regulations, revegetation of disturbance areas would be conducted as soon as practicable (usually the first fall after disturbance, in order to maximize natural moisture content in the soil) to reduce the potential for wind and water erosion, minimize impacts to soils and vegetation, help prevent the spread of noxious weeds and non-native invasive plant species in disturbance areas, and facilitate post-mining land uses. Concurrent reclamation would be conducted to the extent practicable to accelerate revegetation of disturbance areas.
- To minimize the introduction and spread of noxious weeds and non-native invasive plant species in project-related disturbance areas, revegetation efforts described in the Reclamation Plan of the PoO (RCG 2009a) and RCG's Noxious and Invasive Weed Plan (RCG 2011a) would be implemented. These plans outline procedures for the prevention, monitoring, and treatment of noxious weed infestations. The results of the monitoring program would provide the basis for updating the Reclamation Plan, if needed. Noxious weeds and non-native invasive plant species would be controlled on site for at least 3 years after reclamation is complete.
- Certified weed-free seed mixes would be used for reclamation.

2.4.9.4 Wildlife, Special Status Species, and Livestock

- In the event that construction for the Proposed Action should occur during the raptor nesting season (March 1 through July 31), a raptor survey would be conducted, and appropriate mitigation

measures, such as buffer zones around any identified occupied nests, would be developed and implemented in concert with the BLM and Nevada Department of Wildlife (NDOW), as needed.

- During the greater sage-grouse breeding season (March 15 to June 15), no exploration activities would be allowed within 3 miles or line-of-sight of an active greater sage-grouse lek from 1 hour before sunrise to 10:00 a.m.
- To protect nesting birds, surface disturbance on currently undisturbed lands in the project area would be avoided between March 1 and July 31. Should surface disturbing activities be necessary during this time period, RCG would coordinate with the BLM and NDOW to conduct breeding bird surveys and implement appropriate mitigation, such as appropriate buffer zones around occupied nests.
- To minimize wildlife/vehicle-related collision impacts during project operations, RCG would continue its mandatory employee and long-term contractor education program. Speed limits would be posted on access roads. RCG would report any vehicle collisions on roads in the project area with wildlife and any observed wildlife mortalities to NDOW, as required under the Industrial Artificial Pond Permit (IAPP).
- The existing wildlife fences around the storm water pond would continue to be maintained to restrict entry by wildlife and livestock to maintain compliance with the IAPP.
- The existing BLM-approved four-strand barbed wire fence shown on **Figure 2-2** would continue to be maintained to prevent livestock entry but allow wildlife access.
- RCG would promptly repair any fences damaged by construction activities. RCG employees and contractors would close gates when traveling through the project area to ensure livestock are excluded within the above-described fenceline.
- RCG would implement policies designed to discourage employees and contractors from illegal hunting and harassment of wildlife.
- Trash would be managed to avoid being an attraction to wildlife.
- The new transmission line would be designed and constructed to follow APLIC guidelines to minimize raptor electrocution potential. Anti-perching features would be incorporated on the new transmission line to minimize raptor predation on greater sage-grouse.
- Implementation of the proposed Reclamation Plan would minimize habitat impacts for wildlife species. Implementation of the plan also would minimize impacts to range resources through the re-establishment of forage.

2.4.9.5 Cultural Resources

- RCG would abide by all stipulations described in the Programmatic Agreement (PA), per 43 CFR 3809.420 regulations. The applicant would be a signatory to the PA and has responsibilities under the agreement to protect historic properties.

2.4.9.6 Air Quality

- All applicable state and federal air quality standards would be met through compliance with RCG's NDEP-Bureau of Air Pollution Control-approved air quality operating permit.
- To control combustion emissions, all installed pollution control equipment would be operated and maintained in good working order.
- Fugitive dust controls currently in place include: 1) water application on haul roads and other disturbed areas; 2) chemical dust suppressant application (e.g., magnesium chloride); and 3) the use of scrubber/sprays. Dust controls would continue to be implemented.
- Air quality would be protected in accordance with applicable state and national ambient air quality standards, per 43 CFR 3809.420 regulations.

- Temporary disturbance areas (e.g., growth media stockpiles, cut and fill embankments, etc.) would be seeded with an interim seed mix, and concurrent reclamation would be implemented on completed portions of the waste rock facilities, thereby reducing fugitive dust emissions.

2.4.9.7 Visual Resources

- Waste rock facilities would be contoured where feasible to provide a natural looking post-reclamation land form.
- Concurrent reclamation would be implemented to the extent feasible.
- Following the completion of mining, structures and buildings would be dismantled and removed from the site.
- Structures at the Hollister Mine would be painted in colors that match the natural surroundings.

2.4.9.8 Hazardous Materials

- Prior to the initiation of the Proposed Action, the existing SPCC Plan (RCG 2008a) would be amended, as necessary, to include the Proposed Action. Implementation of the prevention, containment, and cleanup procedures in this plan would minimize the potential for impacts to soils, vegetation, wildlife, and water resources, per 43 CFR 3809.420 regulations.
- Prior to the initiation of the project, the existing Solid and Hazardous Waste Management Plan (RCG 2010a) would be amended, as necessary, to include the Proposed Action. Implementation of the management procedures for the handling of solid and hazardous waste generated at the site, reagent storage, transportation, and handling requirements would minimize the potential for impacts to soils, vegetation, wildlife, and water resources.

2.4.9.9 General Measures

- To the extent practicable, RCG would protect all survey monuments, witness corners, reference monuments, bearing trees, and line trees against destruction or damage per 3809.420 regulations. Public land survey system monuments would be protected and preserved in accordance with Nevada BLM IM No. NV-2007-003. If destroyed, RCG immediately would report the matter to the BLM AO.

2.4.10 Reclamation and Site Closure

The reclamation program would restore the site to a beneficial post-mining land use, prevent undue or unnecessary degradation of the environment, and reclaim disturbed areas such that they would be compatible with the surrounding topography.

RCG would implement reclamation practices and procedures consistent with the requirements of the following applicable laws and regulations:

- NAC 519A regulations;
- BLM's surface management regulations at 43 CFR 3809; and
- Final Version of the Revised Guidelines for Successful Mining and Exploration Revegetation (Instructional Memorandum No. NV-99-013).

Most of the area for Hollister Mine surface facilities and infrastructure has been previously disturbed by open-pit mining and subsequently reclaimed by other operators. RCG's Reclamation Plan includes closing and sealing mine portals (**Figure 2-6**), escape raises, and the HPS (**Figure 2-7**); removing surface facilities and infrastructure; and establishing a vegetative community on the surface areas disturbed by the Proposed Action and existing Hollister operations.

The final grading plan for the project is designed, in part, to minimize the visual impacts of unnatural lines and landforms. Slopes would be regraded to blend with surrounding topography, and to facilitate revegetation. Waste rock facilities would have rounded crests and variable slope angles to more closely resemble natural landforms. The conceptual post-mining reclamation topography for the Proposed Action is shown in **Figure 2-20**.

Revegetation of disturbed areas would be conducted as soon as practicable (usually the first fall after disturbance, in order to maximize natural moisture content in the soil) to reduce the potential for wind and water erosion. Following construction activities, areas such as cut-and-fill embankments and growth media stockpiles would be seeded. Section 2.4.9.3, Soils, Vegetation, and Non-native Invasive Plant Species, describes potential growth media sources. Concurrent reclamation would be conducted to the extent practicable to accelerate revegetation of disturbed areas. All sediment and erosion control measures and revegetated areas would be inspected periodically (after high precipitation events, etc.) to ensure long-term erosion control and successful reclamation. Seed bed preparation and seed mixes are described in Section 2.2.10, Reclamation of Existing Facilities.

2.4.10.1 Proposed Reclamation Schedule

Upon completion of mining, final reclamation of facilities would be completed pursuant to the final closure plan and schedule that would be submitted to the BLM and NDEP for approval. The detailed closure plan for each facility component would be prepared at least 2 years prior to the anticipated closure date (NAC 445A.447), and would conform with the WPCP regulations in effect at the time of closure.

2.4.10.2 Post-mining Land Use and Reclamation Goals

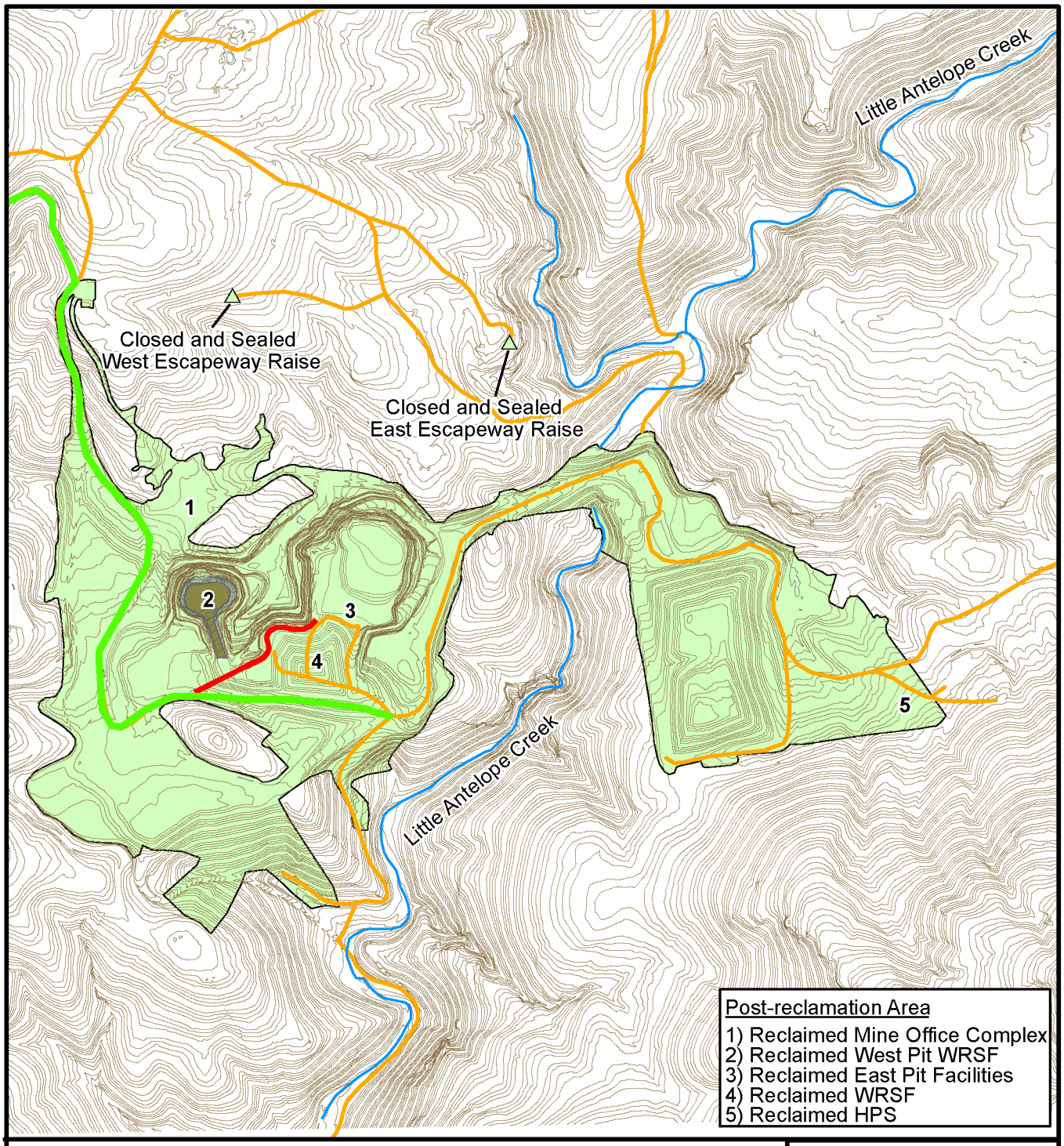
The primary existing land uses in the project vicinity include mineral exploration and development, livestock grazing, wildlife habitat, and dispersed recreation. Following closure and final reclamation, the site would support the multiple land uses of livestock grazing, wildlife habitat, and recreation. The identified post-closure land uses would be in conformance with the BLM Elko Resource Management Plan and Elko County zoning ordinances.

The goals of the reclamation program are as follows:

- Provide a stable post-mining landform that would support defined land uses;
- Minimize erosion and protect water resources through control of storm water runoff;
- Establish post-reclamation surface soil conditions conducive to the regeneration of a stable plant community through stripping, stockpiling, and reapplication of growth media;
- Revegetate disturbed areas with a diversity of plant species in order to establish productive long-term plant communities compatible with post-mining land uses;
- Maintain public safety by stabilizing or limiting access to man-made landforms that could constitute a public hazard; and
- Maintain continued enjoyment/visitation of Tosawihi Quarries by Shoshone and other people.

2.4.10.3 Growth Media Stockpiling and Salvage

Where possible, growth media would be removed from areas to be affected by any new Hollister project surface facilities. This material would be stockpiled for final reclamation and protected from wind and water by seeding and establishment of a vegetative cover to minimize any erosion. During the first full planting season following development of the growth media stockpile, the stockpile would be seeded with a seed mixture developed from the reclamation plant list shown in **Table 2-3**.



Legend

- Existing/Authorized Mining Surface Disturbance
- Post-reclamation Contours
- Unreclaimed Road
- Reclaimed Two-track Road
- Ivanhoe Road
- Surface Water
- Reclaimed West Pit Waste Rock Storage Facility

Contour interval: 5 feet.
Source: RCG 2009a.

N

0 500 1,000 Feet

Hollister Underground Mine Project EIS

Figure 2-20

Post-mining Topography for Proposed Action

3/20/2012

2.4.10.4 Seed Mixes

Prior to seeding, disturbance areas would be recontoured, surfaces would be ripped or scarified (where conditions warrant), and growth media would be redistributed. Where possible, seedbed preparation would be performed immediately prior to seeding to allow seed placement prior to soil recompaction. Seedbed preparation would consist of scarification. Seed would be applied with either a rangeland drill or with a mechanical broadcaster and harrow, depending on accessibility. A hand-held broadcaster would be used on minor disturbed areas such as drill sites or access roads. Seedbed preparation and seeding would take place in the fall after grading and topsoiling of reclaimed areas.

Proposed reclamation seed mixtures and applications rate based on reclamation experience at other mining and exploration operations in northern Nevada and agency requirements would be developed from the reclamation plant list shown in **Table 2-3**. BLM-approved seed mixes would provide forage and cover species similar to the pre-disturbance conditions, facilitating the post-mining land uses of livestock grazing and wildlife habitat. In addition, the seed mixes would be determined based on the species' effectiveness in providing erosion protection, the ability to grow within the constraints of the low annual precipitation experienced in the region, its suitability for site aspect, and the elevation and soil type. Broadcast seeding would be conducted at 1.5 to 2 times the proposed seed application rate.

Species to be used during reclamation could be augmented from the BLM's plant list provided in **Table 2-3**. The species used would be dependent on availability and cost, and would be applied at a rate of approximately 11 to 15 pounds PLS per acre. Modifications in the seed list, application rates, cultivation methods, and techniques could occur based on success of concurrent reclamation. Changes and/or adjustments to seed mixtures and application rates would be developed through consultation with and approval by the BLM and NDEP. Seedlings may be substituted for seeds. The seed mixes selected would represent a reclaimed desired plant community, and the mixes would be appropriate for each ecological site in the project area.

2.4.10.5 Noxious Weed Management

RCG has developed and implemented a noxious weed monitoring and control program for the Hollister Site, which would continue for the Proposed Action. The results of the annual monitoring program are used to update the plan and develop annual treatment programs. Weeds are actively monitored and managed at the Hollister Site using prevention, training, monitoring, and eradication techniques. Disturbed ground is kept to a minimum to discourage weeds from establishing.

RCG's noxious weeds and non-native invasive plant species management program consists of the following general measures.

- Hand pulling and/or hand digging may be used to remove noxious weeds.
- BLM-approved herbicides would be used to prevent and restrict the spread of noxious weeds and non-native invasive plant species.
- Earthmoving equipment would be washed before mobilizing onto the site.
- Areas traversed in the project area by equipment, including water trucks and pickup trucks, would be inspected for noxious weeds and appropriately treated.
- Certified noxious weed-free mulch and seed mixtures would be used to reclaim disturbed areas and control the spread of noxious weeds and non-native invasive plant species.
- Noxious weeds and non-native invasive plant species monitoring and control would be implemented during operations and until the BLM releases RCG from the reclamation responsibility.

2.4.10.6 Hollister Mine Facility Reclamation

Surface disturbance associated with underground mining activities would be recontoured and revegetated. **Figure 2-20** illustrates the post-mining reclamation topography for the Hollister Mine facilities. During reclamation, the side slopes of the WRSFs would be regraded to achieve an average final slope not steeper than 2.5 horizontal (H):1.0 vertical (V). Water treatment ponds would be reclaimed by folding in the pond liners to create an envelope. Pond areas then would be back-filled with a minimum of 5 feet of material, covered with 12 inches of growth media, and regraded to blend with adjacent topography. Growth media placed throughout the site would be graded to allow free drainage for better seedling establishment.

Drill Hole and Water Well Abandonment

RCG would abandon and plug exploration drill holes, water wells, and water monitoring wells in accordance with the NAC 534 regulations. The closure plugging and abandonment procedures are described in Section 2.2.10, Reclamation of Existing Facilities.

Closure of Underground Operations

Underground facilities would be closed in phases starting at the lowest point of the underground mine working up to the surface. The closure procedures are described in Section 2.2.10.2, Closure of Underground Operations.

Reclamation of Waste Rock Facilities

Reclamation of the Existing RCG WRSF is described in Section 2.2.10.3, Reclamation of Existing RCG Waste Rock Storage Facility. The reclamation goals for the West Pit WRSF include stabilizing slopes, ensuring mass stability, shaping the edges to minimize visual impacts, revegetating surfaces, and erosion control. Reclamation procedures for the West Pit WRSF would be the same as for the existing RCG WRSF.

Reclamation of Roads, Parking Lots, Washbay, and Other Compacted Areas

Reclamation of the roads, parking lots, washbay and other compacted areas would be accomplished using the procedures described in Section 2.2.10.4, Reclamation of Roads, Parking Lots, Washbay, and Other Compacted Areas.

Demolition and Disposition of Buildings and Ancillary Facilities

Demolition and disposition of buildings and ancillary facilities would be accomplished using the procedures described in Section 2.2.10.5, Demolition and Disposition of Buildings and Ancillary Facilities. In addition, concrete foundations and slabs would be broken up and buried in place as described below.

Salvageable equipment and trailers would be moved to another project, sold, or properly disposed of off-site. Unsalvageable portions of any facilities, such as a concrete pad used at the office complex and the maintenance shop, would be broken up and buried on-site, either in the bottom of the existing recycle ponds or within the final lifts of the WRSF. The burial would occur prior to final recontouring and would be at a depth suitable to ensure that the materials are not exposed in the future. A minimum of 5 feet of cover would be placed over the concrete within the recycle ponds or the WRSF. If the concrete is subjected to a hazardous substance or oil during the operations, a cleaner or polymer would be applied to neutralize any deleterious residue. RCG also would obtain a NDEP Class III landfill waiver prior to initiating this activity. All burial plans would be BLM-approved.

The RIBs near Little Antelope Creek would be reclaimed as described in Section 2.2.10.6, Reclamation of Storm Water and Surge Ponds. Upon permanent mine closure, pumping of water from the underground operation would cease, and water would be allowed to fill the workings. Section 3.5, Groundwater Resources and Geochemistry, describes predicted post-mining groundwater levels and groundwater chemistry.

The Rodeo Creek substation would be disconnected, disassembled, and hauled off site. The transmission line would be removed upon permanent mine closure. Lines would be disconnected, reeled onto spools, and removed from the site. Poles would be cut at the base (below ground surface), loaded onto flatbed trucks, transported, and disposed of at an approved off site location. Any two-track spur roads accessing pole sites would be scarified and seeded. Holes would be filled, covered, and re-seeded with seed mixtures derived from the list described in **Table 2-3**.

Reclamation of Storm Water and Surge Ponds

All equipment and surface piping associated with the storm water and surge ponds would be reclaimed as described in Section 2.2.10.6, Reclamation of Storm Water and Surge Ponds.

2.5 Alternatives to the Proposed Action

Reasonable alternatives to the Proposed Action include those that are practical or feasible from a technical and economic standpoint. Each alternative, except for the No Action Alternative, represents an alternative means of potentially reducing environmental impacts to one or more resources.

The issues and concerns identified during the scoping process focused primarily on potential impacts to cultural resources and resources important to Native Americans, water quantity and quality, air quality, and wildlife. These issues guided the development of alternatives to be evaluated in the EIS. However, other issues also have been considered in identifying alternatives. The following alternatives are discussed in detail in this EIS.

2.5.1 Alternatives Considered in Detail

Mine operations are composed of a number of facility components. There can be alternative means and locations to implement these components in most settings. The alternatives are limited, however, by the location of the mineral deposit, land and mineral ownership, and existing physical constraints, both natural and man-made. At Hollister, the location of the proposed facilities is constrained by the location of the ore deposit, physical constraints of the geology and hydrology of the area, concentrations of cultural resources, and the topographic and environmental features of the project vicinity.

2.5.1.1 No Action Alternative

Under the No Action Alternative, BLM would not approve the proposed project. RCG would continue to conduct surface and underground exploration and bulk sampling under the current exploration permits, notices and approvals as authorized by the BLM and State of Nevada. Reclamation and closure of the existing exploration facilities would proceed under the current permits and approvals as described in Section 2.2, Existing Hollister Operations. Existing major facilities that may continue to operate under the No Action Alternative would include the existing surface exploration; existing portal, decline, and underground workings; associated water management and RIB infiltration system; the existing RCG WRSF; and ancillary support facilities. Approved surface disturbance for the Hollister operation under the No Action Alternative is approximately 77 acres for the underground exploration and bulk sampling program (**Table 2-5**). These facilities are described in Section 2.2, Existing Hollister Operations.

Exploration would continue within the Ivanhoe, Craig, and Hatter areas under current authorizations or until such time as the Craig and Hatter Notices expire or the BLM requires these areas to be permitted under a PoO. Based on the authorization for the existing exploration program, the total permitted disturbance for surface exploration is 28 acres, which includes the Ivanhoe Exploration PoO (15 acres), the Hatter Notice (5 acres), the Craig Notice (5 acres) and Water Well #5 and associated facilities (3 acres) (**Table 2-6**).

Under current authorizations, underground exploration at the Hollister Site and associated water management operations could be conducted with a groundwater pumping rate of approximately 400 to

700 gpm. Short duration surge flows could reach 900 gpm (BLM 2004a). This water could be used for exploration operations or discharged at the RIBs.

Under the No Action Alternative, ore extraction rates for bulk sampling and testing range from 280 to 400 tpd (RCG 2010b). Ore extracted for bulk testing may continue to be transported in 38-ton trucks from the mine site for processing at the Esmeralda Mill, the Midas Mill, or to other mill facilities capable of processing Hollister ore. Waste rock tonnages range from 350 to 500 tpd (RCG 2010b) and would continue to be disposed of in the existing RCG WRSFs.

Under the No Action Alternative, the existing facilities would be closed and reclaimed in accordance with the currently approved Reclamation Plan, current permits, and applicable federal and state closure and reclamation requirements. Final closure and reclamation of the project site are discussed in the Hollister Development Block EA (BLM 2004a) and generally would follow the procedures described in Section 2.2.10, Reclamation of Existing Facilities. The post-mining reclamation topography for the No Action Alternative is presented in **Figure 2-21**.

2.5.1.2 Mud Springs Road Transmission Line Alternative

Under this alternative, electric power would be provided by NVEnergy through a proposed overhead transmission line that is north of the Proposed Action transmission line route (**Figure 2-22**). Two alignments were considered for the Mud Springs Road Transmission Line Alternative, a North Option and a South Option.

North Option

The Mud Springs Road Transmission Line Alternative (North Option) would be approximately 7.0 miles in length, originating from a new substation (in the southeast quarter of Section 10, T37N, R49E) adjacent to the existing Coyote Creek substation north of the Rossi Mine and terminating at the HPS (**Figure 2-22**).

At the existing Coyote Creek substation, electric power is currently reduced from the main 345-kV line to 120-kV power. The new substation would further reduce power from 120 kV to 24.9 kV, and a new 24.9-kV transmission line would be constructed westward for a distance of approximately 2.7 miles on the north alignment until reaching Mud Springs Road. At the road, the proposed route would essentially parallel the road westward for 4.2 miles until reaching the HPS where the line would travel to the upgraded switchgear facility in the East Pit. The voltage would be further reduced and routed to various surface facilities and the underground mine workings for 1.7 miles. As described in **Table 2-8**, the new substation would disturb approximately 2 acres. Temporary access roads for construction and a temporary 1-acre construction lay-down area would be established adjacent to the proposed new substation to facilitate temporary storage of pole structures, line spools, and miscellaneous transmission line supplies. This temporary laydown yard would be reclaimed upon completion of transmission line construction.

The North Option alternative transmission line construction also would disturb an approximately 4-foot by 4-foot area for each pole on the 24.9-kV line with an estimated 20 poles per mile. This estimated total long-term disturbance area is 0.2 acre (**Table 2-8**). Access for transmission line construction would use existing roads where feasible and overland travel along the proposed route. Temporary access roads would disturb 22 acres on a short-term basis. Total surface disturbance for construction of the North Option of the Mud Springs Road Transmission Line Alternative, new substation, and laydown area would be 25.2 acres (**Table 2-8**).

Table 2-8 Disturbance Associated with the Mud Springs Road Transmission Line Alternative

Component	North Option Disturbance			South Option Disturbance		
	Public Acres	Private Acres	Total Acres	Public Acres	Private Acres	Total Acres
Alternative Transmission Line and Associated Components						
Optional Substation[1]	-	2.0	2.0	2.0	-	2.0
Transmission Line Pads: 24.9-kV[2]	0.1	0.1	0.2	0.1	0.1	0.2
Temporary Access Roads: 24.9-kV[3]	20.1	1.9	22.0	13.4	2.9	16.3
Laydown Areas: 24.9-kV	1.0	-	1.0	1.0	-	1.0
Total Alternative Transmission Line and Associated Components[4]	**21.2**	**4.0**	**25.2**	**16.5**	**3.0**	**19.5**
All Other Mine Components Disturbances[5]	**57.3**	**0.0**	**57.3**	**57.3**	**0.0**	**57.3**
Total[6]	**78.5**	**4.0**	**82.5**	**73.8**	**3.0**	**76.8**

[1] Includes temporary laydown area that would be reclaimed after facility construction.

[2] Assumes 4-foot by 4-foot pads, 20 per mile along the entire 24.9-kV transmission line route, rounded up to the nearest tenth of an acre.

[3] Transmission line temporary access roads assume 20-foot width, following the transmission line directly with spur roads at a maximum of one every mile for access to transmission line where topography or existing road would be difficult to access.

[4] The proposed disturbance associated with the alternative transmission line would be mostly on previously undisturbed land.

[5] Includes mining facilities, water management facilities, roads, and ancillary facilities as calculated in **Table 2-5** above for the Proposed Action.

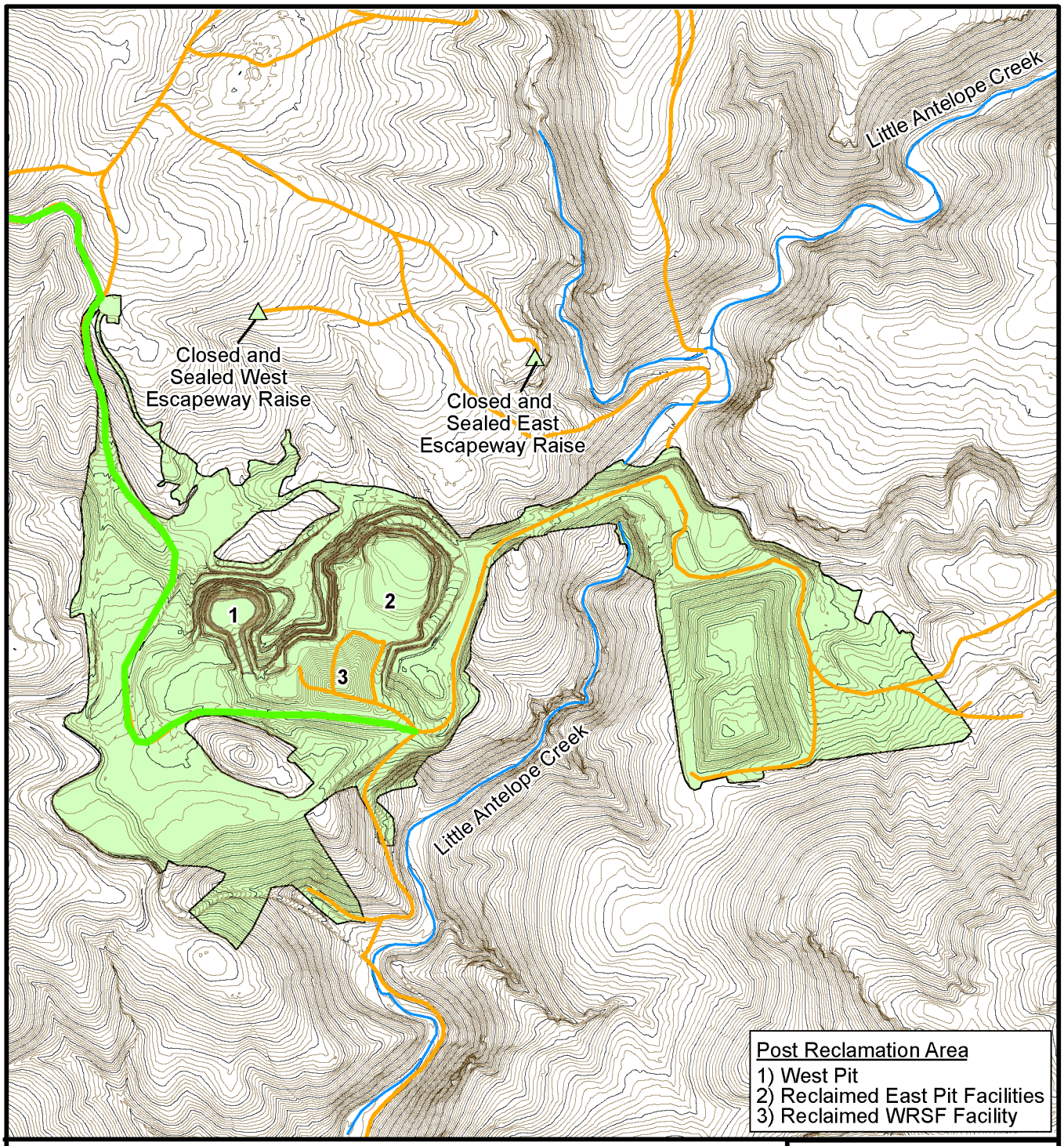
[6] Due to rounding and use of significant digits, sums do not always total across rows and columns.

Source: BLM 2010c; RCG 2010b, 2009a.

The 24.9-kV line pole structures on the Mud Springs Road Transmission Line Alternative route would have the same design as the 24.9-kV line pole structures used elsewhere on site and described in Section 2.4.6.1, Electrical Power.

South Option

The South Option route would locate the new substation in the NW¼ of Section 21, T37N, R49E on BLM land adjacent to the existing 120-kV line and along the Mud Springs Road just west of the Rossi Mine (**Figure 2-22**). The South Option of the 24.9-kV transmission line would originate from this substation location and head northwest for 1.8 miles until intersecting with the Mud Springs Transmission Line Route in Section 7, T37N, R49E (**Figure 2-22**). The total length of the 24.9-kV line along the South Option from the new optional substation #2 to the HPS where the line would travel to the upgraded switchgear facility in the East Pit would be 6.1 miles with 19.5 acres of surface disturbance for the transmission line, new substation, temporary access roads, and laydown area (**Table 2-8**). As with the Proposed Action and the North Option, the voltage would be further reduced and routed to various surface facilities and underground workings for 1.7 miles.



Legend

- Existing/Authorized Mining Surface Disturbance
- Post-reclamation Contours
- Unreclaimed Road
- Ivanhoe Road
- Surface Water

N

0 0.1 0.2 Miles

Note: Contour interval: 5 feet.

Source: RCG 2011b, 2010b.

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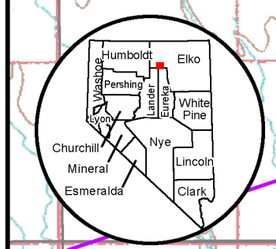
Figure 2-21

Post-mining Topography for No Action Alternative

3/23/2012

Ivanhoe Road
Proposed Mine Office Complex
West Pit
Proposed NPDES Surface Discharge
Proposed HPS
East Pit Facilities
Alternative 24.9-kV Transmission Line Route
Mud Springs Road
North Option
Optional Substation #1
Coyote Creek Substation
South Option
Optional Substation #2
Baroid-Rossi Mine
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
East RIB
West RIBs (2)
Antelope Creek Road
Proposed 120-kV Transmission Line
Proposed Rodeo Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
Antelope Spring
Alkali Spring
Alkali Sprs
Chicken Spring
Mud Spring
Little Antelope Creek
Squaw Creek
Springs
Spring
Creek
1600
1750
1800



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB) and Stockpiles
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Options/Alternatives

- Mud Springs Road Transmission Line Alternative
- Optional Substation

Sources: BLM 2010c; RCG 2010b, 2009a.

N

0 0.5 1 Miles

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Figure 2-22

Mud Springs Road Transmission Line Alternative

3/19/2012

As for the transmission line route for the Proposed Action, the alternative transmission line and substation designs would be based on RUS electrical standards for material and construction. The final transmission line design would be dependent on the final route selection and approval by the BLM. The existing diesel generators at the Hollister Site would remain on-site to serve as emergency electric power in the case of a transmission line or substation failure. The 24.9-kV line pole structures on the Mud Springs Road Transmission Line Alternative route would have the same design as the 24.9-kV line pole structures used elsewhere on site and described in Section 2.4.6.1, Electrical Power.

2.5.1.3 Mud Springs Waste Rock Storage Facility Alternative

Under this alternative, the Mud Springs WRSF would be located in an area east of the historic surface mine heap leach pad facility (**Figure 2-23**). This location could store 1.1 million yd^3 (1,977,124 tons) of waste rock material. Other areas within 0.5 mile of the Hollister project outside of existing disturbed areas were eliminated from consideration for waste rock storage because they included major drainages, require a steep uphill haul of waste rock, have steep topography that would hinder the liner installation, require new roads, and or could affect the Tosawihi Quarries or other cultural sites.

Under the Mud Springs WRSF Alternative, waste rock would be hauled from the existing East Pit Portal or from the proposed HPS on the upgraded segment of Mud Springs Road.

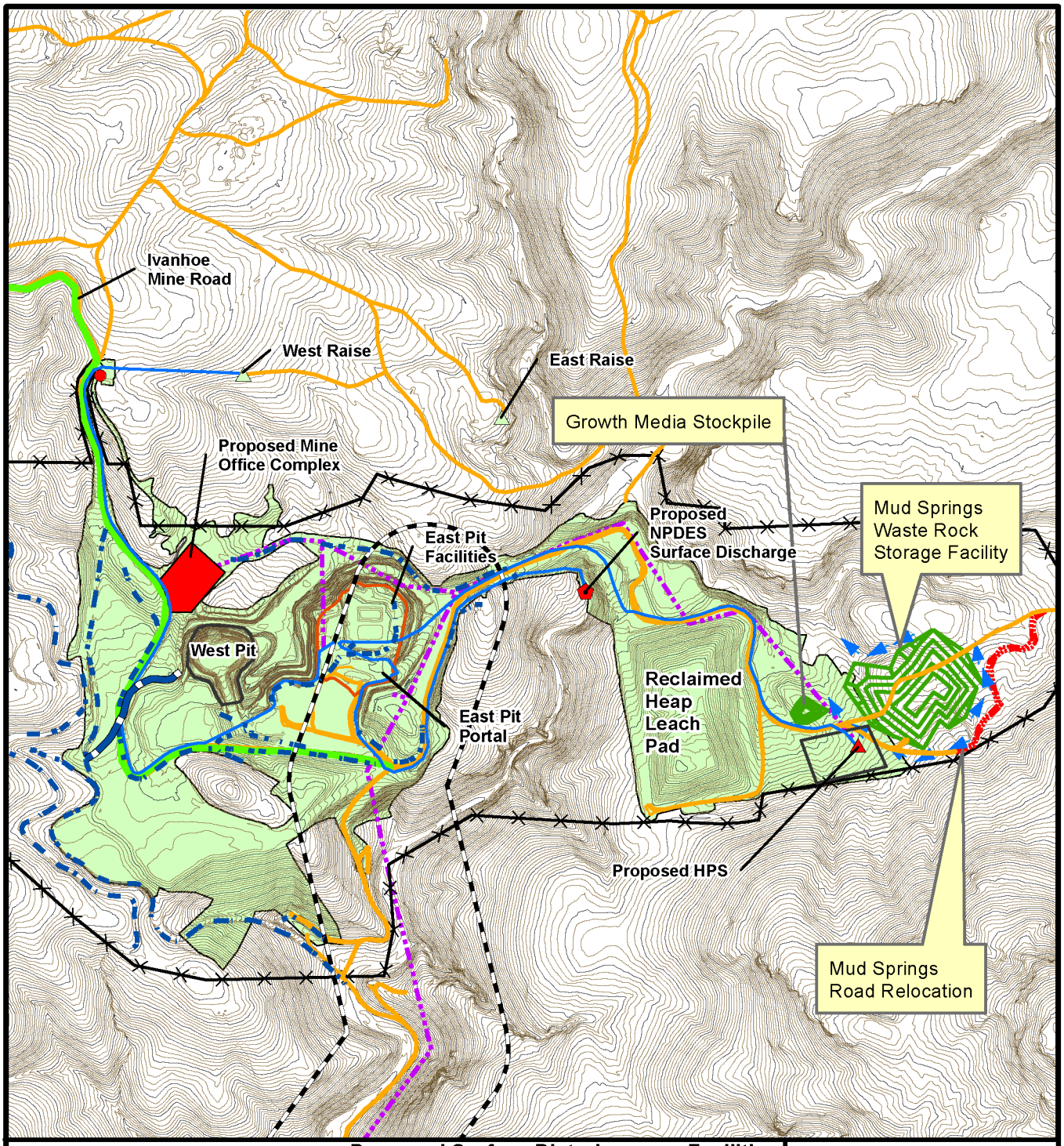
BLM's design, construction, and implementation performance standards for the Mud Springs WRSF would be met, and include:

- A stable design and construction based on a stability analysis so that the WRSF would not fail and no ARD or any other adverse fluid drainage or seepage would flow from the facility;
- A regrade during reclamation of the facility to meet the overall slope angle of 3:1 (with no angle of repose);
- A final shape of the WRSF that would blend into the natural topography in the area and would shed water so that no ponding would occur on the facility;
- Diversion ditches constructed as necessary to restore drainage around the facility and to prevent ponding uphill of the facility or stability problems; and
- Native self-sustaining vegetation established on the WRSF in a weed-free vegetation community.

Construction techniques and environmental safeguards would be similar to those used for the existing RCG WRSF at Hollister (Section 2.2.5, Waste Rock Management) to control and prevent ARD from impacting the environment. These techniques would include a liner system installed beneath the disposal area, and a wet well or an external sump pond to collect any seepage through the WRSF. Surface water diversion channels would be constructed to route runoff from upslope undisturbed areas around the site of the new WRSF.

The construction of this WRSF would require the relocation of approximately 2,080 feet of the existing Mud Springs Road and the upgrading of about 1,800 feet of road to haul road condition with an estimated 40-foot running surface (**Figure 2-23**). Additional field adjustments to roads (access and/or haul roads) and fences would be completed as necessary.

The construction of the Mud Springs WRSF and ancillary facilities would disturb approximately 21 acres, 90 percent of which would be new surface disturbance (**Table 2-9**). The actual area to contain the required 1.1 million yd3 (1,977,124 tons) of waste rock would be about 16 acres, while the ancillary disturbance for the Mud Springs Road relocation, the external drain sump, diversion channels, and the growth media stockpile would disturb approximately 5 acres (**Table 2-9**). It is estimated that about 6 to 12 inches of growth media would be salvaged from the site and stockpiled for use in final reclamation.



Legend

- Existing/Authorized Mining Surface Disturbance
- Fenceline
- Storm Water Runoff Diversions
- Existing Road
- Ivanhoe Road
- Mud Springs Road Relocation
- Mud Springs Waste Rock Storage Facility
- 24.9-kV Transmission Line

Source: Czarnowsky 2011.

Proposed Surface Disturbance or Facilities

- NPDES Surface Discharge
- HPS
- 10,000-gallon Potable Tank and 35,000-gallon Fire Water Tank
- Buried Pipeline
- Proposed Storm Water Diversion Channel
- Mine Office Complex
- Transmission Line Analysis Corridor

N

0 500 1,000 Feet

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Figure 2-23

Mud Springs Waste Rock Storage Facility Alternative

2/28/2012

Table 2-9 Mud Springs Road Waste Rock Facility Disturbance

Facility	Surface Disturbance (acres)
Mud Springs Road WRSF	16.0
External Sump (in place of wet well)	0.1
Growth Media Stockpile	1.0
Diversion Channels	1.4
Mud Springs Road Relocation	1.2
Haul Road Construction	1.3
Total	**21.0**

Source: Czarnowsky 2011.

Haul ramps of 8 to 10 percent slope would be constructed until the dump reaches its ultimate height of approximately 80 feet above the existing high point within the WRSF footprint (elevation 5,740 feet amsl).

The average round-trip haul distance on the surface from the existing mine portal to the centroid of the WRSF and back to the mine portal would be nearly 3.1 miles. This long distance is due to the nature of the existing roads at the site. It may not be efficient to use underground haul trucks to haul waste rock this distance. Therefore, waste rock would be hauled and temporarily stored on the existing RCG WRSF in the East Pit. Periodically, about every 2 to 3 months, a contractor with large surface loading and hauling equipment would be hired to move this waste rock from the East Pit to the Mud Springs WRSF.

The Mud Springs WRSF would be reclaimed upon permanent cessation of mining operations. Slopes would be graded to a 2.5H:1V or 3H:1V configuration. Cover material would be required, and the stored growth media would be replaced. The area would be seeded with plant species as described in **Table 2-3**. This reclamation work would be similar to what would be conducted at the existing RCG WRSF (Section 2.2.10.3), except that a considerable amount of cover material would be required (approximately 79,000 yd^3 [130,350 tons] to obtain the 36-inch-thick cover compared to about 24,000 yd^3 [39,600 tons] required for the Proposed Action West Pit WRSF). This cover material would be imported to the site and approved by BLM if imported from public lands.

2.5.1.4 Backfill Alternative

Under the Proposed Action, RCG would cover the production shaft and East and West escapeway/ ventilation raises (raises) with reinforced concrete cover or steel plates after permanent cessation of mining activities or when it is determined that future access into the underground workings to recover a future resource is considered unnecessary. An alternative to capping the production shaft and site raises is to backfill these facilities with waste rock materials, and cover with a concrete slab or dirt cover. This alternative would enhance public safety by permanently eliminating the possibility of access.

This alternative would include implementation of all components described in the Proposed Action (**Figure 2-24**). The estimated volume of waste rock needed to backfill the production shaft and the site raises is described in **Table 2-10**. Waste rock generated from the Hollister underground mining operation would be used as backfill for the shafts. Waste rock would be recovered from one of the waste rock disposal facilities at the mining operation, crushed to 3-inch minus size material, hauled to the appropriate shaft/raise site, and then placed as backfill material.

Table 2-10 Waste Rock Backfill Volumes for the Production Shaft and Site Raises

Facility	Estimated Backfill Amounts		
	Bank Cubic Feet	Bank Cubic Yards	Tons[1]
Production Shaft[2]	384,000	14,220	30,720
East Raise[3]	43,740	1,620	3,500
West Raise[4]	58,320	2,160	4,670

[1] Assume 0.08 ton/cubic foot (rounded to the nearest 10 tons).

[2] Production shaft dimensions: 2,000 feet deep with sectional dimensions of 8 feet by 24 feet.

[3] East Raise dimensions: 540 feet deep with sectional dimensions of 9 feet by 9 feet.

[4] West Raise dimensions: 720 feet deep with sectional dimensions of 9 feet by 9 feet.

The use of 20-ton capacity trucks to deliver waste rock for backfill would require the approximate following traffic for these trucks:

- Production shaft: 1,536 round trips
- East Raise: 175 round trips
- West Raise: 234 round trips

The production shaft would be concrete lined and thus provide neutralization capacity. However, if additional buffering capacity is needed, dolomite or limestone would be added.

Removal of waste rock for use as backfill would not result in a reduction in surface disturbance for the WRSFs. Due to the long-term potential of waste rock settlement in the production shaft and the raises, backfilling the openings also would require a concrete or steel pad or a polyurethane foam plug; these would be placed at the collar of the shaft and raises. The backfilled openings would then be covered with a mound of rock/dirt/growth medium material to facilitate reclamation and diversion of surface drainage off the mound and the concrete plug.

Backfilling would require an additional 2 acres disturbance around each raise site for backfilling operations to accommodate the stockpiling of waste rock material that would fill the raises, and the maneuvering (turning) of the trucks used to deliver the waste rock. Waste rock would be pushed into the opening with a bulldozer or dumped into the opening with a frontend loader. Backfilling openings would be conducted in a safe manner consistent with RCG and MSHA safety regulations.

The access road to the production shaft would be upgraded as part of the Proposed Action to allow for haul trucks as described in Section 2.4, Proposed Action. No additional road widening or disturbance acreage would be needed in the production shaft area for this alternative. However, the existing two-track roads to the raises would require upgrades to accommodate the trucks that would transport rock material to be used in raise backfilling. At a minimum, the road upgrades to the site raises would include blading to smooth and widen the road surfaces to allow the estimated truck and support vehicle traffic. In addition, some rock surface material (gravel or sub-base road rock) and temporary culverts may be needed to facilitate the expected traffic and vehicles. The necessary road upgrades, berms (20-foot widths) and turnouts (of 1 acre each) would disturb 6.6 acres of land (**Figure 2-24**). Each raise also would require up to 2 acres of surface disturbance to accommodate the backfill activities for a total of 10.6 acres of surface disturbance associated with this alternative.

Access Road to Escapeway Raises

2 Acre Disturbance

2 Acre Disturbance

Ivanhoe Road

West Raise

East Raise

Proposed Mine Office Complex

West Pit

East Pit Facilities

Proposed HPS

Proposed NPDES Surface Discharge

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- Storm Water Diversion Channel
- East Pit Facilities

Proposed Surface Disturbance or Facilities

- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 10,000-gallon Potable Tank and 35,000-gallon Fire Water Tank
- 24.9-kV Transmission Line
- Buried Pipeline
- Proposed Storm Water Diversion Channel

Sources: BLM 2010c; RCG 2009a.

N

0 900 1,800 Feet

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Figure 2-24

Backfill Alternative

3/19/2012

Backfilling of the shaft and raises permanently eliminate the possibility of re-entry into underground workings if future resources are discovered or economics shift so that existing resources become economic to recover.

Under this alternative, backfill and permanent closure of the production shaft and raises would occur at such time that RCG decides to begin final reclamation and site closure and that no further access or activity is required in the Hollister Underground Mine. All closure activities would be in conformance with applicable regulations.

2.5.2 Alternatives Considered but Eliminated from Detailed Analysis

This section describes the alternatives previously considered but subsequently eliminated from detailed analysis by the BLM and the rationale for their elimination. Each potential alternative was evaluated to determine: 1) whether it was technologically and economically feasible and 2) its potential to address and reduce impacts to environmental and cultural resource issues.

2.5.2.1 Irrigation Alternative

This alternative is the same as the Proposed Action except that excess mine water would be piped from the RIBs to nearby ranches for use during the irrigation season. Depending on legal contractual agreements, irrigation would take place April through September at off-site private lands owned by a third-party. Preliminary discussions with area ranches indicate that there is an interest in further developing this alternative. However, this alternative was eliminated from further consideration because of the third-party obligation that could not be required by this EIS, and legal contractual agreements currently do not exist between the parties involved regarding this action.

2.5.2.2 Belowground Transmission Line Alternative

Under this alternative, the proposed 120-kV and 24.9-kV transmission lines would be buried underground to reduce visual and wildlife impacts from an aboveground transmission line. Assuming a 30-foot-wide temporary disturbance width for vehicle and equipment access and installation of the underground transmission line, several access roads, and an 11.6-mile transmission line (following the same route as the Proposed Action), the total long-term surface disturbance would be approximately 42.2 acres. The disturbance would be categorized as long-term because of the long time necessary for the existing sagebrush habitat to re-establish. The belowground transmission line alternative would increase impacts to soils, vegetation, surface water, and cultural resources due to greater surface disturbance for installation of the underground transmission line and the necessity to maintain a cleared ROW. From an electrical engineering and construction standpoint, underground 120-kV and 24.9-kV transmission lines are economically prohibitive due to higher construction, maintenance, and safety costs (American Electric Power 2010).

2.5.2.3 Open-pit Mining of Hollister Narrow Vein Ore Deposits

The underground ore potentially could be extracted using surface mining methods. However, the mineral resource targeted by RCG exists primarily as a small, narrow vein deposit that is not as economically viable using surface mining methods. Surface mining methods were used to extract gold and silver resources from the area in the original Ivanhoe Project in the 1990s, thus creating the existing East and West pits at the Hollister Site. Surface mining of the narrow vein mineral resources would result in increased surface disturbance through excavation of overburden and pit laybacks to access the mineral resource compared with more location-specific underground extraction methods. Surface mining would increase the amount of waste rock produced, thus increasing the size of the existing RCG WRSF as well as increasing the volume of haul road traffic. Additional haul roads would be required, resulting in additional surface disturbance. A leach pad also may be required to process low grade ore from surface deposits, resulting in more disturbance. The increase in surface disturbance would affect sensitive cultural resources within and near the Tosawihi Quarries Archaeological District as well as other environmental resources such as increased surface disturbance, increased potential for soil and water erosion, increased

potential for noxious weeds and non-native invasive plant species establishment, increased noise levels, and increased removal of sagebrush habitat in an area that sustained habitat loss in several wildfires from 2001 to 2006. For these reasons, this alternative was eliminated from further consideration.

2.5.2.4 On-site Ore Processing Alternative

RCG has not proposed on-site ore processing as part of the Proposed Action. However, on-site ore processing would be feasible and is an alternative to the ore transport and off-site ore processing included in the Proposed Action. This alternative would include the construction and operation of on-site ore processing and tailings facilities within the project area in close proximity to the underground mining operations under the Proposed Action. Employment for operation of the facility would range from 30 to 50 employees during full-time operations. Construction would be completed by contractors, and no employment figures have been estimated for construction. RCG would add one to two additional buses to transport workers to and from the mill site.

Potential New On-Site Mill

A potentially viable mill circuit could contain primary and secondary crushers, conveyor systems, a semi-autogenous grinding (SAG) mill, one or more ball mills, vibrating screens, flotation concentrators, thickeners, a regrind mill, CIL agitated leaching tanks, Merrill-Crowe system, reagent handling, a cyanide neutralization circuit, and associated equipment. The production rate could be up to 1,000 tpd and would operate 24 hours per day, 7 days per week. Based on recent expansions of similar facilities, the likely surface disturbance necessary to construct a new mill and support facilities would range between 50 to 150 acres, depending on topography. Depending on location, this disturbance could be on public or private land within or near the project area, and portions of the facilities could be constructed on existing disturbance, previously reclaimed mining disturbance or be new disturbance.

Ore Crushing and Concentration Processing

The ore would be fed to the crusher using front-end loaders or haul trucks. The crusher reduces ore to an appropriate size, after which the ore is conveyed to the crushed ore stockpile. The crushed ore from the stockpile is then fed to the SAG mill. Water is added to the crushed ore as it enters the SAG mill where the ore is milled to minus 0.5 inch. The slurry from the SAG mill is pumped to a set of four cyclones for size classification. The cyclone underflow (oversize material) is recycled to one of two ball mills. The cyclone overflow material is fed to the CIL circuit where cyanide is added. The dissolved precious metals are absorbed onto the carbon, and the tailings pumped to the tailings impoundment.

Tailings Impoundment Facilities

One or more new tailings impoundment facilities would be required to contain up to approximately 8 million tons of tailings over the 20-year proposed life of mine in order to process the authorized 1,000 tpd for an annual throughput of up to 366,000 tpy from full-scale underground mining at Hollister. The specific location and number of tailings impoundments would need to be determined based on technical and feasibility studies that have not been undertaken. Based on recent expansions of similar facilities, the likely surface disturbance necessary to construct one or more tailings impoundments, reclaim ponds and other process facilities would range between 50 to 250 acres, depending on topography. Depending on location, this disturbance could be on public or private land within or near the project area, and portions of the facilities could be constructed on existing disturbance, previously reclaimed mining disturbance or be new disturbance.

The tailings impoundments would be designed and operated in accordance with the NAC 445A regulations. The tailings impoundments would likely be equipped with a peripheral tailings line that rests inside an embankment crest. Tailings slurry would be spigotted from the peripheral line controlling deposition within the impoundment. The tailings material would consolidate in the impoundment.

The tailings embankment(s) would be constructed utilizing non-PAG materials. The tailings impoundment facility would have a synthetic HDPE liner with a sub-grade secondary liner. The tailings impoundment facility would be constructed with a drain system to reduce the hydraulic head on the synthetic liner. A series of perforated pipes encased in gravel would be positioned across the top of the synthetic liner at specified intervals. These pipes would drain to a collection pond below the tailings dam, where the reclaimed water would be pumped back to the mill circuit.

An on-site mill and associated tailings facility would be constructed near or within the project area, much of which overlaps the Tosawihi Quarries Archaeological District, and other areas that contain sensitive cultural resources important to area Native Americans and the public. While RCG conducted preliminary internal review of a potential on-site mill and tailings facility, in order to honor the concerns expressed by Native Americans about on-site processing in this area, it was removed from the Proposed Action prior to submitting the Hollister project PoO. Consequently, although technically and economically feasible, BLM eliminated this alternative from further consideration due to effects on sensitive cultural resources and Native American concerns.

2.5.2.5 Upgrade of Antelope and Little Antelope Creek Roads

This alternative would provide an alternate access and haul road to and from the Hollister Mine in addition to the Ivanhoe Road. This alternative would involve upgrading portions of the Antelope Creek and Little Antelope Creek roads from Battle Mountain to the Hollister Mine. These upgrades would include widening and improving the Little Antelope Creek and Antelope Creek roads from the mine to the Lander County line. Approximately 30 miles of the existing road would need to be improved, including the Little Antelope Creek Road, portions of the Antelope Creek Road, and the Izzenhood Ranch Road to the Lander County line. Additional permits and National Environmental Policy Act analyses would be needed to analyze the impacts at the Rock Creek crossings.

This alternative would provide additional all-season access to the mine, and would provide access to the Hollister Mine from Battle Mountain and Elko, which would be more convenient for some employees. The majority (70 percent) of Hollister employees and contractors live and come from Winnemucca. However, this alternative would result in greater impacts to wildlife and cultural resources due to the location of the road along Little Antelope and Antelope creeks. This alternative was eliminated from further analysis due to greater impacts to wildlife and cultural resources and high costs to upgrade the road. The majority of traffic to the Hollister Site travels established routes on Midas-Tuscarora and Ivanhoe roads.

2.5.2.6 Upgrade of Mud Springs Road

The current Mud Springs Road is a two-track road and largely impassable in inclement weather. This alternative would provide additional access to and from the project area for employees and vendors traveling from the southeast on Dunphy Road. This alternative would require widening and improving the existing road which extends 9.3 miles. It also would require realigning portions of the road to allow safe passage for larger vehicles. Upgrades to creek crossings also may be required. The total disturbance for this alternative would be 31.6 acres.

This alternative would provide additional all-season access from eastern towns such as Carlin and Elko, which would be more convenient for some employees and vendors. This alternative was eliminated from further analysis due to economic costs and the existence of extensive cultural sites that would be impacted by increased road use and upgrades. The majority (70 percent) of Hollister Site employees and contractors travel to Hollister from the Winnemucca area; 9 percent come from the Elko and Carlin area.

2.5.2.7 Expansion of the Newmont Reclaimed South Waste Rock Storage Facility

This alternative would expand the Newmont Reclaimed South WRSF with waste rock from the Hollister Underground Mine. It would eliminate the need for the West Pit to serve as a WRSF. It would require the use of a liner to separate the previous waste rock currently stored in the facility from the new waste rock

material and to capture draindown solution to prevent creating a complex ARD situation. This alternative also would require a method for capturing or re-routing the meteoric water that falls on the WRSF.

Expansion of the Newmont Reclaimed South WRSF alternative was eliminated from consideration due to potential ARD issues, engineering needs, and the potential visual impacts from Big Butte depending on the size of the expanded facility.

2.5.2.8 Midas Substation for Transmission Line

This alternative would provide electric power from the existing substation located at the Midas Mine, located 20 miles north of the Hollister Mine. However, the existing Midas substation does not have the capacity required for the Hollister Mine electric power needs. Upgrading the existing station would require construction of multiple transmission line power back-ups. This alternative was eliminated from consideration due to greater surface impacts and the extensive required upgrades and power back-ups, which would result in economic infeasibility. This alternative would impact multiple cultural resources sites and has the potential to create impacts to greater sage-grouse in areas that currently do not have transmission lines.

2.6 BLM-preferred Alternative

The BLM has selected a preferred alternative based on the analysis in this EIS. This preferred alternative is the alternative that best fulfills the agency's statutory mission and responsibilities, considering economic, environmental, technical, and other factors. The BLM has determined that the preferred alternative is the Proposed Action and Backfill Alternative.

3.0 Affected Environment and Environmental Consequences

3.1 Introduction and General Setting

This chapter describes the environment that would be affected by the development of the Proposed Action and alternatives. It includes a description of the past, present, and reasonably foreseeable future actions (RFFAs) that may result in cumulative impacts with the Proposed Action or alternatives.

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

This chapter also describes the anticipated direct and indirect impacts of the Proposed Action and the alternatives as well as potential cumulative impacts. The analysis of potential impacts from the Proposed Action assumed the implementation of the Applicant-committed environmental protection measures (Section 2.4.9) that would be implemented in association with the proposed project. Potential monitoring and mitigation developed in response to anticipated impacts are recommended for individual resources, and are discussed at the end of each resource section. This chapter also identifies residual impacts, which are the impacts that would remain after mitigation measures have been implemented.

The proposed project may result in cumulative effects associated with other past and present actions and RFFAs in the area. For resources where project-specific impacts are identified, the cumulative effects associated with the proposed project were evaluated together with other past and present actions and RFFAs. The period of potential cumulative impact is defined as the 20-year operational life of the project followed by up to 3 years for final reclamation and closure. The cumulative effects analysis for each resource addressed the potential cumulative effects within resource-specific cumulative effects study areas (CESAs).

The project area (Proposed Action) is the region encompassed by the project boundary and is defined by the Proposed Action (also referred to as the proposed project), which includes the core area for mining and exploration, electric power transmission line (transmission line) analysis area, and the Ivanhoe Road (**Figure 2-11**). The study area is the area assessed for direct and indirect impacts and is defined individually for each resource, and may or may not be the same as the project area. The study area is defined as the region where direct and indirect impacts would occur for a specific resource as a result of the Proposed Action. Direct and indirect impacts would occur within the project area for most affected resources; some indirect impacts may affect the adjacent or immediate area surrounding the project area.

The CESA also is defined individually for each resource, and typically includes a larger area than the study area assessed for direct and indirect impacts. Project region is defined as an area larger than the CESA and is a more generalized area without specific boundaries.

The ore produced from the proposed Hollister Mine would be processed off-site by third parties at the Esmeralda Mill and/or the Midas Mill (see Section 2.3, Third-party Processing Facilities, and Section 3.1.2, General Setting – Third-party Processing). The resources applicable to the mill sites are

different from the resources assessed for impacts at the proposed Hollister Mine. Because the additional ore processing would be within the permitted ore processing capacities of the facilities in the ordinary course of operation, and no additional facilities or new processes are contemplated as part of the Proposed Action, impacts associated with off-site milling are generally limited to impacts caused by transportation and the incremental impact of ores being processed at these facilities. These could include impacts to the following resources: Land Use and Access and Air Quality. Therefore, the ore processing impacts are only discussed in those sections.

This chapter is organized by environmental resource after Section 3.1, Introduction and General Setting, and Section 3.2, Past, Present, and Reasonably Foreseeable Future Actions. Sections 3.3 through 3.24 describe the existing conditions and potential environmental impacts associated with each resource. Subsections for each resource include:

- Affected Environment
- Environmental Consequences
- Cumulative Impacts
- Potential Monitoring and Mitigation Measures
- Residual Impacts

Energy requirements and climate change for the Proposed Action and alternatives are provided in Section 3.25. The short-term use of the environment relative to the long-term productivity of resources is discussed in Section 3.26. Short-term is defined as the life of the project operations or less (proposed plan is 20 years plus up to 3 years for final reclamation and closure); long-term impacts are defined as impacts that would continue post-reclamation. The irreversible or irretrievable commitment of resources is described in Section 3.27.

For the purpose of the environmental impact statement, the Hatter production shaft, ramp, or raise are collectively referred to as the HPS. Under the Proposed Action, the production shaft was quantitatively assessed for potential impacts because it is taller and would cause the most visual impact and greatest surface disturbance. Alternatively, the construction of either a raise or ramp would be less visible and would result in less surface disturbance.

3.1.1 General Setting – Hollister Mine

The Hollister Mine is located in northern Nevada in the northern portion of the Great Basin. The surrounding terrain consists of moderately dissected uplands immediately north and west of the junction of the Sheep Creek Range and the Santa Renia Mountains within the Rock Creek Valley Watershed Subbasin (**Figure 3.1-1**). This region is characterized by extensive valleys located between the Tuscarora Mountain Range to the east, Antelope Creek to the south, and the Sheep Creek Range to the southwest. Little Antelope Creek, an intermittent tributary of Antelope Creek, bisects the project area and drains a portion of the Rock Creek Valley Watershed. Elevations in the project area range from approximately 5,300 feet to 6,500 feet above mean sea level (amsl). The climate is marked by extreme weather conditions characterized as arid and accompanied by temperatures ranging from -20 degrees Fahrenheit (°F) to more than 100°F. Overall precipitation averages approximately 10 inches a year, with erratic rainfall patterns that tend to be localized.

3.1.2 General Setting – Third-party Processing

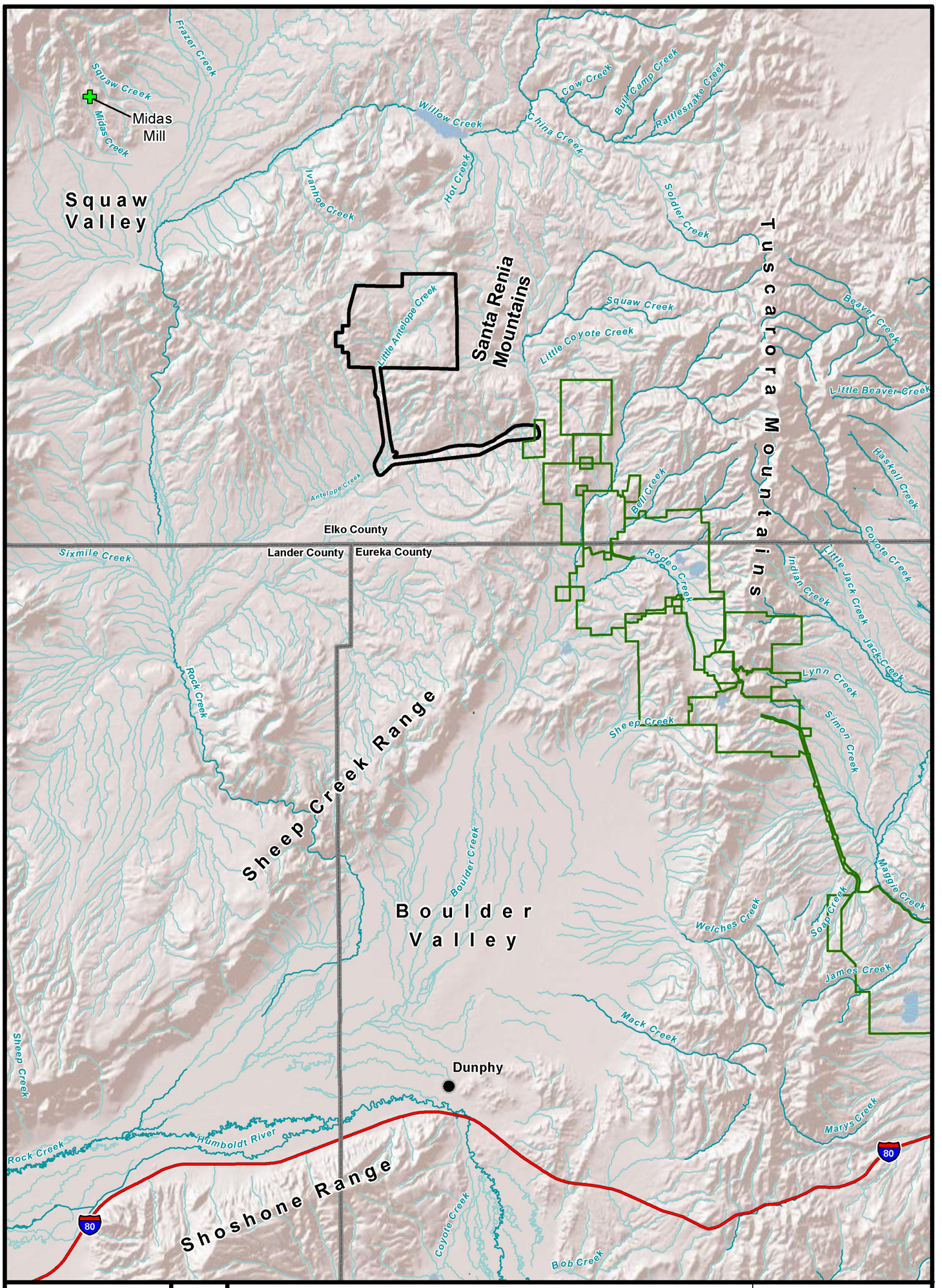
Esmeralda Mill

The Esmeralda Mill is located in Mineral County, Nevada, approximately 22 miles southwest of the Town of Hawthorne, in the historic Aurora Mining District (**Figure 3.1-1**). The Esmeralda Mill encompasses

both private and federal lands, with the federal land administered by the United States Forest Service, Humboldt-Toiyabe National Forest through the Bridgeport Ranger District. Elevations at the site range from 7,000 to 7,200 feet amsl. The Wassuk Mountain Range is on the west, and the Gillis Range is to the northwest of the site. These two mountain ranges, along with the Sierra Nevada and Garfield Hills, provide a temperate climate. Average temperatures typically range from 30 to 80°F; average yearly precipitation is 4.6 inches (Mineral County Chamber 2010).

Midas Mill

The Midas Mill is located 20 miles from the Hollister Mine, also in northern Nevada in the northern portion of the Great Basin (**Figure 3.1-1**). The mine site is bordered on the north by Squaw Creek and the south by Midas Creek. Elevations in the project area range from approximately 5,240 feet to 6,250 feet amsl. Like the Hollister Site, the climate is marked by extreme weather conditions characterized as arid and accompanied by temperatures ranging from -20°F to more than 100°F. Precipitation averages 10 inches a year, with erratic rainfall patterns that tend to be localized.



Legend

- Project Area Boundary
- Other Mine Plan Boundaries
- Midas Mill
- Esmeralda Mill (see inset map)
- Interstate 80
- Perennial Stream
- Intermittent Stream
- County Line

N

0 2 4 Miles

Source: BLM 2010d,e.

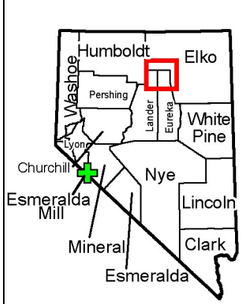


Figure 3.1-1
General Setting

Hollister Underground Mine Project EIS

3/19/2012

3.2 Past, Present, and Reasonably Foreseeable Future Actions

This section summarizes past, present, and reasonably foreseeable future actions (RFFAs) for the Proposed Action and forms the basis for the discussion of cumulative impacts. Cumulative impacts are defined by the Council on Environmental Quality as:

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

Bureau of Land Management (BLM) Instruction Memorandum NV-90-435 specifies that impacts first must be identified for the proposed project before cumulative impacts with past, present, and RFFAs can occur. Cumulative effects are discussed on a resource-by-resource basis in Chapter 3.0 sections, including the description of and rationale used to develop individual resource cumulative effects study areas.

Relevant projects and actions are defined for the Environmental Impact Statement (EIS) as those past, present, and RFFAs that could interact with the Proposed Action or alternatives in a manner that would result in cumulative impacts, resulting primarily from mining, commercial activities, public uses, and wildland fires.

The geographic area for which past, present, and RFFAs are described for the Proposed Action or alternatives generally encompasses the Carlin Trend. The Carlin Trend is a mineralized zone approximately 50 miles long by 5 miles wide in north central Nevada where mining operations have been developed over the past 100 years. Mining and mineral exploration are the primary surface-disturbing actions throughout the Carlin Trend. For this EIS, the Carlin Trend is defined as the area from Gold Quarry Mine in the southeast to the Midas Mine in the northwest. Carlin Trend mining and mineral exploration surface disturbances are identified in **Table 3.2-1**. **Figure 3.2-1** illustrates mining and mineral exploration disturbance areas and mine facilities. **Figure 3.2-2** illustrates mining and mineral exploration areas within the Carlin Trend as well as some other past and present projects such as the electric power transmission lines (transmission lines) and the Ruby Pipeline. The past, present, and RFFAs recently identified in the Leeville and South Operations Area Project Amendment (SOAPA) Cumulative Effects Study (BLM 2010d,e), and Betze Pit Expansion Project Supplemental EIS (BLM 2008b) have been reviewed and considered.

Table 3.2-1 Mine and Mineral Exploration Surface Disturbance Associated with Past and Present Actions and RFFAs

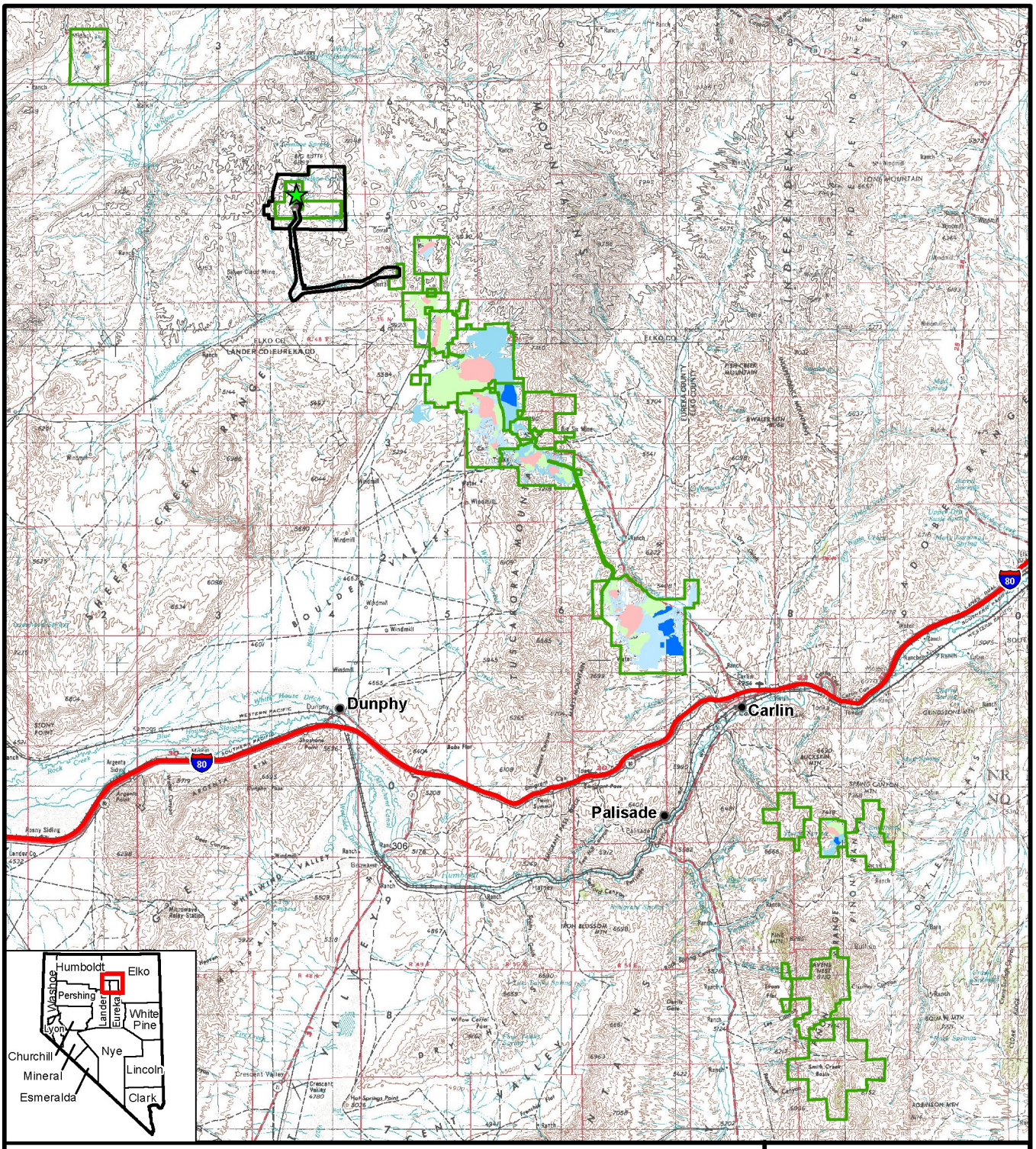
Figure 3.2-2 Reference No.	Action	Past and Present Disturbance (acres)	RFFA Projected Disturbance[1] (acres)	Total Past, Present, and Projected Disturbance (acres)
Mining Projects				
1	Newmont – Midas Mine	154	80	234
2	Newmont – Ivanhoe Open Pit Mine/Rodeo Creek Gold-Hollister Underground Mine	268	92	360
3	Halliburton – Rossi Mine	585	1,000	1,585

Table 3.2-1 Mine and Mineral Exploration Surface Disturbance Associated with Past and Present Actions and RFFAs

Figure 3.2-2 Reference No.	Action	Past and Present Disturbance (acres)	RFFA Projected Disturbance[1] (acres)	Total Past, Present, and Projected Disturbance (acres)
6	Barrick – Storm Underground, Dee Arturo	814	2,774	3,588
8	Newmont – Bootstrap	1,900	0	1,900
9	Barrick – Betze, Meikle, Rodeo, Goldbug	9,062	0	9,062
10	Newmont – Blue Star/Genesis, Section 36, Deep Star, Lantern, North Lantern, Bullion Monarch	4,739	0	4,739
10	Newmont – North Area Leach	1,526	0	1,526
10	Newmont – Carlin Mine, Pete	3,673	100	3,773
12	Newmont – Leeville Underground	566	0	566
14	Newmont – Mike Mine	0	100	100
15	Newmont – Gold Quarry/South Operations Area Project (SOAP), MC Reservoir, N-S Haul Road	9,961	1,000	10,961
17	Newmont – Rain Mine	961	100	1,061
18	Newmont – Emigrant Mine	1,418	0	1,418
--	Sand and Gravel Operations	395	0	395
Subtotal		**36,022**	**5,246**	**41,268**
Mineral Exploration				
2	Rodeo Creek Gold – Ivanhoe/ Hollister Development Block	95	25	120
4	Trio Gold Corp – Rodeo Creek	42	0	42
5	Barrick – Rossi	51	0	51
6	Marigold – Dee Gold Mine	84	0	84
7	Barrick – Ren	30	30	60
9	Barrick – Goldstrike Project	233	0	233
10	Newmont – Carlin	255	0	255
11	Newmont – Chevas	168	0	168
13	Newmont – High Desert	164	0	164
14	Newmont – Mike	48	0	48
16	Newmont – Woodruff Creek	66	0	66
18	Newmont – Emigrant Springs	155	0	155
19	Royal Standard Minerals – Railroad-Piñon	20	200	220
Subtotal		**1,411**	**255**	**1,666**
Total		**37,433**	**5,501**	**42,934**

[1] Approximate acreages. Acreages subject to change upon submittal of the Plan of Operations (PoO).

Source: BLM 2010c,d,e, 2008b, 2007a,b.



Legend

- Hollister Underground Mine
- Project Area Boundary
- Mine Plan Boundaries
- Ancillary Disturbance
- Leach Pads
- Pits
- Waste Rock Storage Facilities

Source: BLM 2007a,b.

N

0 2.5 5 Miles

Hollister Underground Mine Project EIS

Figure 3.2-1

Mining Disturbance in the Carlin Trend

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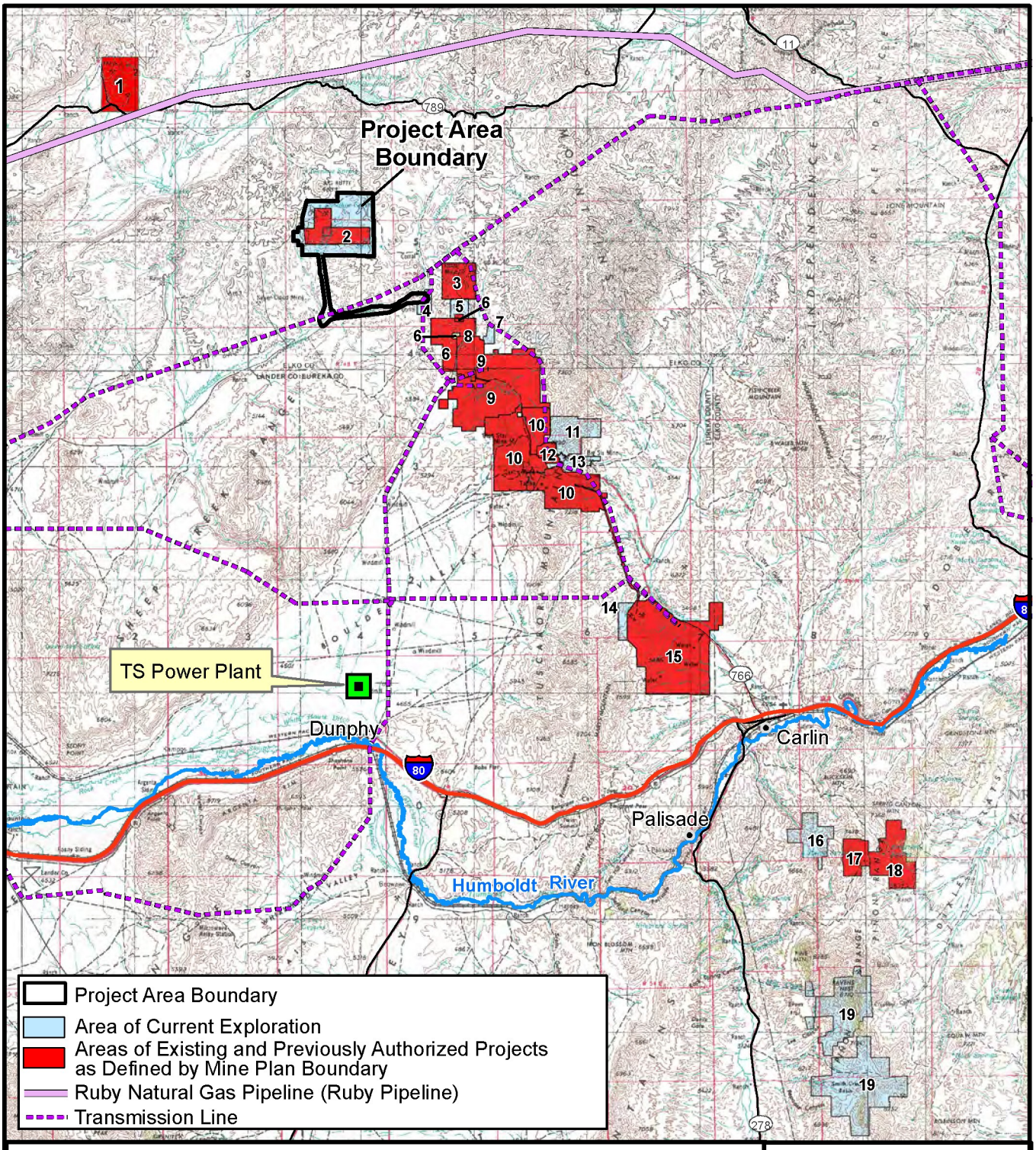


Legend

1) Newmont- Midas
2) Newmont-Ivanhoe Open Pit Mine/ Rodeo Creek Gold-Hollister Underground Mine
3) Halliburton-Rossi
4) Trio Gold Corp-Rodeo Creek Exploration
5) Barrick-Rossi Exploration
6) Barrick-Storm Underground, Dee, Arturo
7) Barrick-Ren Exploration
8) Newmont-Bootstrap
9) Barrick-Betze, Meikle, Rodeo, Goldbug
9) Barrick-Goldstrike Exploration
10) Newmont-North Area Leach
10) Newmont-Blue Star/Genesis/Carlin
10) Newmont-Carlin Exploration
11) Newmont-Chevas Exploration
12) Newmont-Leeville
13) Newmont-High Desert Exploration
14) Newmont-Mike Exploration, Mike
15) Newmont-Gold Quarry/SOAP, MC Reservoir, N-S Haul Road
16) Newmont-Woodruff Creek Exploration
17) Newmont-Rain
18) Newmont-Emigrant Springs Exploration, Emigrant
19) Royal Standard Minerals-Railroad-Pinon

Source: BLM 2010c,d,e.

N

0 2.5 5 Miles

Hollister Underground Mine Project EIS

Figure 3.2-2

Mining and Other Past, Present, and Reasonably Foreseeable Future Actions

3/6/2012

3.2.1 Past and Present Actions

The past and present projects and actions considered in the cumulative effects analysis are described below. Included in this category are historic and ongoing projects and actions (e.g., mining, grazing, recreation, commercial activities, and wildfire phenomena) within the general vicinity of the proposed project.

3.2.1.1 Mine-related Disturbance

The Ivanhoe Mining District is located in the Carlin Trend in northeastern Nevada, and specifically includes the Battle Creek Range north of Battle Mountain, Nevada, and the drainage basins of Ivanhoe and Little Antelope creeks. For many thousands of years, Native Americans recognized the white chert outcroppings in this region as a source of raw materials for tool making (BLM 2004a). This mining district was discovered in 1916, and the primary commodities mined from this district included mercury and gold. Ivanhoe was historically a mercury district, but recent gold production has overshadowed mercury production (Gianella 1945; Granger et al. 1957; La Pointe et al. 1991 as cited in Tingley 1998; Lincoln 1923; Smith 1976; Stoddard 1932). Exploration and modern mining activities have been conducted in the Ivanhoe Mining District over the past 100 years, with the majority of activity occurring from 1980 to the present. The district has been actively explored for mercury, molybdenum, uranium, and gold. Several companies including U.S. Steel Corporation, Touchstone Resources Corporation, Newmont Exploration Ltd., Hecla Ventures Corporation, and Great Basin Gold Ltd have recently been involved with gold exploration (BLM 2004a). Remnants of surface disturbance from the old mining and exploration activities, including the mercury mines still exist, although overgrown with vegetation.

Gold was first discovered in 1907 in Lynn Creek, 19 miles northwest of Carlin, within what would later become widely known as the Carlin Trend (Tingley 1998). Placer gold deposits also were discovered in Sheep, Rodeo, and Simon creeks around the same time period. Prior to the 1907 gold discovery, claims in the Carlin Trend produced silver and lead. More modern and larger scale mining activities began with the Newmont Carlin Mine in 1965, Gold Quarry in 1981, and the Barrick Goldstrike Mines Inc. (BGMI) Betze/Post Mine in 1988. Brief descriptions of the past and present mines considered in the cumulative effects analysis are presented below.

Midas Mine (Newmont Mining Corporation). The Midas Mine occurs in the Midas Mining District and is located approximately 20 miles north of the Hollister Site. Development of the underground mine began in 1997 following the discovery of the Midas ore body in 1994. In 2002, Newmont acquired the Midas Mine and began underground mining operations consisting of a decline and ramp system to access the steeply dipping gold-silver bearing vein deposit, a temporary waste rock storage area, a crushing plant, a 1,000-ton per day conventional mill incorporating gravity separation and cyanide leaching with the Merrill-Crowe recovery system, a refinery, a cyanide destruction circuit, a tailings impoundment system, two collection ponds, and various process and administrative support facilities. Permitted mining activities include approximately 234 acres of disturbance. Currently, the mine is permitted to February 2013 and approximately 154 acres have been disturbed (BLM 2010d,e).

Ivanhoe Mine (Newmont Mining Corporation). Ivanhoe Mine occurs within the Ivanhoe Mining District at the northwest end of the Carlin Trend. Operations of this mine by Newmont occurred from 1990 through 1996. The property consists of two open pits, a heap leach facility, and waste rock storage facilities (WRSFs) that are undergoing reclamation and closure, as well as exploration activities. Currently, approximately 268 acres have been disturbed (BLM 2010d,e).

Hollister Operations (Rodeo Creek Gold Inc [RCG]). RCG's Hollister Development Block Exploration Project and proposed Hollister Underground Mine also are located at the Ivanhoe Mine open pit site. The Hollister Development Block Exploration Project currently is removing water from the underground workings and is permitted for discharges up to 700 gallons per minute (gpm) within the Rock Creek

Hydrologic Basin. Groundwater entering the underground workings is pumped into a recycle pond for storage, reuse, and infiltration into alluvium via Rapid Infiltration Basins (RIBs) located near the confluence of Little Antelope Creek and Antelope Creek (see Section 2.2, Existing Hollister Operations). Permitted activities include approximately 77 acres of disturbance within the 268 acres of disturbance previously authorized for the Ivanhoe Mine (BLM 2010d,e).

Rossi Mine (Halliburton). The Rossi Mine occurs in the Bootstrap Mining District and is located approximately 8 miles southeast of the Hollister Site, in the Santa Renia Fields area, Elko County. Barite mining operations began in 1947. The Rossi Mine project includes continued mining at the Queen Lode and Sage Hen barite mines. Facilities include open pits at both the Queen Lode and Sage Hen deposits, WRSFs, haul roads, and ore stockpiles. The jig plant and ponds are located at the Sage Hen deposit. The mine is permitted for another 15 years of operations. No dewatering is associated with the Rossi Mine. Permitted mining activities include approximately 585 acres of disturbance, of which, all of the 585 acres has been disturbed (BLM 2010d,e). An additional 1,000 acres are reasonably expected to be disturbed at the Rossi Mine facilities (BLM 2012).

Dee Mine (Barrick Dee Mining Venture). The Dee Mine occurs in the Bootstrap Mining District and is located approximately 7 miles southeast of the Hollister Site. The Dee deposit was discovered in 1981. Production began in 1984 by the operating partnership of the Dee Gold Mining Company with Rayrock Mines Inc. Glamis Gold Ltd. became the operator of the Dee open-pit mine in 1999 and initiated underground mining from the Dee Deep North deposit that same year. The Dee Mine facilities, including both the open-pit and underground mines, were closed in December 2000 and are currently in reclamation and closure. Permitted mining activities include approximately 814 acres, of which approximately 269 acres remains disturbed (BLM 2010d,e).

Storm Mine (Barrick Dee Mining Venture). The Storm decline is located within the Dee Pit approximately 10 miles southeast of the Hollister Site. Barrick developed the Storm Decline from the lowest level of the Dee open-pit in March 1999. The Storm Decline Mine was developed to explore ore bodies and identify potential gold-bearing ore reserves on the Barrick-Meridian joint-venture. It currently is used to extract ore from that joint-venture, which began commercial production in April 2007. The life of the Storm Mine project is estimated at approximately 5 more years (BLM 2010d,e).

Goldstrike Mine (Barrick Goldstrike Mines Inc.). The Goldstrike Mine (Betze/Post Project) occurs within the Lynn Creek Mining District and is located approximately 15 miles southeast of the Hollister Site. Western States Minerals initiated mining in the area of the Betze/Post Mine in 1986. BGMI acquired the mine in 1988, expanded operations, and has continued mining to the present. The Goldstrike Mine includes the Betze Pit and Meikle and Rodeo underground mines, processing facilities, WRSFs, tailings facilities, and ancillary support facilities. Current disturbances are associated with the Betze open-pit, dewatering and water treatment facilities, WRSFs, tailings facilities, roads, reclaimed leach pad, mills, processing facilities, and ancillary support facilities. Barrick dewatering operations discharge into the Boulder Valley. The Boulder Valley Monitoring Plan results are reported on a quarterly basis. This discharge was previously evaluated by BLM in the Cumulative Impact Analysis (CIA) of Dewatering and Water Management Operations for the Betze Project, SOAP, and Leeville Project (BLM 2000b). Permitted mining activities include approximately 9,062 acres of disturbance, of which all of the 9,062 acres has been disturbed. Mining of the Betze Pit is anticipated to be completed in 2015 with ore processing from stockpiles continuing through 2031 (BLM 2010d,e).

North Operations Area (Newmont Mining Corporation). The North Operations Area occurs within the Lynn Creek Mining District and is located approximately 15 miles southeast of the Hollister Site and approximately 20 miles northwest of the Town of Carlin. Newmont began its mining activities in the North Operations Area at the Carlin Open Pit Mine in 1965. The North Operations Area includes all of Newmont's mining operations located between (and inclusive of) the Bootstrap and Pete mines. Past and present mining activity in the North Operations Area includes:

- Bootstrap Mine – open-pit mining operations were initiated in 1974 and continued until 1984. Closure and reclamation were completed at the mine in 1988. Mining operations were reinitiated at the Bootstrap Mine in 1996 by Newmont with development of the Bootstrap, Capstone, and Tara gold deposits. Approximately 1,900 acres have been authorized for disturbance (BLM 2010d,e). This project is currently in reclamation and closure status. The Capstone pit was backfilled, and the site has been regraded and seeded (BLM 2011a).
- Bluestar/Genesis Project – continued mining of the Genesis area, which includes open-pit mining, sequential backfill, and increased height of existing external WRSFs. Approximately 4,739 acres would be disturbed from this mining action. Newmont began open-pit mining operations at Bluestar in 1974.
- The Exodus Underground mining operation – facilities at this site consist of open pits, underground mines, WRSF, haul roads, and surface exploration and began in 2004 (BLM 2011a).
- North Area Leach – leaching operations began in 1988. Currently, all of the 1,526 acres permitted have been disturbed. The life of this leach facility is estimated to be at least 12 additional years (BLM 2010d,e).
- Carlin Mine/Pete Project – gold was discovered in1962 and the first gold was poured in 1965. Approximately 3,673 acres have been disturbed at this site (BLM 2010c,d,e). Facilities consist of open pits, underground mines, WRSFs, tailings impoundment, haul roads, and surface exploration. The mill was demolished in 1999. The maintenance and office buildings were demolished in 2011. Life of the Carlin Mine is an additional 5 years. The Pete Project is an open pit mine expansion at the Carlin Mine (BLM 2011a). The Bajo Project is an underground mine expansion project at the Carlin Mine Project.
- Leeville Mine – Leeville began mine development and operations in 2002. Major project components include the underground mine with one hoist and one ventilation shaft and underground access; the mine dewatering system, including a water treatment facility and pipeline system to convey groundwater from the Leeville Mine to BGMI's water management facility; WRSF; access and haul roads; shipment of ore to Newmont's Mill 6 facility in the South Operations Area; and ancillary support facilities. All of the 566 permitted acres have been disturbed for this facility. The operational mine life is estimated at an additional 9 years (BLM 2010d,e).

South Operations Area Project/Gold Quarry (Newmont Mining Corporation). The South Operations Area Project (SOAP) occurs within the Maggie Creek Mining District and is located approximately 30 miles southeast of the Hollister Site. In 1979, Newmont discovered gold on their South Operations Area property. Open-pit mining began in 1980 and has expanded periodically. Newmont's SOAP consists of the Gold Quarry, Mac, and Tusc open pits; a mine dewatering, water treatment, and management system; WRSFs; tailings disposal facilities; ore processing facilities; heap leach facilities; access and haul roads; and ancillary support facilities. Dewatering and discharge activities in the Maggie Creek Basin result from Newmont's SOAP mining operation. The SOAP mitigation plan currently is in place to address potential adverse impacts from dewatering. Details of the dewatering and mitigation plan can be found in the SOAP and SOAPA EIS documents (BLM 2007a). The Gold Quarry Mine currently discharges via Maggie Creek to the Humboldt River. This discharge was previously evaluated by BLM in the CIA of Dewatering and Water Management Operations for the Betze Project, SOAP, and Leeville Project (BLM 2000b). A road connecting Newmont's North Operations Area with the South Operation Area (N-S Haul Road) was approved in 1993. The SOAP/Gold Quarry complex has disturbed approximately 9,961 acres (BLM 2010d,e).

Rain Mine (Newmont Mining Corporation). Newmont acquired the Rain claims in 1979 and conducted exploratory drilling in the early 1980s to define the gold reserves. These deposits occur approximately 10 miles south of Carlin, Nevada and include Emigrant, Gnome, Snow Peak, Southern Mineralized

Zone, Rain Extension, Tess, NW Tess, and Saddle. Mining operations were initiated at the Rain property in 1987. Mining operations consisted of open-pit and underground mining, waste rock disposal, ore processing, a tailings facility, a heap leach pad facility, and ancillary facilities. Open-pit mining at Rain continued through 1994. Underground operations began in 1994 and continued through 1998. The Rain Mine is currently in reclamation and closure phases. Permitted mining activities include approximately 961 acres of disturbance, of which all of the 961 acres has been disturbed. Mining activities have ceased at the Rain Mine (BLM 2010d,e). An additional 100 acres are reasonably expected to be disturbed at the Rain Mine facilities (BLM 2012).

Emigrant Mine (Newmont Mining Corporation). The Emigrant open-pit mine project is located within 1 mile of the Rain Mine. The BLM approved the Emigrant Mine in January 2011 that includes plans for an open pit mine, WRSF, a run-of–mine heap leach pad, and ancillary support facilities. The Emigrant Mine has an estimated operational life of 10 additional years for mining and 4 additional years of active leaching. Permitted mining activities include approximately 1,418 acres of disturbance (BLM 2010d,e).

Sand and Gravel Mines. In addition to precious metal mines, sand and gravel mines also operate in the Carlin Trend. Approximately 395 acres of private land have been disturbed by sand and gravel operations in the Carlin Trend. These operations have been used to support construction maintenance of area roads (particularly Interstate 80 [I-80] and State Highway [SH] 766) (BLM 2010d,e; Newmont Mining Corporation [Newmont] 2010 as cited in BLM 2010e).

3.2.1.2 Mine Dewatering and Discharge

Dewatering to facilitate other mining operations in the Carlin Trend has been ongoing in the vicinity for approximately 20 years. As mines have advanced to deeper levels, pump systems, dewatering wells and associated discharge systems have been installed to lower the groundwater inflow to open pits and underground workings. BLM recently evaluated dewatering and discharge activities in the Betze Pit Expansion Project Supplemental EIS (as cited in BLM 2009a) and the Leeville Project Final Supplemental EIS (BLM 2010d). Dewatering at Newmont's and BGMI's mines in the Carlin Trend is accomplished by creating a cone of depression while dewatering the area around the mine workings. Findings included:

- Dewatering and discharge activities in the Maggie Creek Basin result from Newmont's SOAP mining operation. The SOAP mitigation plan currently is in place to address potential adverse impacts from dewatering. Details of the dewatering and mitigation plan can be found in the SOAP (BLM 1993b) and SOAPA (BLM 2002b) EIS documents. The Gold Quarry Mine currently pumps water at a rate of approximately 14,000 gpm for use in mine operations, occasional storage in Maggie Creek Reservoir, irrigation, and discharge directly to Maggie Creek and ultimately the Humboldt River.
- Dewatering in the Boulder Creek area includes activities at BGMI's Betze/Post pit and underground Meikle Mine (approximately 14,500 gpm). Dewatering is managed according to a water management plan for use in mine operations, storage in a ranch reservoir, irrigation, the Boulder Valley reinjection system, the Sand Dune drainage and evaporation network and/or discharge to the Humboldt River.
- Newmont's Leeville Project dewaters approximately 13,400 gpm for use in mine operations, and the remainder is discharged to a ranch reservoir and irrigation projects through BGMI's dewatering system.
- The Hollister Development Block Exploration Project, has been permitted to pump water collected via gravity drainage and seepage in the underground exploration decline. Groundwater entering the exploration decline (up to approximately 700 gpm) is pumped to the surface and into a recycle pond for storage, reuse and infiltration into alluvium near the confluence of Little Antelope Creek and Antelope Creek.

3.2.1.3 Exploration-related Disturbance

Exploration activities within the Carlin Trend include access road and drill site construction, drilling, and trenching. Exploration operations have resulted in isolated areas of land disturbance for PoO level exploration programs, as summarized in **Table 3.2-1**. PoO level of disturbance is defined as over 5 acres of approved surface disturbance. Several Notice Level exploration operations also have existed and continue to exist within the Carlin Trend. Notice Level exploration operations are defined as creating under 5 acres of surface disturbance and expire every 2 years unless extended. Notice Level programs are closed after reclamation is complete.

3.2.1.4 Oil, Gas, and Geothermal Leases

The BLM State Office has quarterly oil and gas lease sales. The BLM Elko District Office conducts competitive oil and gas lease sales on an annual basis (BLM 2010d,e). Lease areas are designated based on a nominations process involving interested parties. After parcels of land have been nominated for a lease to the BLM State Office, the parcel of land containing a proposed lease is placed on a competitive auction for sale. Geothermal lease areas are nominated for leasing to the Nevada State Office by interested parties. After receiving nominated parcels for geothermal commodities, the Nevada State Office would hold a sale with a bidding process to lease these parcels. Currently, no geothermal leases exist in the vicinity of the proposed project.

3.2.1.5 Utilities Actions

Several rights-of-way (ROWs) exist and are permitted to various entities. Surface disturbing activities associated with most of the ROW actions pertain to transmission lines and substations, water wells and pipelines, natural gas pipelines, fiber optic lines, communications sites, and access roads. The surface disturbance associated with the existing ROWs varies for each action. Usually ROWs issued for roads are for existing roads. However, they can be issued for proposed roads. ROWs would continue to be issued in the future for activities that are developed, proposed and are required by regulation.

Present utility and community actions resulting in surface disturbance in the Cumulative Effects Study Areas (CESAs) include state, county, and public roads; the Ruby Pipeline; the TS Power Plant; transmission lines; and development primarily associated with the communities of Carlin, Elko, Spring Creek, Battle Mountain, and Winnemucca.

The Ruby Pipeline, a 675-mile natural gas pipeline was completed in July 2011 and extends from southwest Wyoming, across Utah, Nevada, and terminates near the California-Oregon border. The pipeline route is located approximately 19 miles north of the Hollister Site and was constructed within a 115-foot-wide corridor (**Figure 3.2-2**). Pipeline construction temporarily disturbed an estimated 2,300 acres along the 167-mile route within Elko County.

The TS Power Plant, transmission lines, and associated facilities are located 3 miles north of Dunphy and approximately 30 miles south of the Hollister Site in Eureka County, Nevada. The TS Power Plant is owned by Newmont's subsidiary Newmont Nevada Energy Investment, LLC. This 242-megawatt capacity coal-fired power plant became operational in June 2008 and provides power for Newmont's mining operations throughout northeast Nevada. Excess annual capacity is made available to the NVEnergy Power Company. Approximately 600 acres of surface disturbance are associated with the TS Power Plant (BLM 2007a,b).

Surface disturbance has occurred within the Carlin Trend due to transmission line upgrades and ROWs that support ongoing mining activities and municipalities in Nevada, Idaho, and California. Although there are designated ROWs associated with transmission lines, the associated surface disturbance typically is minimal (e.g., restricted to the pole locations and maintenance access, as needed). A 345-kilovolt (kV) transmission line near the RIBs transmits electricity from the Valmy Power

plant to the Coyote substation and eventually supplies power to the states of Idaho and California. The existing 120-kV transmission lines transmit electricity from the Falcon and Bell Creek substations to the Coyote substation and mine substations, which are part of the power grid for the mines in the Carlin Trend.

3.2.1.6 Other Development and Actions

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

Fuel Reduction Program

BLM has a vegetation treatment program that reduces vegetation for wildfire suppression purposes. Fuel reduction programs within the Elko District consist of creating fuel (vegetation) breaks to help manage wildfires. Fuel breaks are changes in vegetation height and/or type. Fuel breaks may include, but are not limited to, mowing vegetation, planting greenstrips, controlled burns, and treatment of noxious weeds or non-native invasive plant species. Greenstrips are vegetation planted in strips with species that are more fire resistant because they stay greener longer during the dry summer months.

Fuel reduction is used around communities to help reduce damage to property from wildfires, create mosaic vegetation patterns for wildlife habitat, create varying vegetation age classes in vegetation communities in an attempt to prevent catastrophic wildfires, remove diseased vegetation, and attempt to eliminate non-native invasive plant species such as cheatgrass.

Wildfires

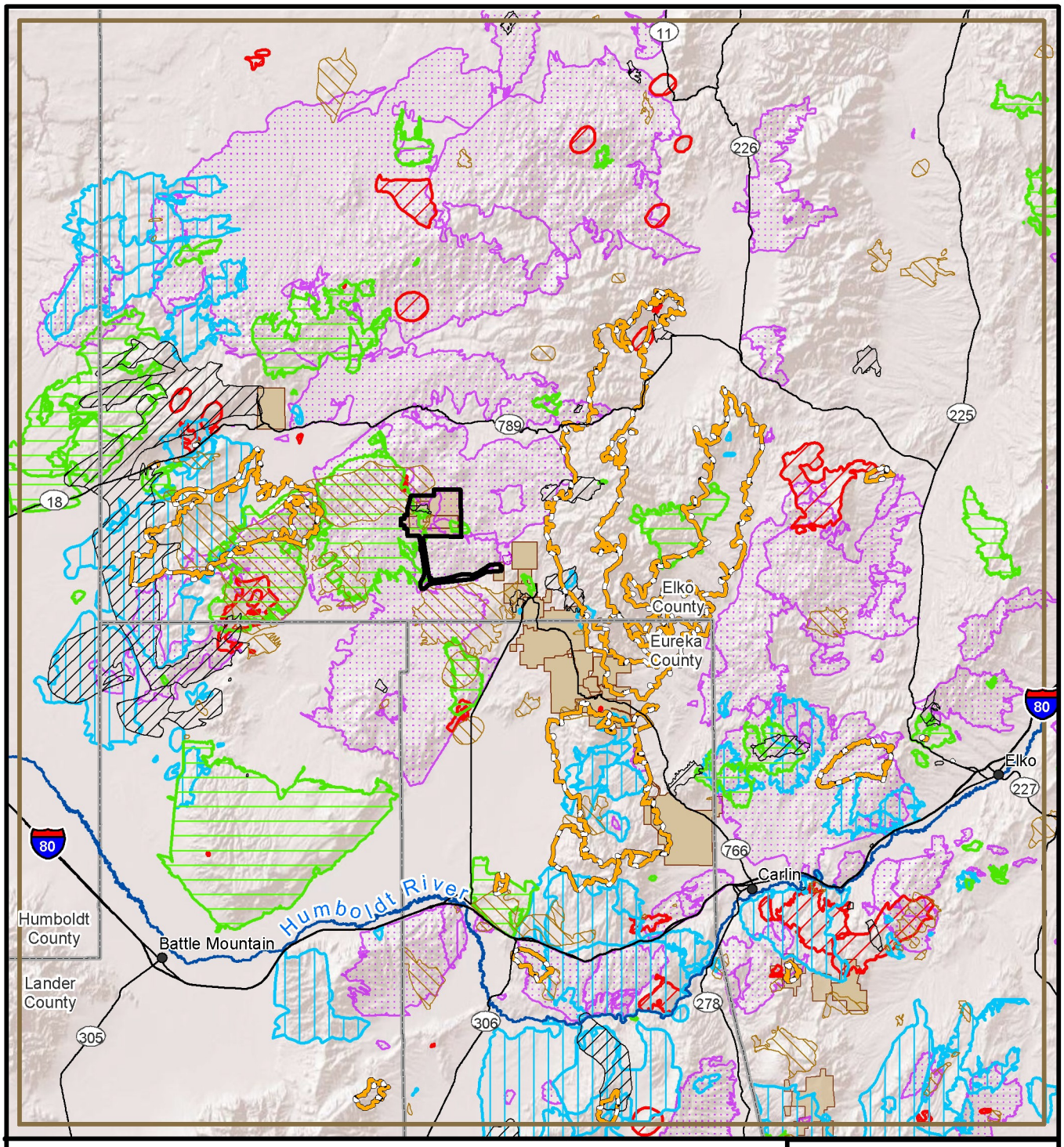
Between 1980 and 2011, approximately 47 percent (1,822,357 acres) of land containing wildlife habitat and livestock grazing range in the Carlin Trend vicinity was impacted by fire. Since then, public and private entities have worked to restore 382,787 acres of habitat for wildlife and range for livestock on areas affected by wildfire. Some tracts were allowed to revegetate naturally while critical habitat areas were re-seeded with forbs, grasses, and shrubs (BLM 2010d,e). **Figure 3.2-3** illustrates the fire history along the Carlin Trend between 1980 and 2011. Wildfires may be started by lightening or human errors and range in size from less than 1 acre to large catastrophic fires encompassing hundreds or thousands of acres. Wildfire occurrence, sizes, and locations are unpredictable and may occur on lands within the CESAs any time when conditions are favorable.

Seeding

Figure 3.2-4 illustrates the extent of BLM's re-seeding efforts on the burned areas. Three seed mixes were used to support rangeland, watersheds, and wildlife. Various methods including all terrain vehicle and harrow, drill seeding with rangeland drill, broadcast seeding with broadcaster, and aerial seeding were used to plant grass, forb, and shrub species. Shrubs also were planted in the grass and forb seeded areas to establish a mixed canopy. A total of 330,098 acres were re-seeded with the wildlife seed mix. Rangeland and watershed seed mixes were applied to 139,492 and 18,140 acres, respectively.

Wildlife Management Programs and Habitat Improvements

Several restoration projects for wildlife and riparian habitats have been implemented within the Carlin Trend area. Primary projects/programs, which resulted from mitigation from the National Environmental Policy Act analyses on mining projects in the Carlin Trend include the following (BLM 2010d,e):



Legend

- Project Area Boundary
- Mine Plan Boundaries
- Vicinity Boundary

Year of Fire

- 1980-1984
- 1985-1989
- 1990-1994
- 1995-1999
- 2000-2004
- 2005-2009
- 2010-2011

N

0 5 10 Miles

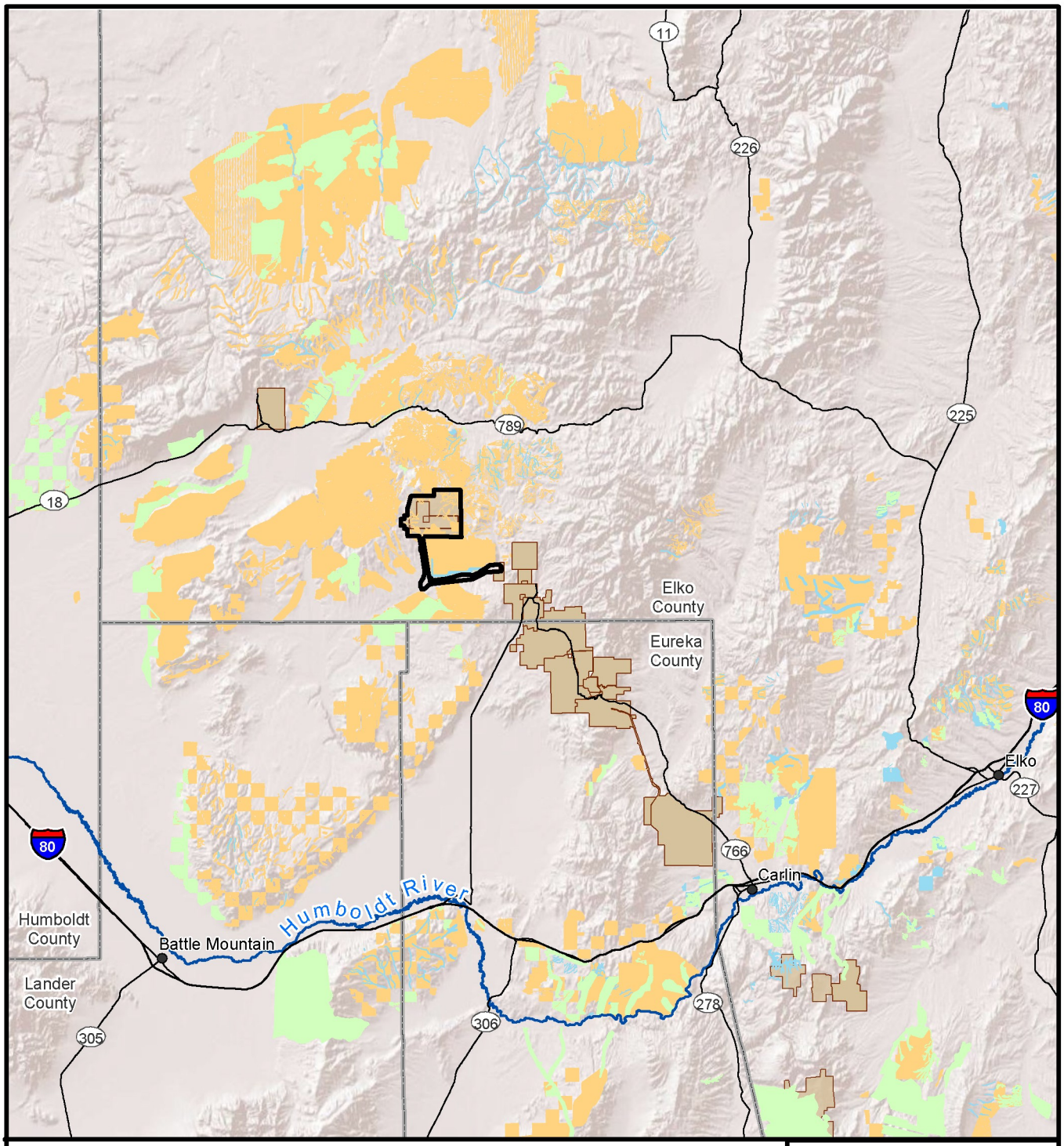
Source: BLM 2011a, 2010c,f.

Hollister Underground Mine Project EIS

Figure 3.2-3

Fire History in the Vicinity of Carlin Trend 1980-2011

3/20/2012



Legend

- Project Area Boundary
- Mine Plan Boundaries

Seeding Type

- Range
- Watershed
- Wildlife

N

0 5 10 Miles

Source: BLM 2011a, 2010f.

Hollister Underground Mine Project EIS

Figure 3.2-4

Seeding in the Vicinity of the Carlin Trend

3/23/2012

- Barrick Riparian/Wetland Conservation and Mitigation Fund – 1991 Betze Project;
- Maggie Creek Watershed Restoration Project – Mitigation Plan for 1993 SOAP;
- Mitigation Plan for 2002 SOAPA;
- Mitigation Plan for 2002 Leeville Project;
- Barrick Upper Willow Creek Habitat Enhancement Plan – Mitigation Plan for 2003 Betze Project;
- Susie Creek Riparian Restoration Project;
- Mule Deer Transition Range Seeding Project;
- T Lazy S Sage-grouse Habitat Improvements;
- 709-acre Mule Deer Habitat Improvement Project in the Sheep Creek Range;
- Carlin Trend Mule Deer Habitat Management Plan;
- Nevada Department of Wildlife (NDOW) Mule Deer Population Management Programs;
- Trout Unlimited Strategies for Restoring Native Trout Program; and Beaver Creek Riparian Pasture; and
- Barrick Springs Mitigation – 15 spring enhancement projects.

Range Improvements

Other surface disturbing activities that exist and may be constructed in the future within the CESAs are range improvements. Range improvements include fences and cattleguards; water systems consisting of spring developments, wells, pipelines, troughs, and ponds; and seedings. Fences are linear features that create small amounts of surface disturbance. Surface disturbance associated with water systems varies dependent upon the components of the specific project. Usually the pipelines are buried; therefore, the associated surface disturbance is temporary until the area has revegetated. Temporary exclusion fences may be installed for a few growing seasons while vegetation re-establishes after a wildfire, and then would be removed. Seedings are implemented to re-establish vegetation for wildlife habitat or livestock range after wildfires as well as for treatment of noxious weeds and non-native invasive plant species infestations. Disturbance from implementation of seedings is a short- or long-term disturbance lasting until such time as vegetation is successfully re-established.

3.2.2 Reasonably Foreseeable Future Actions

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

3.2.2.1 Mine-related Actions

Mining activities are expected to continue in the area in the foreseeable future. Associated mining disturbance acreages are presented in **Table 3.2-1**. Reasonably foreseeable mine development in the area includes the following:

Arturo Mine Project (Barrick Dee Mining Venture). Barrick Dee Mining Venture, a joint venture between Barrick Gold Exploration and Marigold Mining Company, a subsidiary of Goldcorp Inc., proposes to reopen the Dee Mine as the Arturo Mine Project (SRK Consulting (U.S.), Inc. 2009). This project would include the expansion of the existing open pit, new WRSFs, and a new heap leach

facility. The life of the proposed mine is estimated at 8 years and would disturb approximately 2,774 acres including additional proposed surface exploration.

Railroad-Pinon Exploration (Royal Standard Minerals). Exploration drilling for gold is expected to continue into the future in this area located approximately 15 miles south of Carlin, Nevada. Approximately 20 acres are currently disturbed out of the total 220 acres approved for exploration. Potentially, a mine could be developed on these properties pending exploration results.

Newmont Mining Corporation

- Gold Quarry – Expansion of the Gold Quarry Pit and WRSFs. Approximately 1,000 acres would be disturbed from this mining action.
- Rain Mine – Expansion of the existing open pit or underground mining activities. Approximately 100 acres would be disturbed from this mining action.
- Midas Mine – Construction of ventilation raises for the Midas Underground Mine and associated ROW for a transmission line. Approximately 80 acres would be disturbed from this mining action.
- Mike – Development and operation of gold reserves near Gold Quarry/SOAP. Approximately 100 acres would be disturbed from this mining action.

Rossi Mine (Halliburton). Expansion of the mining operations and exploration activities would disturb approximately 1,000 acres and would include increasing the size of the open pits (Queen Lode and Sage Hen deposits), WRSFs, project area, access and haul roads, and ancillary facilities.

Some mining operations in the Carlin Trend have advanced to depths that require lowering of the regional groundwater table to limit inflow to mine pits. Each of these major mine developments have installed dewatering wells or pumping systems and discharge systems to ensure mining can proceed without groundwater inflow into open pits and underground workings. Dewatering in the Carlin Trend has been ongoing for approximately 20 years and is expected to continue for the foreseeable future.

3.2.2.2 Exploration-related Actions

Exploration drilling, trenching, and road construction at current and proposed mine operations and mineral exploration projects would be expected to continue throughout the Carlin Trend. New Notice level (less than 5-acre exploration projects) may be initiated, completed, reclaimed, and closed. Existing Notice level projects may be reclaimed and closed. Notice level exploration projects are either completed or extended on a 2-year basis. Notice level exploration projects may advance to Plan of Operations level (over 5 acres of surface disturbance with no expiration).

3.2.2.3 Utilities Actions

The North Elko Pipeline Project consists of the construction and installation of a buried natural gas pipeline. This pipeline would connect in to the Ruby Pipeline and run south to the Betze/Post Project. This project would create approximately 140 acres of disturbance. This project is in the process of being permitted.

3.2.2.4 Community Actions

Individual community development activities would increase and decrease, depending upon the strength of the local economy, employment levels, and population. Development, both commercial and residential, is expected to continue at current levels in Carlin, Winnemucca, Battle Mountain, Elko, and Spring Creek.

Surface disturbance associated with residences, commercial development, and the supporting infrastructure exists in the towns of Winnemucca, Battle Mountain, Carlin, Elko, and Spring Creek. Approximately 565 acres have been platted for development in the areas between I-80 and the Humboldt River in and adjoining the Town of Carlin. Other development plans are occurring east of SH 766 near its intersection with I-80. Another 23 acres have been platted at Palisades, midway between Carlin and Dunphy. Development in the Dunphy area consists of approximately 6 acres (BLM 2010d,e).

3.2.2.5 Other Development and Actions

Wildfires

Wildfires are likely to continue in the project vicinity for the foreseeable future due to arid conditions. Prescribed burns would continue to be used to help reduce fuel loads in selected areas on public lands.

Wildlife Management Programs and Habitat Improvements

The development of wildlife management programs and habitat improvement projects include many factors, but are not limited to, size, resource damage, availability of seed for plant species, weather, equipment, implementation timing, funding, etc.

Habitat restoration activities in the area include: 1) re-seeding areas disturbed by mining activities, fire, livestock, or noxious weeds and non-native invasive plant species treatments; 2) limiting livestock access to riparian areas through strategic fencing and grazing management practices; and 3) general restoration of seeps and springs. These activities are undertaken by both private and public entities and are expected to continue and even increase within the project region in the future. Habitat restoration measures are anticipated to improve habitat for terrestrial and aquatic species, including threatened and endangered species and species of concern. Greater sage-grouse habitat restoration would continue in the project region through programs implemented by NDOW and other organizations.

3.3 Land Use and Access

3.3.1 Affected Environment

There are separate study areas for land use and access. For land use, the study area is limited to the project area (**Figure 3.3-1**), based on the limited anticipated potential extent of effects from the proposed project. The cumulative effects study area (CESA) for land use is the same as the direct and indirect effects study area and was selected based on anticipated potential cumulative effects that are confined to the project area. The study area for access includes the project area, but also includes the primary access road, Ivanhoe Road, approaching the project area and the transportation corridors for hauling ore to the mill sites (**Figure 3.3-2**). The CESA for access is the same as the direct and indirect effects study area and is based on the extent of the road access to the Hollister Site and mills. Past, present, and reasonably foreseeable future actions (RFFAs) are discussed in Section 3.2.

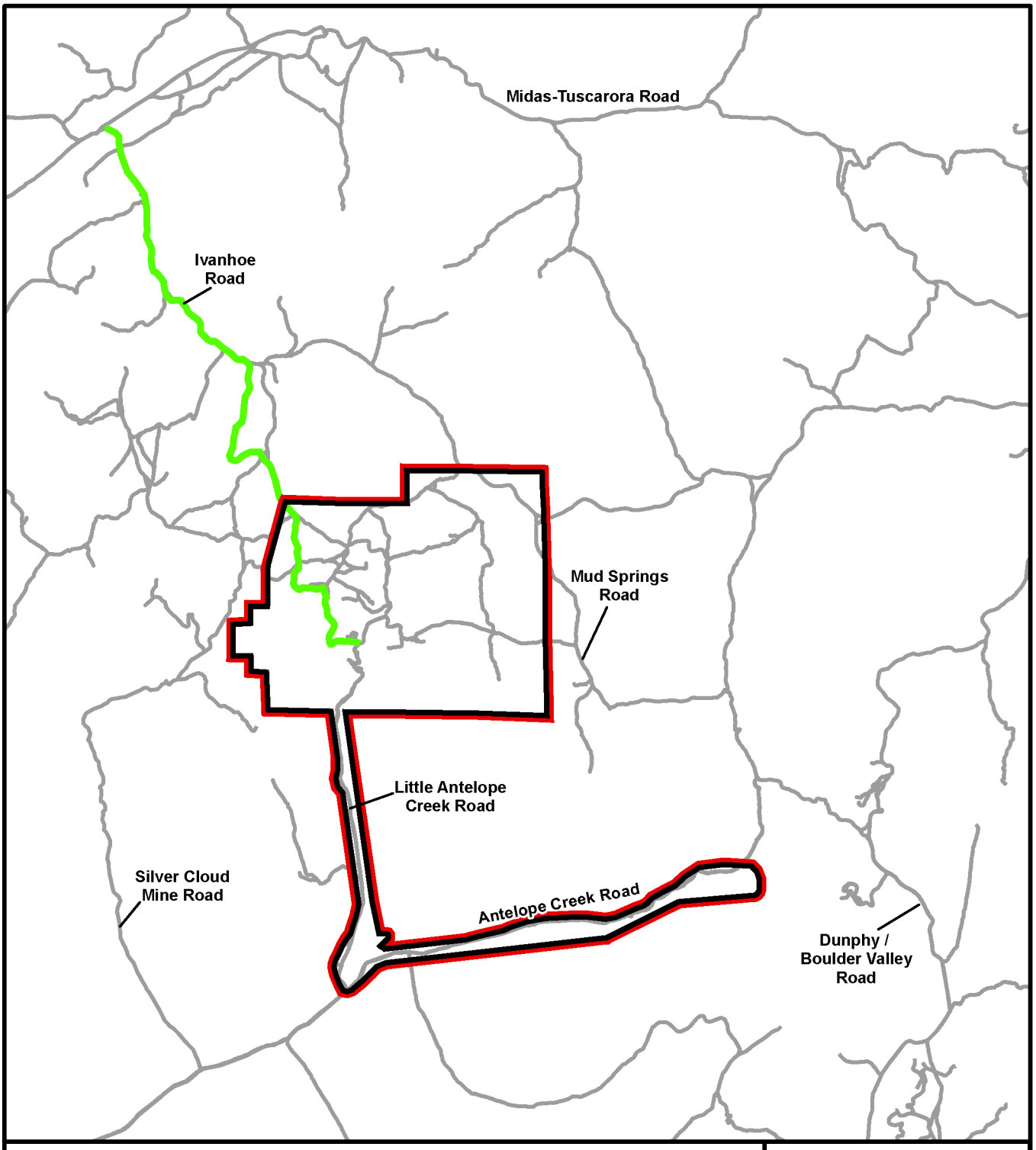
3.3.1.1 Land Use

The proposed project is located in Elko County, Nevada. Elko County is the fourth largest county in the lower 48 states with a land area of 17,181 square miles (Elko County 2008). Approximately 72.7 percent of the county is federal land administered by the Bureau of Land Management (BLM) (62.6 percent), the United States (U.S.) Forest Service (9.8 percent), the U.S. Fish and Wildlife Service (0.2 percent), and the Defense Department (0.1 percent). Although substantial, the percentage of federally administered lands is less than the 86.5 percent of the state as a whole. Tribal lands comprise 1.5 percent of the county and the state owns approximately 0.1 percent of the county. The remaining 25.7 percent of land in Elko County is privately owned or owned by local governments (Elko County 2008).

The land within the project area is mostly public land administered by the BLM Elko District, Tuscarora Field Office. There are private lands adjacent to the west edge of the project area, along much of Antelope Creek to the south, along the electric power transmission line (transmission line) corridor, and scattered in smaller parcels in the project vicinity (**Figure 1-2**). There are no state or county-owned lands in the project vicinity.

Public lands in the area are managed under the guidance of the BLM Elko Resource Management Plan (RMP). The RMP has designated project area lands "… open for mineral entry for locatable minerals …" (BLM 1987). Elko County does not have a master plan for the project vicinity. However, it has adopted the "Elko County Public Lands Policy Plan" (Elko County 2008). Among other provisions, the policy plan encourages continued mining under Policy 14-1, which states, "Retain existing mining areas and promote the expansion of mining operations and areas not specifically withdrawn" (Elko County 2008). There are no areas within the project boundary that have been withdrawn or restricted from mineral entry. Other relevant mineral policies in the plan include Policy 14-4, which encourages enforcement of reclamation standards to prevent "… undue degradation of the public lands," and Policy 14-6, which encourages that reclamation be "… consistent with the best possible post mine use for each specific area" (Elko County 2008). Elko County does not have zoning jurisdiction over public lands (Pierce-Fitzgerald 2010). Private land along Antelope Creek is zoned as open space, which would not restrict development of overhead transmission lines, but would require county approval of a conditional use permit for construction of a proposed substation (Pierce-Fitzgerald 2010).

Mining is the dominant economic use of land in the project vicinity with numerous large scale mines along the Carlin Trend from south of Carlin beyond the project area to the northwest. Livestock grazing is an established historic use in and surrounding the project area and is the dominant use in the project vicinity (see Section 3.11, Range Resources). Rangeland in the project vicinity is part of the Twenty-Five and Squaw Valley grazing allotments. There also is some hay production on irrigated

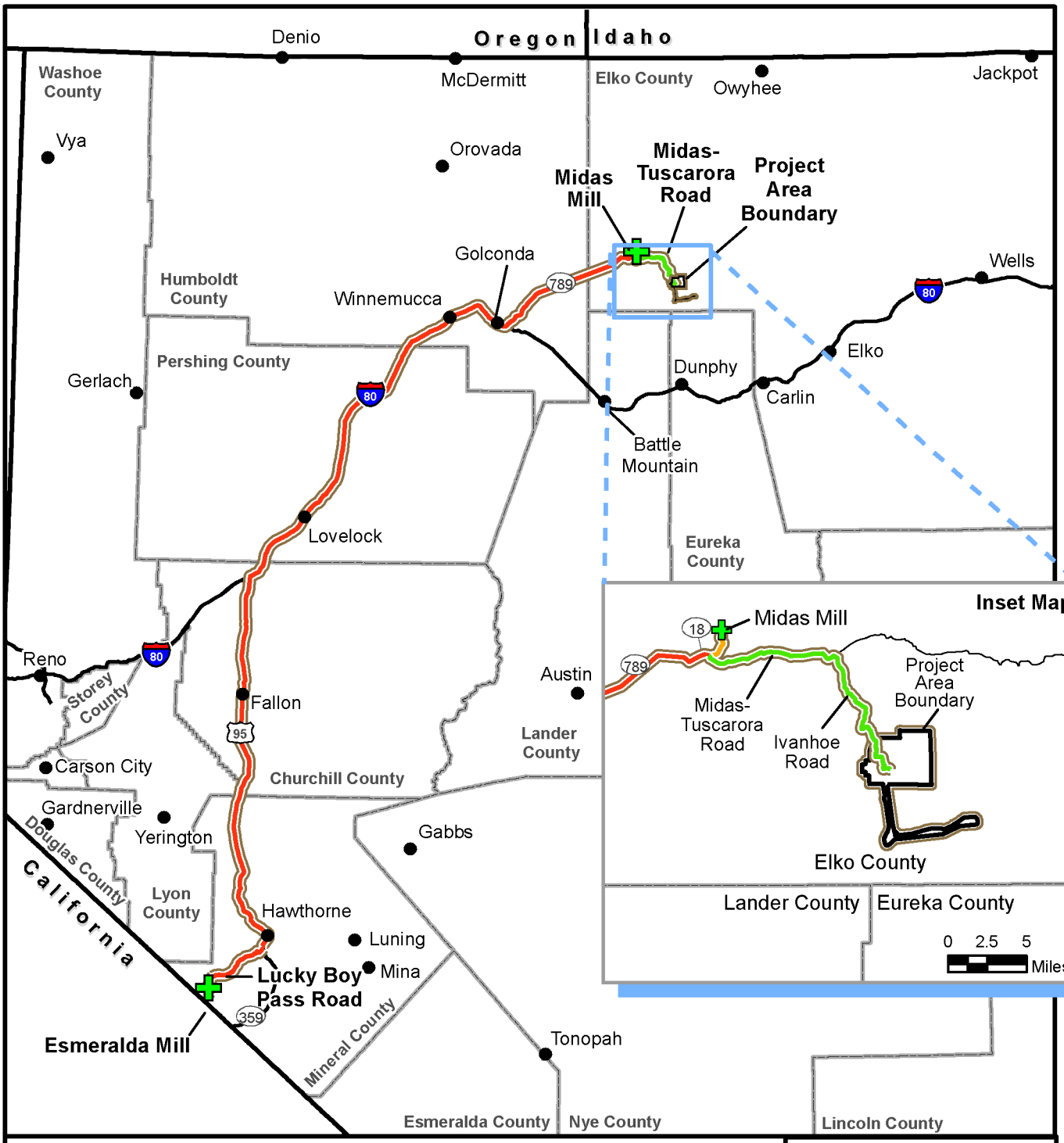


Hollister Underground Mine Project EIS

Figure 3.3-1

Land Use Direct, Indirect, and Cumulative Effects Study Area and Local and Regional Roads in the Project Vicinity

2/28/2012



Legend

- Project Area Boundary
- Direct and Cumulative Effects Study Area for Access
- Esmeralda Mill Route
- Midas Mill Route
- Esmeralda Mill and Midas Mill Routes
- Mill Site
- Nevada State Route
- U.S. Federal Highway
- U.S. Interstate Highway

N

0 20 40 Miles

Note: CESA width is not drawn to scale.
Source: RCG 2010b.

Hollister Underground Mine Project EIS

Figure 3.3-2

Access Direct, Indirect, and Cumulative Effects Study Areas

3/19/2012

lands along water courses at the Squaw Valley Ranch to the northwest along the Midas-Tuscarora Road. Additionally, dispersed outdoor recreation, including hunting, camping, limited off-road vehicle use, sightseeing, photography, hiking, rock climbing, and visiting old mining camps, occurs on a seasonal basis, although not by large numbers of people. There are no developed recreation areas in the project vicinity (see Section 3.18, Recreation and Wilderness).

There are no tribal lands within the project vicinity; although there is concern from local tribal members regarding potential sacred sites and traditional use areas in the project vicinity (see Section 3.16, Cultural Resources and Section 3.17, Native American Traditional Values). The 4,000-acre Tosawihi Quarries Archaeological District lies within the project area. Tosawihi Quarries are culturally and religiously important for the Western Shoshone. The Western Shoshone use the area as a source of spiritual power, religiously important materials, medicines, opalite, wild game, and plants (see Section 3.16, Cultural Resources, and Section 3.17, Native American Traditional Values).

The project area encompasses a total of approximately 10,168 acres, the majority of which are BLM-managed land; approximately 117 acres would be affected by the Proposed Action. Approximately 105 acres of previously authorized disturbance would bring the total Hollister disturbance to approximately 222 acres. Approximately 2.7 miles of the proposed 11.6-mile-long transmission lines would cross private land along Antelope Creek and the remainder would cross BLM-managed land. **Figure 1-2** depicts the ownership status of lands in the project area.

There are a limited number of land use authorizations and rights-of-way (ROWs) on BLM lands in the Land Use study area. **Table 3.3-1** provides specific information on the authorizations and ROWs based on review of BLM Master Title Plats and the LR2000 system (BLM 2010g). The two road ROW authorizations both refer to Ivanhoe Road (BLM Road 1065), the primary access route to the project area. The transmission line ROWs include the existing 345-kilovolt (kV) and 120-kV transmission lines that are in the vicinity of the proposed project.

Table 3.3-1 Land Use Authorizations and Rights-of-Way in the Land Use Study Area

Serial Number	Grantee	Use	Legal Description	ROW Width or Size
NVN-048616	Newmont Mining Corp.	Roads (Ivanhoe Road)	Township 38 North (T38N), Range 48 East (R48E), Section 32; and T37N, R48E, Section 5	78 feet
NVN-077637	Rodeo Creek Gold Inc	Roads (Ivanhoe Road)	T38N, R48E, Section 32; and T37N, R48E, Section 5	78 feet
NVN-007639B	Sierra Pacific Power Co.	Transmission Line (345-kV)	T37N, R48E, Sections 25, 26, 32, and 33; and T37N, R49E, Sections 16 and 21	140 feet
NVN-042788	NL Industries, Inc.	Patent Issued (mining claims located at Rossi Mine along Mud Springs Road)	T37N, R49E, Sections 21 and 22	74.9 acres
NVN-053160	Sierra Pacific Power Co.	Transmission Line (120-kV)	T37N, R49E, Sections 21 and 29	140 feet

Source: BLM 2010g.

3.3.1.2 Access

The project area is served by a sparse network of roadways typical of rural Nevada (**Figures 3.3-1** and **3.3-2**). Interstate 80 (I-80) is the primary east-west traffic artery across northern Nevada, connecting Winnemucca, Battle Mountain and Elko with Reno to the west and Salt Lake City, Utah, to the east. The project area is approximately 28 miles north of the community of Dunphy on I-80.

The primary access to the project area is via the Golconda exit on I-80, approximately 16 miles east of Winnemucca. From Golconda, State Route (SR) 789 is a paved, two-lane highway for approximately 16 miles to the Midas Road. From SR 789, the project area can be accessed using the Midas Road (22 miles), Midas-Tuscarora Road (9 miles), and Ivanhoe Mine Road (9 miles). The final three road segments are all gravel-surfaced roads with approximately 15- to 30-foot-wide travel surfaces in generally good condition, and treated with water or dust suppressants to minimize dust. Midas Road and the Midas-Tuscarora Road are typically fairly straight, with mostly mild grades and with long sight distances in most places. The Ivanhoe Road is more circuitous with fairly steep grades in some locations.

There are alternate access routes to the project area from Battle Mountain, Dunphy and Elko, although all of these routes have limitations due to poor road conditions. From Battle Mountain, the North Battle Mountain Highway, a two-lane paved road, connects to Izzenhood Road (gravel), which becomes the Antelope Creek Road (dirt) (BLM 1139) at the Rock Creek crossing. From Antelope Creek Road, access to the mine site is via Silver Cloud Road (BLM 1220) and Ivanhoe Road (BLM 1065), or via Little Antelope Creek Road (BLM 1065). Access from Dunphy follows the Boulder Valley/Dunphy Road (gravel) north to the Rossi Mine area. From there, it turns westerly onto an unnamed road, which connects to the Antelope Creek Road, and then the Mud Springs Road (BLM 1065) to the mine site. Access from Elko follows the Mountain City Highway (SR 225) to the Taylor Canyon Highway (SR 226) and the Midas-Tuscarora Road to the Ivanhoe Mine Road as previously noted. None of these alternate routes provides a quality of access comparable to the primary route because they are not useable during winter or inclement weather. The Silver Cloud Road is an unimproved dirt road with steep grades, sharp turns, and a ford at Rock Creek that is not passable during high water. The Rock Creek Road, although partially graveled, is in poor condition. The lower crossing at Rock Creek is impassible during high water. The Mud Springs Road connection to the Rossi Mine area is a dirt road in very rough condition for approximately 10 miles, although the Boulder Valley/Dunphy Road is a well-maintained gravel road in excess of 30 feet wide.

Access to the Tosawihi Quarries is provided from the Ivanhoe, Silver Cloud, and Mud Springs roads, and from the various two-track roads that occur within the quarries.

Esmeralda Mill Transportation Route

The proposed transportation route for transporting ore to the Esmeralda Mill would follow the access routes noted above to Golconda. From Golconda, trucks would follow I-80 west for 110.6 miles to U.S. Highway 95 (U.S. 95), U.S. 95 south for 104 miles to Hawthorne, SR 359 for 3.4 miles to Lucky Boy Pass Road for the final 22.4 miles to the mill. All highways from Golconda to Lucky Boy Pass Road are paved state or U.S. highways in generally good condition. I-80 is a four-lane, divided, interstate standard highway. U.S. 95 and SR 359 are at minimum two-lane, undivided highways or better. Lucky Boy Pass Road is a gravel surface road in generally good condition, comparable to the gravel roads to the Hollister Site.

The Nevada Department of Transportation (NDOT) (2009) classifies project-related roadways as follows:

- I-80 is an Interstate Highway.
- U.S. 95 is a Principal Arterial.

- SR 359 is a Rural Major Collector.
- SR 789, Midas Road, Midas-Tuscarora Road, and Lucky Boy Pass Road are Rural Minor Collectors.

Traffic is relatively light compared to road capacity on all project access roads and on the ore transport route to the Esmeralda Mill. Traffic on the gravel-surfaced county roads is mostly generated by the mines in the area and a small number of ranches, occasionally supplemented by recreation-related traffic. There are rarely, if ever, more than several vehicles per hour on these roads. Existing traffic conditions on all paved highways are at level of service (LOS) "A". I-80 carries an average of approximately 7,400 to 7,800 vehicles per day (vpd) between Golconda and U.S. 95, well below its capacity. The rural segment of SR 789 carried an average of 760 vpd in 2009, down from an estimated 900 vpd in 2008. Counts were slightly higher at 1,100 vpd in Golconda. U.S. 95 carried between 1,500 vpd and 3,100 vpd on rural segments. Counts for U.S. 95 were higher in Fallon (7,600 vpd) and Hawthorne (3,700 vpd), but the highway is four lanes wide in both communities, speed limits are lower for the urbanized areas, and major intersections have traffic controls in both communities to provide safe conditions for the higher traffic volumes. SR 359 carried 2,400 vpd in Hawthorne, but just 670 vpd between Hawthorne and Lucky Boy Pass Road in 2009. Lucky Boy Pass Road carried just 60 vpd in 2009 (NDOT 2009). Counts were not available for other county roads. There was some variability in the count data over the past 5 years, but the direction of change was not consistent for individual roadways or between roadways so there were no readily discernible trends suggesting major growth or declines in traffic in the study area.

Midas Mill Transportation Route

The Midas Mill is approximately 20 miles from the Hollister Site. Access to the mill from the Hollister Site is northwest via the Ivanhoe Road (9 miles), west on the Midas-Tuscarora Road (9 miles) and north 2 miles on a gravel road to the mill site. All roads have a gravel surface. Haul trucks would be based at the Hollister Mine site and would follow this route to and from the site.

3.3.2 Environmental Consequences

The Proposed Action or alternatives could affect land use and access both directly and indirectly. For example, direct impacts could occur if existing land uses or ROWs are terminated or modified in the project area. Indirect impacts may result in altered land use patterns to other use areas adjacent to or near the project area. Indirect impacts also would occur if the Proposed Action or alternatives stimulated or encouraged the development of land uses not presently anticipated, or conversely, precluded other planned or proposed uses.

3.3.2.1 Proposed Action

Land Use

The project area encompasses a total of approximately 10,168 acres, of which 9,301 acres are BLM-managed public lands and 867 acres are private lands. For the Hollister mine, total surface disturbance would be approximately 172 acres (not including exploration disturbance), most of which would be on public land. The proposed project would add approximately 92 acres to the previously approved disturbance of approximately 80 acres due to mining activities. Approximately 34.7 of the 92 acres would be associated with construction of the transmission lines and associated components. Of the 92 acres that would be disturbed, 51.5 acres would be new disturbance (see **Table 2-5**). Rodeo Creek Gold Inc (RCG) also is proposing 25 acres for surface exploration in addition to the previously authorized 25 acres for surface exploration dispersed throughout the project area over the course of the 20-year mine life (**Table 2-6**) for a total project disturbance of approximately 222 acres.

As previously noted, sheep, cattle, and horse grazing activities occur in the project vicinity under the grazing permits held by the Twenty-Five and Squaw Valley allotments. There is a small amount of

dispersed recreation use. Native Americans also use the Tosawihi Quarries for traditional cultural purposes (Section 3.17, Native American Traditional Values). None of these uses brings large numbers of public citizens into the project vicinity. The current use of land within the project area is low. Restrictions to the public use of the area for recreation, sightseeing, etc. would only apply to lands within the perimeter fence as well as exploration sites outside the perimeter fence while occupied by drill rigs (see Section 2.4.6.6, Site Security, Fencing, and Signs). Areas open to grazing and recreation include the surface exploration and transmission line corridor outside the Hollister Site perimeter fence.

Project-related disturbance of 50 surface acres for exploration would reduce the amount of land available for livestock grazing and dispersed recreation, although the loss would be very small relative to the amount of land available for those activities in the vicinity. The area inside the Hollister Site perimeter fence is excluded from grazing and recreation. This is the same area where the proposed mining disturbance would occur. The specifics of the loss of use and access to public lands for livestock grazing and recreation are addressed in Section 3.11, Range Resources, and Section 3.18, Recreation and Wilderness, respectively. The approximately 117 acres of proposed surface disturbance would comprise less than 1 percent of the Twenty-Five and Squaw Valley allotments. None of the proposed surface disturbance would occur on currently irrigated cropland. There would be no loss of hay production from the Proposed Action.

The proposed project would not conflict with the few existing ROWs in the project vicinity. New ROW authorizations would be required for the proposed 120-kV and 24.9-kV transmission lines. Access and use of the private land for construction and installation of the proposed transmission line is determined by the private landowner, powerline company, and the proponent of the Proposed Action. The proposed new ROWs would not adversely affect land use or power availability in the area.

Post-reclamation land use of the disturbance area would be returned to open space, grazing, dispersed recreation, and wildlife habitat. These uses would be consistent with local and BLM land use plans and guidelines. The existing East Pit topography created from historical surface mining activities would remain after reclamation of the facilities. The West Pit would be backfilled with waste rock and reclaimed. All surface disturbance proposed in this project would be reclaimed, including exploration drill sites, exploration roads, and transmission line disturbance.

Access

Five categories of traffic would be generated by the proposed project including transmission line and mine facility construction traffic, mine worker commuting traffic, general company and contractor traffic, ore hauling to an off-site mill, and material deliveries. Construction traffic would likely be a combination of medium-duty trucks for delivery and installation of poles and conductors, heavy trucks delivering construction materials and supplies, and worker pickup trucks. Mine workers living in Winnemucca would mostly commute in company contracted busses. General RCG and contractor traffic would be predominantly light traffic using automobiles and pickup trucks. Ore hauling and material deliveries would use mainly heavy trucks and tractor-trailer rigs.

Transmission line construction likely would involve small crews for several weeks. Traffic would include a few large trucks and pickup trucks commuting in the morning and evening for the brief construction period. The Little Antelope Creek Road and Antelope Creek Road may continue to receive very low level maintenance activity such as blading during transmission line construction. Effects from transmission line construction on transportation would be minor and short-term, lasting until construction is completed.

Worker commuter traffic currently consists of two busses operating at shift change times for two, 10-hour shifts per day and three vans operating at shift change times for two, 12-hour shifts per day. General company and contractor traffic includes 12 to 15 pickup trucks for staff and security personnel

operating variably throughout the day. It is anticipated that there would be very little, if any, change in traffic levels from this activity under the Proposed Action.

Heavy traffic from material deliveries to the project area consists of occasional tractor-trailer deliveries at variable times throughout the day. It is expected that this traffic would increase by a small amount for most materials under the Proposed Action. Diesel fuel deliveries to the Hollister Site would decline because most use of the generators would be replaced by the new transmission line. Material deliveries would continue to be a minor contributor to traffic on mine access routes, likely averaging fewer than one or two loads (two to four vehicle trips) in any given hour of the work day.

Little Antelope Creek Road crosses the Little Antelope Creek approximately three times within the project boundary. Increased water discharge into Little Antelope Creek via the National Pollutant Discharge Elimination System discharge described in Section 2.4.3.4, Water Management, may cause the existing low water crossings to no longer be passable, thus limiting access along Little Antelope Creek Road.

Concern has been expressed about the possibility that improved access would attract more public use of the project vicinity, which could result in adverse effects on the resources of the Tosawihi Quarries Archaeological District. The primary access route into the project area is currently in good condition, however, and no major improvements are proposed. Ongoing maintenance during the project life would sustain good access conditions, but would not noticeably improve them. Consequently, access to the area would be essentially the same as it currently is and access-related effects on the quarry resources would be minimal.

Maintenance would continue on the Ivanhoe Road. Therefore, dust suppressants and sediments may enter adjacent drainages and streams. Also, culverts may be cleaned periodically, which may temporarily cause sediments to enter drainages and streams.

Esmeralda Mill Ore Hauling

The most notable change in traffic anticipated under the Proposed Action would be an increase in ore hauling. Current ore hauling consists of 5 days-per-week trips between Golconda, where the 38-ton tractor-trailer rigs are based, and the Hollister Site, and between Golconda and the Esmeralda Mill. Between 2:00 p.m. and midnight, up to 12 trucks make empty inbound trips to the Hollister Site and loaded return trips to Golconda. Between midnight and 10:00 a.m., the 12 trucks make loaded outbound trips to the Esmeralda Mill and empty return trips to Golconda. Under the Proposed Action, ore hauling would increase to 7 days per week and there could be an increase of between 6 and 13 truck trips on each of the 4 segments of the ore hauling route, resulting in a maximum total of 18 to 25 truck trips for each travel segment each day. The four segments are Golconda to the Hollister Site; Hollister Site to Golconda; Golconda to Esmeralda Mill; and Esmeralda Mill to Golconda.

Midas Mill Ore Hauling

As an option, ore could be hauled to the Midas Mill and sold to Newmont for processing and sale to the market. Ore would be hauled in 38-ton trucks, comparable to those utilized for the Esmeralda Mill haul, from the Hollister Site to the Midas Mill. The number of truck trips per day would vary depending on contract arrangements. If RCG entered into an agreement with Newmont to have all of the ore processed at Midas Mill, there would be up to 18 to 25 truck trips per day, 7 days per week, on each of 3 route segments. The trucks would travel empty in bound from Golconda to the Hollister Site. They would travel loaded from the Hollister Site to the Midas Mill, and they would return empty from the Midas Mill to Golconda.

Highway Traffic Effects

Highway traffic effects of the Proposed Action were analyzed using techniques provided in the Highway Capacity Manual (HCM) (Transportation Research Board [TRB] 2000). The standard measure of traffic flow from the HCM is LOS for a given segment of roadway. LOS is a method of qualitatively measuring the operational conditions of traffic flows on roadways and the perception of those conditions by motorists and passengers (TRB 2000). A road's LOS is determined based on the ratio of traffic flow volumes to estimated capacity (V/C ratio). LOS is rated "A" through "F"; "A" generally represents free-flowing conditions with few restrictions, and "F" represents a "forced or break-down" flow condition with queues forming and traffic volume exceeding the theoretical capacity of the roadway (TRB 2000). Generally, LOS "E" represents a traffic volume condition at the theoretical capacity of the roadway. The performance of each relevant roadway section in the study area was determined using the HCM procedures.

Under the scenario anticipated for Esmeralda Mill ore processing, there would be up to 25 tractor-trailer trips per day in each direction on the highway segments of the transportation corridor between Golconda and the Esmeralda Mill or the same number of tractor-trailer trips to the Midas Mill on the Midas-Tuscarora Road. As previously noted, all of the highway segments currently operate at LOS A. It is unlikely that this level of traffic would occur during the peak traffic hour for most of the route; however, if it did, all of the highway segments would continue to operate at LOS "A". LOS "A" indicates traffic operates in a free flowing condition allowing individual motorists considerable freedom to maneuver and to select their desired speed; LOS "A" provides ample opportunities for passing and entering or exiting the traffic flow safely (TRB 2000). Consequently, the effects of the Proposed Action on highway traffic would be minor.

HCM procedures are not applicable to rural gravel roads so evaluating the potential effects on these roads is more subjective. Because of the shuttle system employed to transport ore from the mine to Golconda, and because the trucks run in campaigns (groups) and are not spread out throughout the day, the potential peak hourly activity would be in the range of 12 to 15 truck trips, rather than 25, or 1 truck every 4 to 5 minutes during the peak hour. At this level, given the proposed new total of 18 to 25 trips in each direction per day, and considering the very low levels of traffic on these roads currently, and the generally long sight distances along most of the route, it is expected that the effects of the Proposed Action on traffic flow and safety along the gravel-surface segments of the corridor would be minor as well.

Transportation safety concerns related to traffic generated by the Proposed Action would be minimal. Lines of sight at intersections are unobstructed and sight distances are ample. Development of the proposed project would have no effect on the physical characteristics of the major intersections or the geometry of roadways. The increase in traffic would be modest, remaining well within the capacity of the roadways. The mix of heavy vehicles in the traffic stream would increase slightly, but not substantively. As such, any increase in the risk of traffic accidents would be minor and proportional to the overall increase in traffic.

The low level of maintenance proposed for Little Antelope Creek Road and Ivanhoe Road over short distances would make access slightly better, but would not likely result in more than very minor changes to access patterns or traffic levels in the area.

3.3.2.2 Mud Springs Road Transmission Line Alternative

The Mud Springs Road Transmission Line Alternative would be essentially the same as the Proposed Action except that the transmission line would be slightly shorter. The transmission line construction period would be slightly shorter. Construction access via Mud Springs Road would be necessary and would most likely require maintenance, which could impact cultural resources. For the North Option, approximately 9.5 fewer acres would be disturbed. For the South Option of the Mud Springs Road Transmission Line Alternative, 15.2 fewer acres would be disturbed. Most of the disturbance for either

transmission line alternative is associated with short-term vegetation compaction on construction and access roads. Compared with the Proposed Action, effects on land use and access/transportation would be essentially indistinguishable from those of the Proposed Action.

3.3.2.3 Mud Springs Waste Rock Storage Facility Alternative

Construction of the Mud Springs Waste Rock Storage Facility (WRSF) and ancillary facilities would increase surface disturbance by approximately 21 acres compared with the Proposed Action; 90 percent of the disturbance would be on previously undisturbed land (**Table 2-9**). This would be a long-term, but minor increase in disturbance in the context of the overall study area. All other effects on land use and access would be the same as described for the Proposed Action.

3.3.2.4 Backfill Alternative

Under this alternative, a small increment – less than 2 percent – of the waste rock from the proposed West Pit or existing WRSF would be transported to the Hatter production shaft and the East and West raises to backfill the shaft and raises as part of the reclamation and closure process. There would be a total of 10.6 acres of additional surface disturbance associated with this alternative. In the context of the study area, the short-term effects on land use would be effectively indistinguishable from the effects of the Proposed Action. Traffic and access activities associated with this alternative would occur entirely within the project area on existing roads and modestly upgraded two-track access routes to the raises. There would be no additional effects on traffic or access outside the project area. Effects within the project area would occur during reclamation of the proposed project and would be essentially unnoticeable to the general public.

3.3.2.5 No Action Alternative

Under the No Action Alternative, BLM would not approve the proposed project. RCG would continue to conduct surface and underground exploration and bulk sampling under the current mine exploration permits and approvals as authorized by the BLM and State of Nevada. Reclamation and closure of the existing Hollister facilities would proceed under the current schedule.

Land Use

Under the No Action Alternative, 77.4 acres of disturbance have been approved for bulk sampling and testing activities. This disturbance is on-going and would continue to be permitted under the existing Environmental Assessment (BLM 2004a). Surface exploration would continue with the current level of 25 acres of surface disturbance occurring from the combination of the Craig (5 acres) and Hatter (5 acres) Notices and Ivanhoe Surface Exploration Plan of Operations (15 acres) areas.

Access

Most, if not all, of the traffic associated with the No Action Alternative is already occurring on the local road network from Ivanhoe Road to Golconda at I-80 and from there to the Esmeralda Mill in Mineral County. The traffic is being accommodated with no measurable adverse effect on the roads beyond regular maintenance, and all roads are well within their capacities to accommodate traffic. Public access to public lands is not restricted, except inside the perimeter fence of the Hollister Site. The effects of the No Action Alternative on land use and access in the project area would be minor.

3.3.3 Cumulative Impacts

The CESAs for land use and access are shown in **Figures 3.3-1** and **3.3-2**, respectively. The past, present, and RFFAs are described in Section 3.2. **Table 3.2-1** identifies the mining and exploration projects and their associated acreages. Mining and exploration projects, Ruby Pipeline, and transmission lines are shown in **Figure 3.2-2**. It would be impractical to identify all past and present actions and RFFAs utilizing the major highway system between the project site and the Esmeralda

Mill. As discussed in Section 3.3.1.2, Affected Environment, the addition of ore haul traffic to the Esmeralda Mill resulting from the Proposed Action would not degrade LOS on these highways. Consequently, no cumulative impacts have been identified for the Esmeralda Mill ore haul corridor.

Past and present actions on the Carlin Trend have an approved mining, mineral exploration, and energy development (pipelines) surface disturbance of 45,257 acres. RFFAs would disturb an estimated additional 5,386 acres from mining, mineral exploration, and pipeline construction activities for a total of 42,817 acres of disturbance. Approval of the Proposed Action would add an increment of approximately 117 acres (including 25 additional acres of exploration) to the disturbance for a total of 45,374 acres, a 0.3 percent increase over past, present, and reasonably foreseeable disturbance.

Wildfires and wildlife/habitat management activities add a substantially greater disturbance acreage (1,822,357 acres) but wildfires in particular are uncertain except to assume that they would continue and are part of the natural process of the high desert ecosystem. Fire suppression activities to wildland fires in the vicinity of the proposed project would temporarily increase traffic on the access roads and increase the number of people working in the areas to fight a fire, which would continue until a wildland fire was extinguished. Increased traffic on roads could cause damage to dirt and gravel roads, increasing the need for maintenance. Any such damage would be minor to the graveled roads because fires would be unlikely when roads are soft from spring thaw or precipitation events. In some soils that consist of mostly clay material, damage to roads can be severe under dry conditions. These roads have a tendency to cause the soil particles to break apart during heavy travel creating a “powdery” material. These road conditions can become impassable, causing roads to widen or new travel paths to develop, increasing surface disturbance.

The foreseeable improvements in range and habitat restoration would be expected to improve the economic viability of ranching in the CESA, partially offsetting the losses of grazing land from mineral development.

Traffic generation data from the approved and reasonably foreseeable mineral development activities are unknown. However, most of these actions previously have been approved or are affiliated with existing mining operations. Consequently, it is assumed that most of the traffic that could be anticipated is currently on the road system. Based on this assumption and the substantial unused capacity on CESA roads and highways, it is expected that cumulative effects on traffic flow and safety would be essentially undetectable.

Improved road conditions may allow better access for Native Americans to Tosawihi Quarries resulting in an increase in its use. There would be minimal improvements, if any, to road conditions from the Proposed Project, however, such project-related cumulative effects would be minimal as well.

Cumulative impacts to land use and access under the other action alternatives would be essentially the same as cumulative impacts of the Proposed Action with the following exceptions:

- Mud Springs Road Transmission Line Alternative – a 9.5- and 15.2-acre decrease in cumulative land use disturbance including North and South Options, respectively.
- Mud Springs WRSF Alternative – a 21-acre increase in cumulative land use disturbance constituting an increase of 0.05 percent over past, present, and RFFA disturbance.
- Backfill Alternative – a 10.6-acre increase in cumulative land disturbance constituting an increase of 0.03 percent over past, present, and RFFA disturbance.

3.3.4 Potential Monitoring and Mitigation Measures

LU-1

Issue: Low water crossings may be made impassable as a result of the Proposed Action's water discharge into Little Antelope Creek and Antelope Creek.

Monitoring/Mitigation Measure: If the water discharge into Little Antelope Creek causes the low water crossings to become impassable along the Little Antelope Creek Road and at the intersection of the Little Antelope and Antelope Creek roads or the Antelope Creek – Silver Cloud road crossing, which is within the maximum extent of the 10-foot groundwater drawdown contour, then RCG would install culverts that are fish-friendly at each crossing that is no longer drivable or passable by vehicle.

Effectiveness: In the event that the additional water discharge rendered the Little Antelope Creek Road, Little Antelope Creek-Antelope Creek crossing, or Antelope Creek -Silver Cloud crossing inaccessible, placing fish-friendly culverts on the road crossings would maintain their accessibility with a vehicle and allow for aquatic species to move up and down the stream channels.

3.3.5 Residual Impacts

All surface disturbance would be reclaimed after mine operations have been completed except for the BLM-designated roads (e.g., Ivanhoe and Little Antelope Creek roads), and the land would be returned to pre-project uses including grazing, dispersed recreation and wildlife habitat. Consequently, there would be no residual land use effects from the project. Upon completion of mining and reclamation, there would be no project-related traffic or road maintenance so there would be no residual access effects from the proposed project.

3.4 Geology and Minerals

3.4.1 Affected Environment

The study area for geology and minerals includes the project area, and transmission line analysis corridor (**Figure 3.4-1**). The cumulative effects study area (CESA) for geological and mineral resources is shown on **Figure 3.4-2** and is essentially the Carlin Trend north of Interstate 80 (I-80). The CESA extends from Newmont's Gold Quarry/South Operations Area Project in the south to the Midas Mine in the north to include mining and mineral exploration (exploration) activity in the Carlin Trend. Past, present, and reasonably foreseeable future actions (RFFAs) in the CESA are described in Section 3.2. **Figures 3.2-1** and **3.2-2** illustrate the mining and mineral exploration along the Carlin Trend. The CESA chosen provides an adequate area of analysis in which to compare the relative effects of the Proposed Action to overall mining activity in the Carlin Trend. Within the CESA, there are projects and activities not related to mining and include community development and wildfire management programs, as described in Section 3.2.

3.4.1.1 Physiography and Topography

The proposed project is located in the northern part of the Great Basin section of the Basin and Range Province (Fenneman and Johnson 1946). The Basin and Range is typified by northeast to southwest trending mountain ranges and intervening valleys, the Great Basin being characterized as generally having internal drainage. The project area is located in the northern portion of the Sheep Creek Range, which trends northeast-southwest. The Sheep Creek range is somewhat diffuse and is 25 miles wide and 50 miles long. The topography consists of rolling hills and cone-shaped rounded buttes. Little Antelope Creek drainage cuts through the project area in a generally north-south direction. In the Hollister area, the topography consists of rolling hills, drainages, rock ledges, and outcrops. It is somewhat rugged with elevations ranging from 5,400 to 7,000 feet above mean sea level.

3.4.1.2 Stratigraphy

The geologic units in the project area range from Paleozoic to Recent (**Figure 3.4-1**). The major rock units are shown in **Figure 3.4-3**. The oldest rocks that outcrop in the area are part of the Ordovician-age Vinini Formation, which is composed of quartzite, chert, and argillite (Wallace 2003a). The formation is characterized by repeating, coarsening-upwards sequences of orthoquartzites, muddy quartzites, sandy argillites, and bedded to laminated argillites. Minor calcareous siltstone and sandstone are present in some of the fine-grained facies of the Vinini Formation (Oelofse et al. 2009). The Vinini Formation sediments have undergone a very low grade metamorphism in the Hatter Expansion area. The Vinini Formation also has been altered by the heat of one or both of two Tertiary intrusive bodies. The alteration has changed the character of the Vinini Formation argillites to hornfels, a hard metamorphic rock that exhibits brittle deformation (Brown and Caldwell 2010a). The Vinini Formation was deposited in a subsiding marine basin, but the thickness of the formation is difficult to determine because the rocks have been deformed and folded and there are limited exposures of the entire stratigraphic section. Estimated thicknesses have ranged from 500 to 6,000 feet in various places in northern Nevada (Western Cordillera 2006). In the project area, the Vinini Formation may be up to approximately 5,000 feet thick (Rodeo Creek Gold Inc [RCG] 2011b), but there are limited outcrops in the northeastern portion of the Willow Creek Southeast Quadrangle (Oelofse et al. 2009; Wallace 2003a). The Vinini Formation is primarily in the subsurface in the study area and also is the host rock for the gold mineralization that is the objective of the proposed mine. The Roberts Mountain Thrust forms the base of the Vinini Formation and below the thrust are the Devonian Rodeo Creek and Roberts Mountain Formations (**Figure 3.4-4**). The Vinini Formation is characterized in the project area as having sheeted breccia zones that are indicative of Paleozoic deformation (Wallace 2003a).

Along the eastern reaches of the Mud Springs Road, there are exposures of a unit called the Slaven Chert, which is Devonian and is a ridge-former due to its resistance to erosion (Theodore et al. 2006). The Slaven Chert consists of alternating beds of chert and black shale, the layers being a few inches thick. The unit is often highly contorted and fossil evidence indicates it was deposited in a deepwater environment. In places the Slaven Chert is so deformed that it is described as a mélange, a descriptive term for a mappable unit that has been squeezed and contorted and which may contain fragments and blocks of rocks from other formations.

Another Paleozoic unit that outcrops in the project area is Strathearn Formation, a chert-pebble conglomerate that occurs in discontinuous outcrops east of the mine area and north of the Mud Springs Road and is estimated to be late Pennsylvanian to early Permian in age (Theodore et al. 2006). The Strathearn Formation (Late Pennsylvanian and Early Permian) consists of poorly exposed rocks 1.0 and 2.0 miles east of the project area (Theodore et al. 2006) (**Figure 3.4-1**). The lower part of the formation outcrops in the area and it is described as a poorly sorted chert-pebble conglomerate, with many of the pebbles and clasts derived from the Vinini Formation.

The majority of rocks primarily exposed in the project area are Tertiary igneous rocks. The oldest of the Tertiary igneous rocks are found in the Hatter Stock, an intrusive body of Eocene age composed of granodiorite-dacite (Wallace 2003a). The Hatter Stock is located about 3 miles east of the Hollister Site, but surface evidence is limited to float (isolated blocks of displaced rock). Geophysical data show a strong positive aeromagnetic anomaly in the location of the stock. Drilling data have further defined the limits of this igneous body.

At the base of the Tertiary volcanic rocks (volcanic rocks) and between the volcanic rock and the Vinini Formation is a tuff unit that has been altered to clay. The clay alteration zone is present near the base of the existing East and West pits and has been found in borings around the Hollister Site. This zone of clay alteration provides a low-permeability zone with respect to vertical groundwater flow (Brown and Caldwell 2011a).

Most of the igneous rocks in the vicinity of the Hollister Site are Miocene volcanic rocks consisting of tuffs, tuffaceous sedimentary rocks, andesite, and rhyolite. The Miocene rocks cover most of the surface of the study area and form a layer over the Vinini Formation that is approximately 600 to 700 feet thick (Oelofse et al. 2009). In the Hollister area, the Miocene rocks are much thinner, approximately 250 to 500 feet thick, and the top of the unconformity between the Vinini and Miocene rocks is exposed in the mine pit (RCG 2009a) (**Figure 3.4-4**).

In the Willow Creek Southeast Quadrangle, Wallace (2003a) has divided the tuffs and tuffaceous rocks on the basis of whether they occur north or south of Antelope Creek. The tuffaceous rocks on the south side of Antelope Creek appear to be directly correlative with the Carlin Formation to the east, but the apparent equivalents to the north of the creek are poorly exposed, so conclusive correlation is not possible. The Carlin Formation rocks consist of an upper member of sandstone and siltstone beds of reworked ash in part. There is a lower member composed of non-welded to partially welded ash-flow tuff. In addition, the lower member has tuffaceous rocks that were deposited in water or by wind.

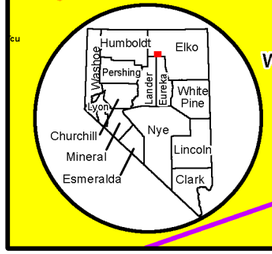
North of Antelope Creek, the tuffaceous rock sequence has been divided into upper, middle, and lower units (Wallace 2003a,b). The rocks appear to represent continuous sedimentation and in part are very similar to the Carlin Formation on the south side of the creek, but poor exposures prevent definitive correlation. Increasing thickness of tuffaceous rocks to the west of the project area indicates a westerly, highland source that shed material in an easterly direction into lower lying areas. To the east of the Willow Creek Southeast Quadrangle, the Miocene tuffaceous rocks are mapped as Carlin Formation regardless of location (Theodore et al. 2006).

X:\0Projects\60137_424_Rodeo_Creek_Gold_Hollister\Figures_DEIS\Figure_3-4_1_Geology.mxd

Ivanhoe Road
Proposed NPDES Surface Discharge
Proposed Mine Office Complex
West Pit
East Pit Facilities
Proposed HPS
Transmission Line Analysis Corridor
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
East RIB
Proposed Rodeo Creek Substation
West RIBs (2)
Antelope Creek Road
Proposed 120-kV Transmission Line
Mud Springs Road
Coyote Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
A
A'

Geologic Units

- Qu - Alluvium, undivided
- QTgc - Gravel terraces and poorly exposed Carlin Formation
- Tvu - Tertiary volcanics, undivided
- Tcr - Craig Rhyolite (Miocene)
- Trp - Rhyolite Porphyry (Miocene)
- Tri - Rhyolite intrusions (Miocene)
- Trv - Rhyolite Velvet Area (Miocene)
- Tdh - Dacite (Eocene)
- Ttsm - Tuffs and tuffaceous sedimentary rocks
- Tcu - Carlin Formation, sedimentary and volcanic rocks, undivided
- Dsc - Slaven Chert (Ordovician)
- Du - Devonian rocks, undivided
- Ov - Vinini Formation (Ordovician)
- PIPs - Pensylvanian-Permian Strathearn Formation
- dmr - Mining disturbance
- Water



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Geologic Information

- Geologic Fault
- Cross Section

Source: Theodore et al. 2006; Wallace 2003a,b.

N

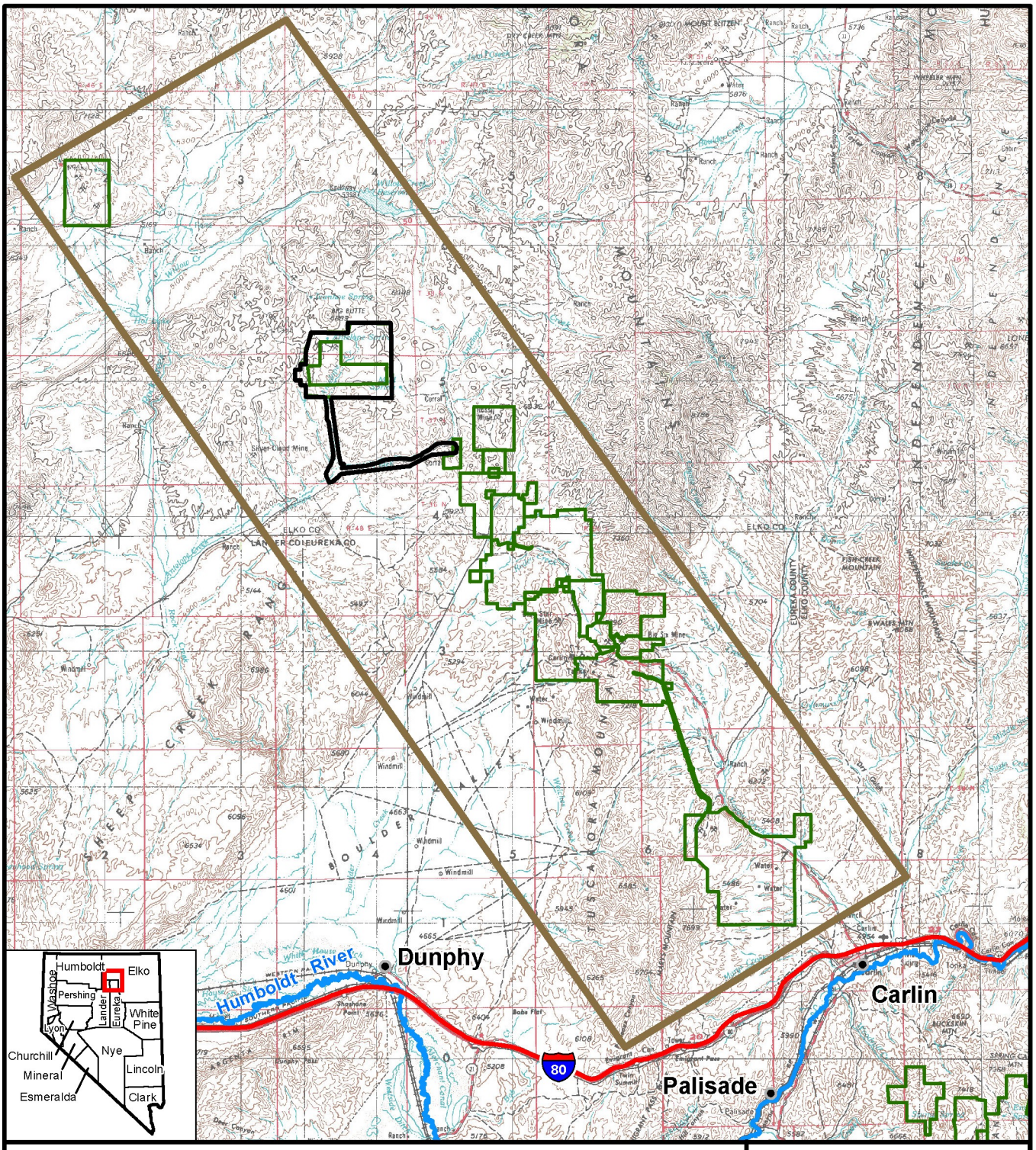
0 0.45 0.9 Miles

Hollister Underground Mine Project EIS

Figure 3.4-1

Geology in the Study Area and Vicinity

3/1/2012

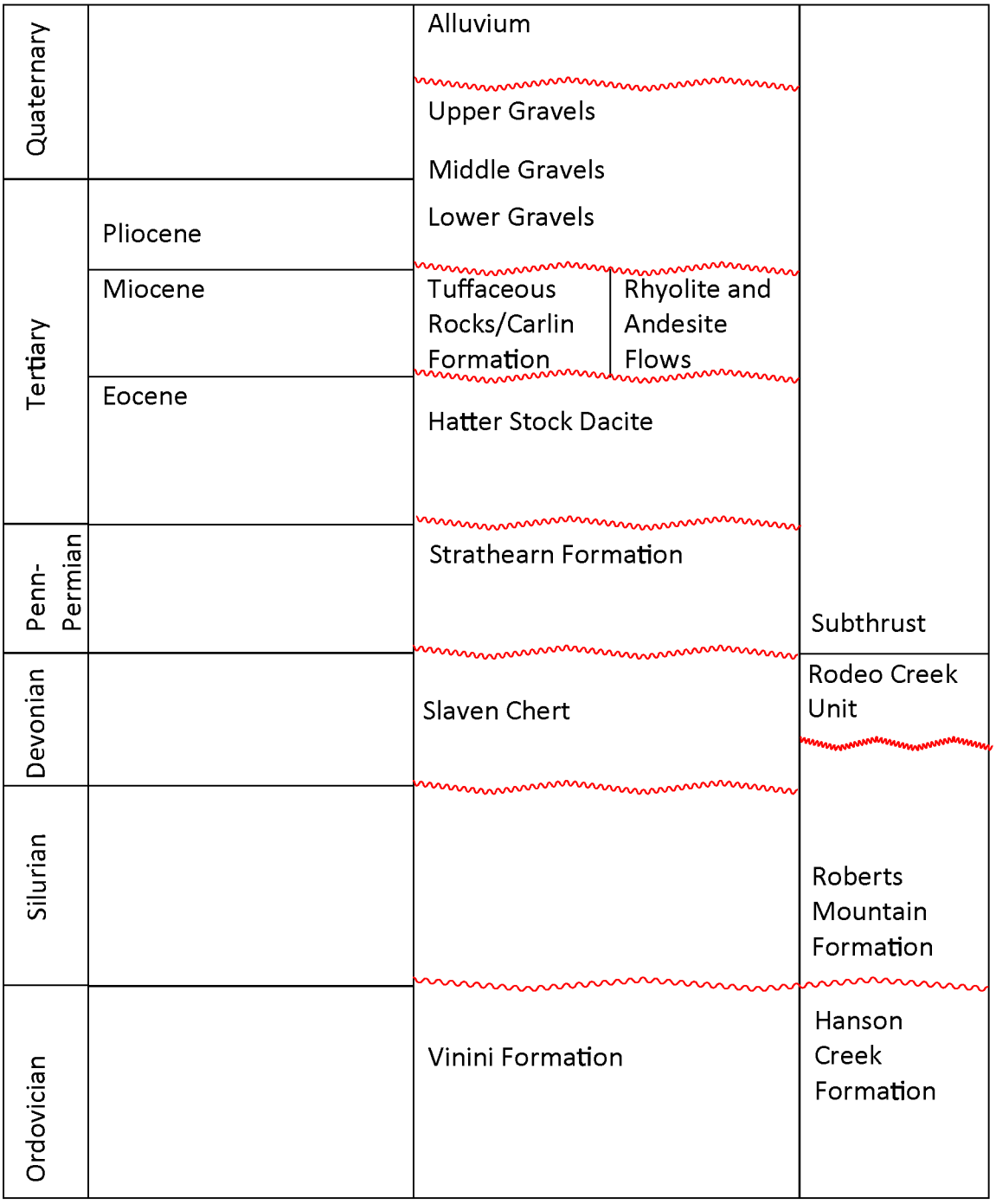


Hollister Underground Mine Project EIS

Figure 3.4-2

Geology and Minerals Cumulative Effects Study Area

05/10/2011



Unconformity

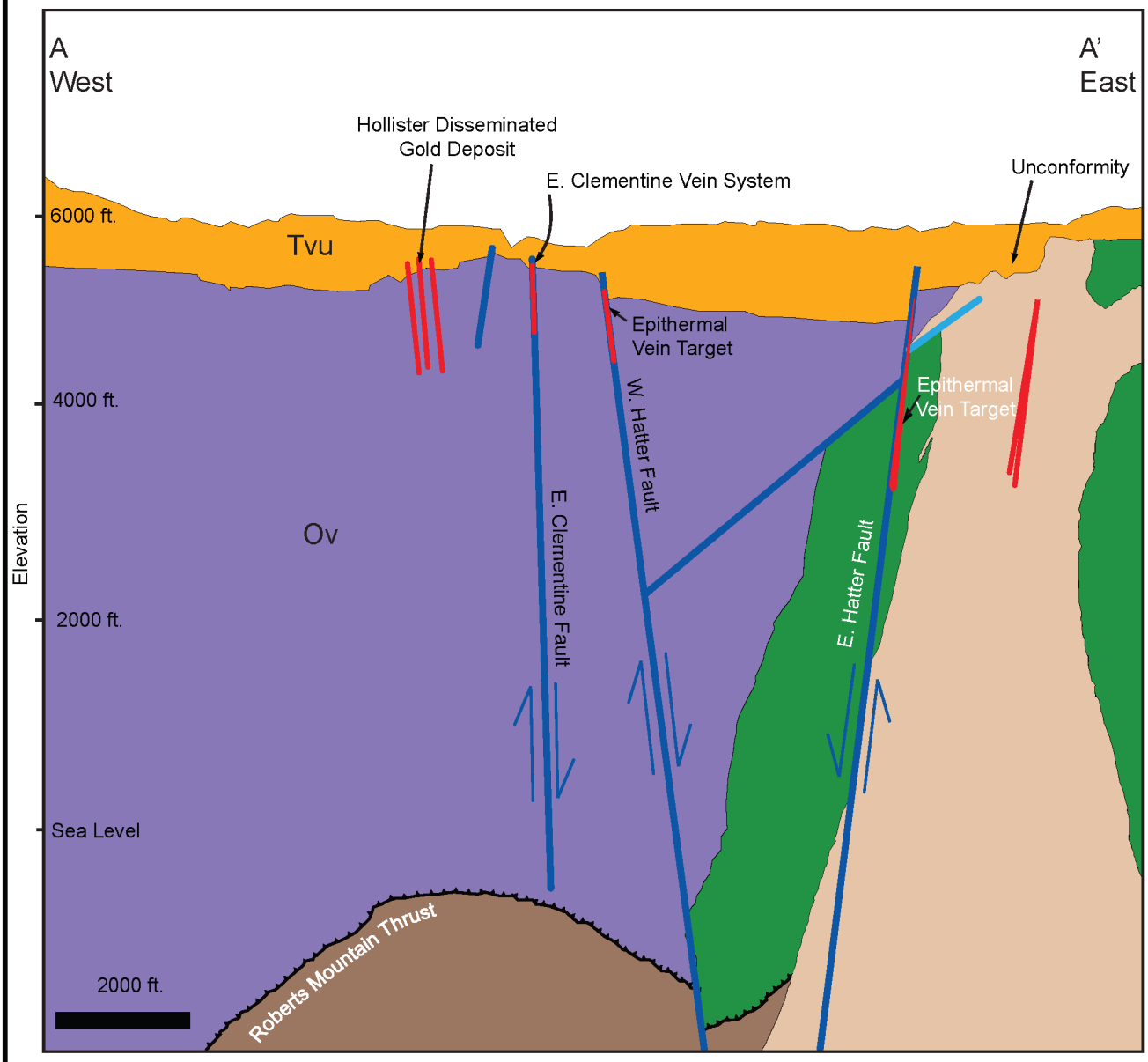
Hollister Underground Mine Project EIS

Figure 3.4-3

Generalized Stratigraphic Chart, Hollister Area

Source Oelofse et al. 2009; Theodore et al. 2006; Wallace 2003a.

03/19/12



Legend

- Ov - Vinini Formation (Ordovician)
- Hornfels Metamorphic Rocks
- Rodeo Creek Unit (Devonian)
- Hatter Stock (Eocene)
- Tvu - Tertiary Volcanic Rocks Undivided
- Veins

Note: The cross-section A-A' is shown on Figure 3.4-1.
Source: RCG 2011b.

Hollister Underground Mine Project EIS

Figure 3.4-4

Schematic Cross-section of the Hollister Area

03/19/12

The other volcanic rocks in the area consist of andesite and rhyolite deposited as lava flows. Just to the east and southeast of the mine site is a flow called the Craig Rhyolite, which extends for about 7 miles from the Hollister Site in a generally easterly direction (Theodore et al. 2006; Wallace 2003a). The rhyolite is 600 feet thick and contains flow units of variable thickness. North of the Hollister Site, rhyolite porphyry is present that forms distinct dome-like features, the best example of which is Big Butte. Another rhyolite flow, the rhyolite of the Velvet area, is a separate flow identified northeast of the Hollister Site and overlaps the Craig rhyolite. Andesite flows occur within and west of the mine area and reach a thickness of more than 300 feet (Wallace 2003a). The andesite is poorly exposed and is highly weathered in places.

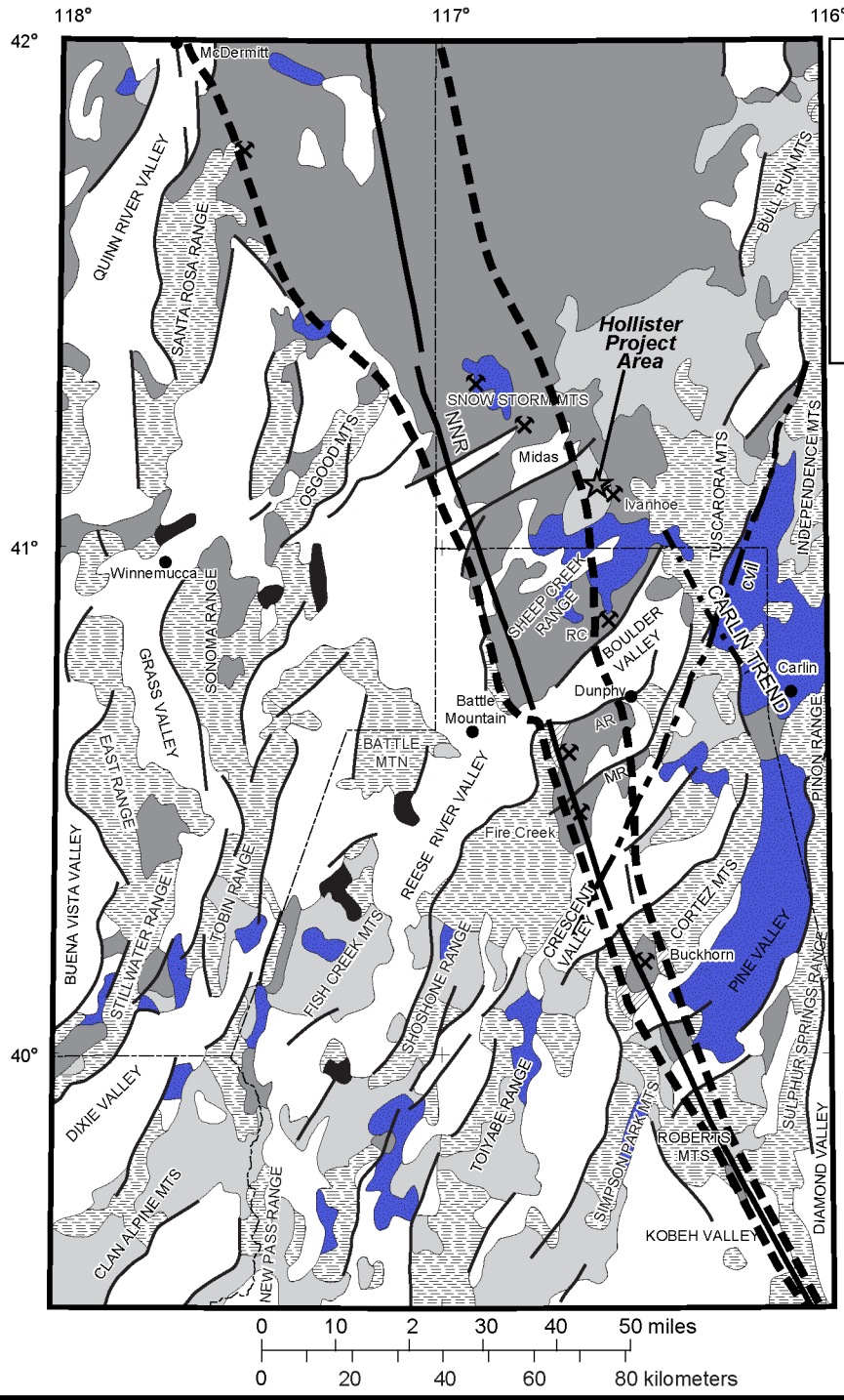
The youngest deposits in the area consist of probable Pliocene-Pleistocene gravels and Recent alluvium. The gravels have been subdivided by Wallace (2003a) into three units; lower, middle, and upper. The gravel units are generally composed of unconsolidated and poorly sorted fanglomerate deposits that occur on pediment surfaces south of Antelope Creek. Alluvium is generally found along the Antelope Creek and Little Antelope Creek drainages and is composed of unconsolidated and poorly sorted silt, sand, and gravel. Older alluvium deposits also are present in these drainages and occur as terraces 3 to 6 feet above the creeks.

3.4.1.3 Structure

The Carlin Trend, including the Hollister Site, is astride the suture zone at the Western edge of the Paleozoic North American continent. During the Early Paleozoic, this area lay near the continental shelf with shallow water shelf assemblage (predominantly) carbonates being deposited toward the continent, to the east, and continental margin, slope, and rise (predominantly) siliciclastics being deposited oceanward, to the west. Early Mississippian mountain building activity, termed the Antler Orogeny, thrust the deep water siliciclastics over the shallow water carbonates. During and subsequent to its emplacement, the allochthon (a geological formation not formed in the region where found and moved to its present location by tectonic forces) formed a highland which shed siliciclastics into the foredeep to the east. The allochthon was progressively eroded and by Late Mississippian it was covered by a shallow-water overlap assemblage. The Roberts Mountain Thrust is a thrust zone containing a series of thrust faults (McFarlane 1991) (**Figure 3.4-4**). The direction of movement was from west to east. In the project area, the Vinini Formation is on the upper plate and the thrust fault is the base of the formation. The thrust fault moved the older Ordovician Vinini Formation rocks over the younger Devonian Rodeo Creek Formation (Oelofse et al. 2009).

After the Antler Orogeny, there is little or no evidence of major tectonic events in the project area until the Miocene (Stewart 1980; Wallace 2003a). West of the Hollister Site, there are northwest and northeast striking normal faults that are consistent with crustal extension that began about 15 million years ago during the Miocene. Vertical displacement along the faults is less than 1,000 feet and fault blocks tend to tilt towards the east. The faulting and volcanism during the Miocene is related to a feature called the Northern Nevada Rift, a zone of faulting and volcanic activity that is 30 miles wide and 110 miles long and extends from Midas north of the project area to the north end of the Roberts Mountains (**Figure 3.4-5**) (Western Cordillera 2006). Although the project area is east of the defined rift area, the volcanic rocks and faulting are similar to areas inside the defined rift zone (John et al. 2000). The project area also is at the northern end of the Carlin Trend, a nearly 40-mile northwest-southeast trending group of mineral deposits generally characterized by gold deposits hosted in a variety of Paleozoic sedimentary rocks (Teal and Jackson 2002). The Carlin Trend, aside from the mineralization that is present, could be defined by structural features including high-angle northwest and northeast trending faults, anticlinal folds in the Paleozoic rocks, and collapsed breccia bodies.

The Sheep Creek Range is an uplifted block that tilts slightly to the east and was formed during Basin and Range faulting in the late Cenozoic (Wallace and John 1998). The faults bounding the range may have been reactivated Miocene faults.



Legend

- Alluvial and Playa Deposits
- Volcanic Rocks (<6 Ma)
- Upper Volcanic Rocks (6–17 Ma)
- Tuffaceous Sedimentary Rocks (6–17 Ma)
- Sedimentary Rocks (17–34 Ma)
- Lower Volcanic Rocks (mostly 17–43 Ma)
- Sedimentary, Igneous, and Metamorphic Rocks (>43 Ma)
- Quaternary Faults
- Epithermal Gold-silver Deposits and Prospects
- County Line
- Rift
- Rift Boundary

Note: Ma = million years ago.
Source: John et al. 2000.

Hollister Underground Mine Project EIS

Figure 3.4-5

Northern Nevada Rift Zone

02/29/12

3.4.1.4 Mineralization and Mining History Ivanhoe Mining District

The Hollister Site is located in the southern portion of the Ivanhoe Mining District (Wallace 2003a). Mineralization in the district occurs as mercury in shallow replacement silica zones or small sinter deposits, Tertiary volcanic-hosted disseminated gold deposits, and high-grade gold and silver vein deposits hosted by Vinini Formation characterize the mineralization in the district. **Figure 3.4-6** shows the older workings and prospects with respect to the Hollister area including both mercury and gold prospects and mines. The epithermal (shallow hydrothermal) gold-silver and mercury mineralization is thought to be associated with faulting and igneous activity related to the Northern Nevada Rift that was active during the Miocene (John et al. 2000). The Ivanhoe Mining District, containing the Hollister Site, also could be placed at the northern extent of the Carlin District (Teal and Jackson 2002). The mineralization at Hollister is younger than at other mines in the Carlin Trend, 14.5 to 15 million years ago for the Hollister Site as opposed to 27 to 28 million years ago for the Gold Quarry Mine. The mineralization at the Ivanhoe District was part of episodic south to north movement of mineralization along a general zone of weakness and volcanism. The Hollister Site is located between the Northern Nevada Rift zone and Carlin Trend.

Mercury Deposits

The mercury deposition occurred during silica replacement in tuff and tuffaceous units (Wallace 2003a). The ore bodies are opalite-type with cinnabar, the mercury-bearing mineral, disseminated in the opalite or fracture coatings (Bailey and Phoenix 1944). The ore bodies occurred as tabular "blanket" deposits, vein deposits, and irregular replacement bodies (LaPoint et al. 1991). Mercury was discovered in 1915 and was mined sporadically from 1916 to the 1970s. The largest producer was the Silver Cloud Mine, which reported 1,150 flasks of mercury over a period of about 40 years from ore grading an average of 5 pounds per ton (a flask contains 76.5 pounds of mercury). In addition to the Silver Cloud Mine, mercury was mined at the Velvet, Butte #1, Butte #2, and Mayflower Mines. Sections 3.2 (Past, Present, and Reasonably Foreseeable Future Actions) and 3.16 (Cultural Resources) have expanded discussions of the history of the Ivanhoe Mining District.

Tertiary Volcanic Rock Disseminated Gold Deposits

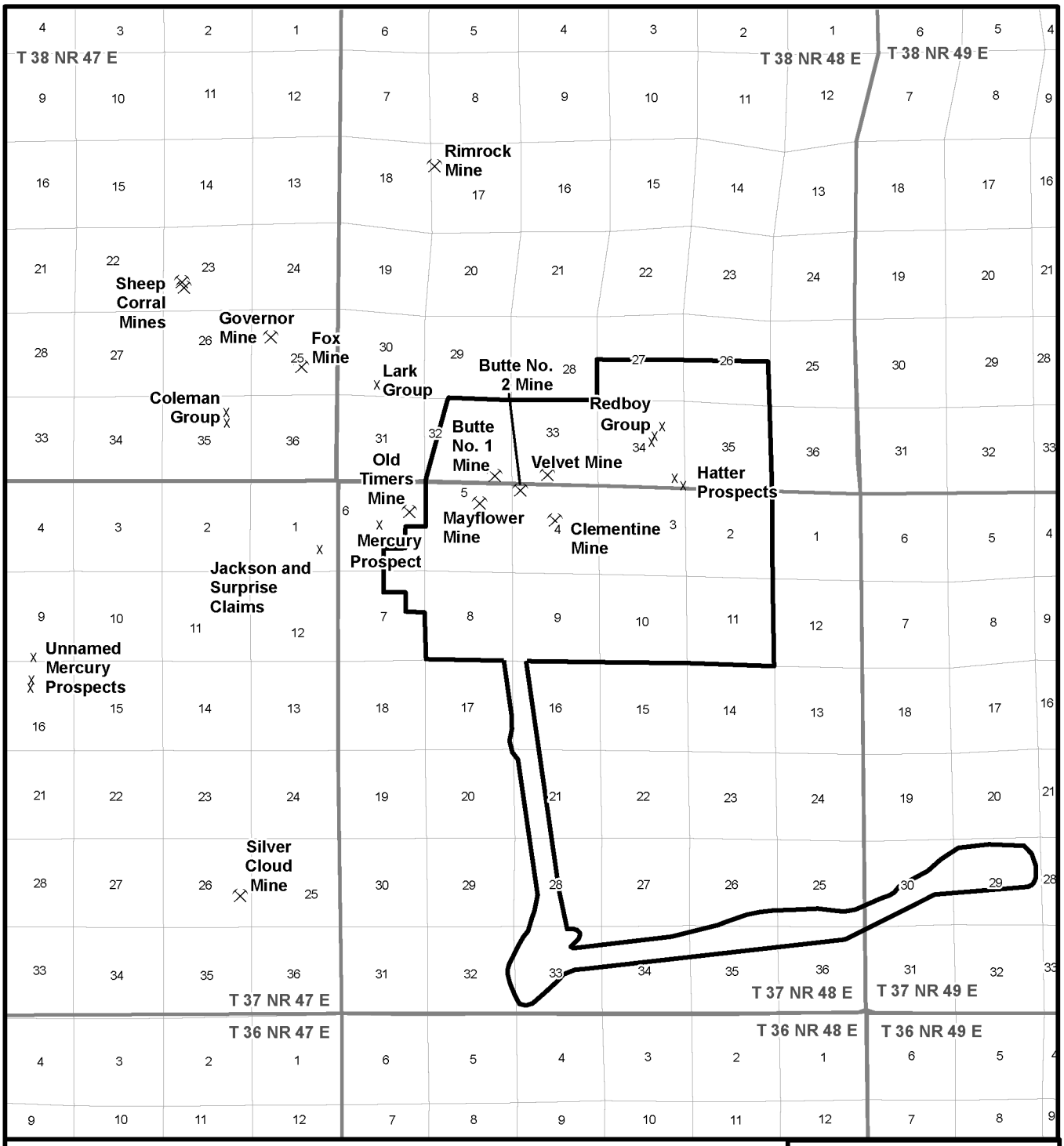
Beneath the mercury deposits are bulk mineable gold deposits that are hosted mainly by the volcanic rocks (Oelofse et al. 2009). The system is low-grade with disseminated gold occurring in tuffaceous deposits and andesite with the major ore mineral being electrum, with adularia, quartz, and chalcedony being gangue (non-ore) minerals. The Tertiary gold deposits at Hollister occur as four separate ore veins in a zone 6,500 feet long and 2,500 feet wide (LaPointe et al. 1991). The four ore bodies were the USX, Clementine, Velvet, and Butte #1. Exploration from the 1960s to the 1980s resulted in the opening of the Ivanhoe open-pit mine in 1990 (Oelofse et al. 2009). The reported production for 1990 and 1991 was 66,000 ounces of gold (Bonham and Hess 1995). Total production after residual heap leaching was concluded in 1996 was 115,696 ounces (Oelofse et al. 2009).

Ordovician Sedimentary Rock Gold Mineralization

Deeper exploration drilling in the 1990s indicated the presence of higher grade vein deposits hosted in the Vinini Formation (Oelofse et al. 2009). There are three vein systems oriented generally east-west and they appear to begin below the Tertiary-Ordovician contact 250 to 300 feet below the surface (**Figure 3.4-7**). The major vein systems are named the Clementine, Gwenivere, and South Gwenivere. The veins have banded textures created by alternating silica and clay minerals; silver alloy is present in particular bands. The gangue consists of quartz and clay.

Other Mineral Resources

The other important mineral resources in the area are barite deposits that were formed as sedimentary exhalative (SEDEX) deposits in a marine environment (Emsbo and Hofstra 2003). SEDEX deposits are formed from the injection of fluids and gases into sediments through volcanic vents in the seafloor.



Legend

- Project Area Boundary
- Mine Location
- Claim or Prospect Location

N

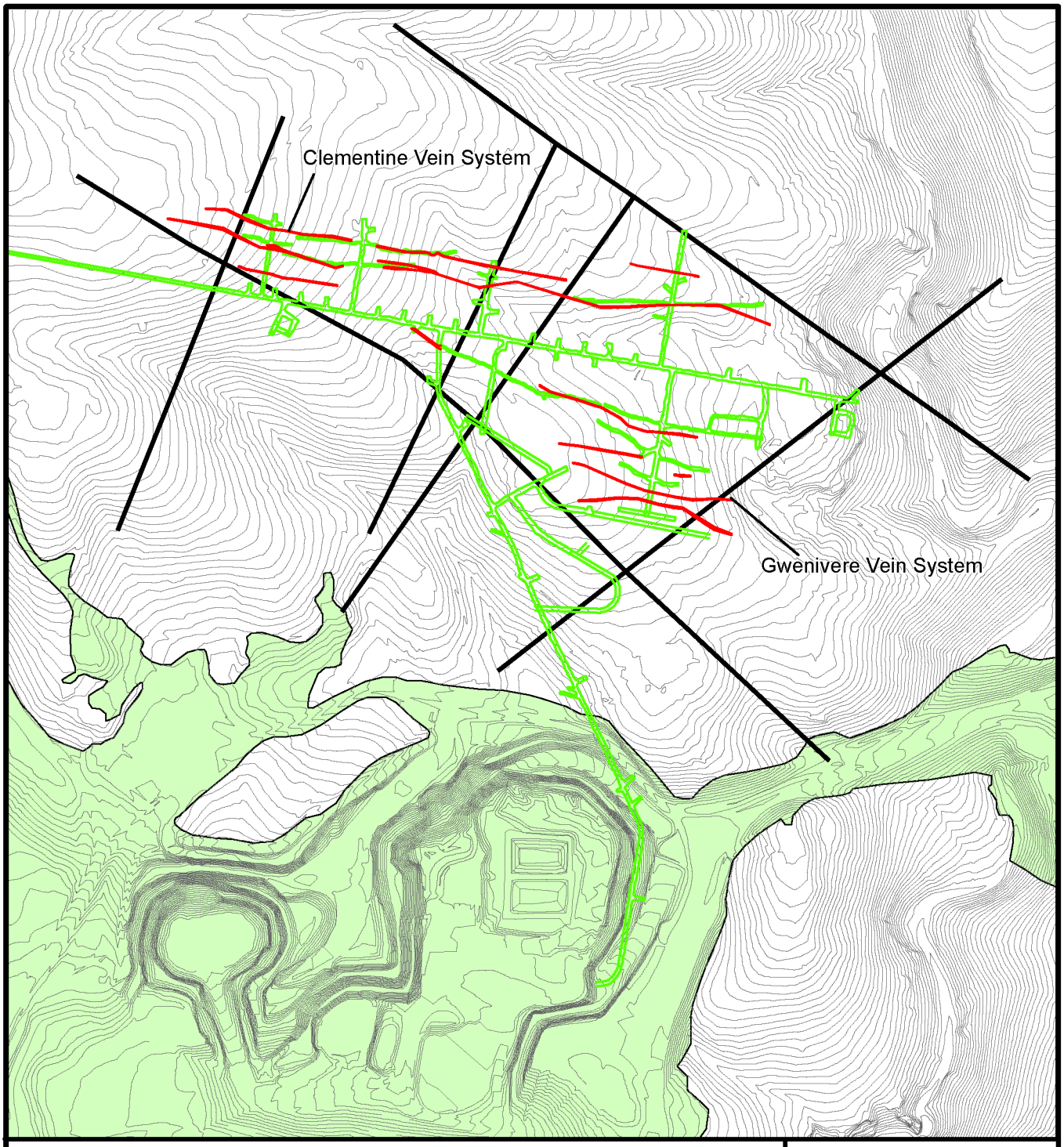
Hollister Underground Mine Project EIS

Figure 3.4-6

Historic Mines and Prospects in the Ivanhoe Mining District

Source: LaPointe et al. 1991.

2/28/2012



Legend

- Veins
- High Angle Fault (Domains)
- Existing Underground Exploration Workings
- Existing/Reclaimed Mining Disturbance

N

0 400 800

Feet

Source: Brown and Caldwell 2010a.

Hollister Underground Mine Project EIS

Figure 3.4-7

Veins and Faults in the Project Area

1/16/2012

The Rossi Mine, located 8 miles east of the Hollister Site (Sections 14-16, 21-23, 26-28, 34-35, Township 37 North, Range 49 East) was the second largest producer of barite in Nevada in 2008 with an output of 186,138 tons (Davis 2009). Barite is primarily used as an additive for drilling fluids.

There is geothermal energy potential in northern Nevada, but there are no identified geothermal resources in the project area (Shevenell and Garside 2005).

Although the Vinini Formation can contain high levels of total organic carbon and may be a potential source rock for oil and gas (Western Cordillera 2006), no oil and gas wells have been drilled in the project area (Garside and Hess 2007).

Mineral material (gravel) sites are located near the entrance to the Town of Midas and Squaw Valley Ranch, approximately 18 miles west of the Hollister project boundary, along the Midas-Tuscarora Road. RCG has used a clay pit developed for the Hollister Development Block Project that is located along the Ivanhoe Road, approximately 3 miles south of the Midas-Tuscarora Road intersection.

3.4.1.5 Geological Hazards

Seismicity

Seismicity involves the potential hazards due to earthquakes and movement on active faults. There is little recorded seismicity in the project area. Within a 60-mile radius of the mine, earthquake activity from 1973 to the present has consisted of 47 earthquakes, of which the largest magnitude recorded was 4.6 (U.S. Geological Survey [USGS] 2010). There are Quaternary (the last 1.6 million years) faults in the project area, but no faults that are considered active (movement within the last 15,000 years) (DePolo 2008). The Quaternary faults include the Willow Creek Fault, the Southeastern Sheep Creek Range Fault, an unnamed fault zone south of Willow Creek Reservoir, and an unnamed fault near China Camp (**Figure 3.4-8**) (Adams et al. 1999; Adams and Sawyer 1999a,b; Anderson 2000). The nearest active faults are in the Shoshone Range Fault Zone that borders the northern flank of the Shoshone Range and extend into the Boulder Valley 15 miles south of the project area. Ground motion from a maximum credible earthquake event is predicted to be less than 10 percent of the acceleration of gravity, with a 10 percent probability of being exceeded in 50 years (Petersen et al. 2008).

Other Geological Hazards

The project is located in an area that has low incidence of landslides and a low landslide susceptibility (National Atlas 2009). No karst potential was identified in the area. The lack of near-surface carbonate or evaporite rocks that would be susceptible to solution and subsequent subsidence would preclude karst development.

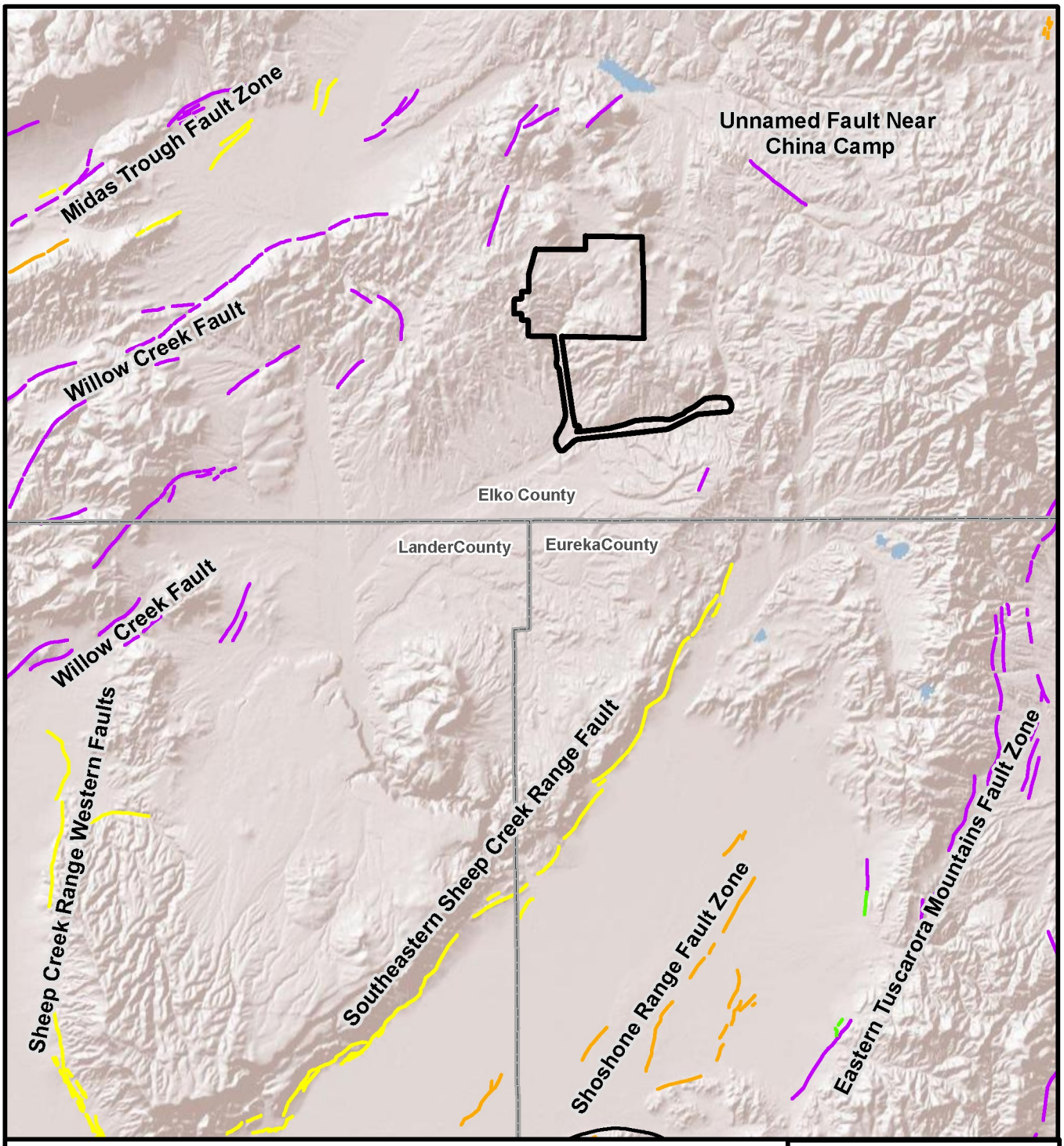
Waste Rock Storage Facility Stability

A stability analysis was not performed for the existing RCG waste rock storage facility (WRSF) in the East Pit because the WRSF is located in an open pit.

3.4.2 Environmental Consequences

3.4.2.1 Proposed Action

Direct impacts of the Proposed Action on geologic and mineral resources would include the generation and disposal of about 2.6 to 3.7 million tons of waste rock and the extraction of 2.0 to 3.0 million tons of ore. The proposed project would have no impact to access or extraction of other mineral resources.



Legend

Project Area Boundary

Age of Faulting

- <15,000 Years Ago (Latest Pleistocene)
- <130,000 Years Ago (Latest Quaternary)
- <750,000 Years Ago (Mid-Quaternary)
- <1,600,000 Years Ago (Quaternary)

Source: DePolo 2008.

N

0 2.5 5 Miles

Hollister Underground Mine Project EIS

Figure 3.4-8

Quaternary Faults
Sheep Creek
Range Area

11/16/2010

The Proposed Action would create limited changes to topography mostly on pre-existing authorized mining-disturbed and reclaimed land. Because of pre-existing disturbance, the direct impacts to topography would be minimal, but permanent. The existing West Pit would be backfilled with waste rock below the rim, and through reclamation would result in a final topography closer to the original topography of the area prior to historical surface mining activities. Waste rock backfill in underground mine stopes would have no direct impact on surface topography, but would result in lessening the volume of the WRSFs and subsequent impacts to topography.

The Shoshone Range Fault Zone, 15 miles from the project area (**Figure 3.4-8**), contains potentially active faults (evidence of movement within the last 15,000 years) that could cause ground motion in the event of an earthquake. USGS ground motion hazard mapping indicates there is a low probability that ground motion presents a hazard at the site. There are no identified geologic conditions that would be exacerbated by project activities that would result in geologic hazards. The West Pit WRSF would be constructed to conform to regulatory standards to minimize potential for instability. A stability analysis would not need to be performed for the proposed West Pit WRSF because it is located inside an existing open pit, which would confine the WRSF.

3.4.2.2 Mud Springs Road Transmission Line Alternative

Impacts to geological and mineral resources for the Mud Springs Road Transmission Line Route Alternative would be the same as described for the Proposed Action.

3.4.2.3 Mud Springs Waste Rock Storage Facility Alternative

Impacts to geological and mineral resources for the Mud Springs WRSF Alternative would be the same as those described for the Proposed Action. A stability analysis would be performed for the Mud Springs WRSF if this is chosen as the Preferred Alternative.

3.4.2.4 Backfill Alternative

Impacts to geological and mineral resources for the Backfill Alternative would be the same as those described for the Proposed Action.

3.4.2.5 No Action Alternative

The No Action Alternative would have less impact on topography than the Proposed Action. A total of approximately 612,000 cubic yards of waste rock material would be generated and stored in the smaller existing WRSF compared with the Proposed Action that would construct the West Pit WRSF. Under this alternative, RCG would continue bulk sampling, test mining, and exploration as currently authorized.

3.4.3 Cumulative Impacts

The CESA for geology and minerals is shown in **Figure 3.4-2**. The past and present actions associated with mining and RFFAs in this area are identified in Section 3.2. Mining and exploration locations are shown in **Figure 3.2-2**. Other than mining and mineral exploration activities, past, present and future RFFAs would not affect geologic resources. Primary mineral production in these areas has included gold, silver, barite, and mercury (historically). Most of the mineral production has come from gold mining operations. Gravel has been mined for road construction. Surface mining activity affects geology and mineral resources by excavating, modifying, or covering natural topographic and geomorphic features and by removing mineral deposits.

Mining disturbance in the CESA includes exploration (i.e., drilling, trenching, sampling, and road construction), open-pit and underground mining, WRSFs, heap leach pads, ore milling and processing, and tailings disposal facilities. For the purposes of this evaluation, disturbed areas (or geologic disturbance) are open pits, underground mines, WRSFs, heap leach pads, and tailing impoundments

that permanently alter the natural topographic and geomorphic features in the area, even if reclaimed (**Figure 3.2-1**).

Based on available information, past, present, and reasonably foreseeable future mine, mineral exploration, and pipeline construction activities have resulted, or would result, in approximately 39,860 acres of disturbance within the geology and mineral resources CESA (Carlin Trend north of I-80) (**Table 3.2-1**). The Proposed Action would incrementally increase the permanent alteration of topography in the CESA by approximately 117 acres, in addition to the approximately 105 acres of previously authorized disturbance for a total of approximately 222 acres of disturbance. The proposed new disturbance in the CESA is 39,977 acres, less than 0.3 percent of the total projected disturbance caused by past, present, and foreseeable future activity within the CESA. In addition to cumulative impacts to topography, the proposed project potentially would remove approximately 1,000,000 ounces of gold (proven and probable reserves) (Muntean 2009). The Carlin Trend deposits have produced cumulatively 71.6 million ounces of gold by the end of 2008 and would produce up to 100 million ounces by 2018 (Price 2009).

Cumulative impacts to geological and mineral resources for the Mud Springs Road Transmission Line Alternative, Mud Springs WRSF Alternative, and Backfill Alternative, in combination with past, present, and RFFAs, would be the same as described for the Proposed Action.

3.4.4 Potential Monitoring and Mitigation Measures

No monitoring or mitigation measures are recommended because changes to geology and topography would be irreversible and permanent. The impacts to mineral resources would be an irretrievable commitment of resources.

3.4.5 Residual Impacts

Residual impacts would occur to the topography within small, localized areas within the project area due to permanent alteration of the landscape. The mined ore would be permanently removed from the area.

3.5 Groundwater Resources and Geochemistry

The proposed Hollister Underground Mine Project is described in detail in Section 2.4, Proposed Action. The underground workings would extend approximately 2,000 feet below ground surface (bgs) to a final bottom elevation of 4,570 feet above mean sea level (amsl). As discussed in Section 2.4.3.4, Water Management, groundwater would be removed from the underground workings at an approximate maximum rate of 1,100 gallons per minute (gpm) on a continuous basis for the 20-year mine life. As discussed in Section 2.4.4, Waste Rock Management, waste rock would be disposed of in the existing Rodeo Creek Gold Inc (RCG) waste rock storage facility (WRSF), a new WRSF located in the West Pit, and in underground mined-out areas as backfill. At the conclusion of mining, groundwater removal would cease, and the underground facilities would be allowed to flood over time.

The proposed Hollister underground mining would be in the Vinini Formation and would not involve either the overlying Tertiary volcanic rock (volcanic rock) or the underlying Rodeo Creek unit.

The direct and indirect effects study area and cumulative effects study area (CESA) for groundwater resources are illustrated in **Figure 3.5-1** and include the projected area of the maximum extent of the 10-foot groundwater drawdown contour in the Vinini Formation. The CESA was selected based on the prediction that direct and indirect impacts from groundwater withdrawal from the proposed project would be confined to the maximum extent of the 10-foot groundwater drawdown contour in the Vinini Formation. Other mines on the Carlin Trend are dewatering the carbonate formations and have little effect on water in the Vinini Formation. The other mines in the Carlin Trend (Newmont and Barrick operations) dewater their mining operations by installing wells to constantly pump the groundwater in order to create a cone of depression (area void of groundwater) around the mining operation. The groundwater is pumped and disposed of in various methods to keep the area around the mining operation dry.

At the proposed Hollister Underground Mine the groundwater flows, seeps, or gravity drains into the underground workings. Grouting is utilized to slow or eliminate some of the groundwater seepage into the underground workings. The groundwater that seeps into the underground workings is collected in sumps or pond-like areas and is then pumped to the surface, which is called geotechnical water removal. This water is then disposed of via the pipeline to the rapid infiltration basins (RIBs) or also would be disposed of by the proposed discharge into Little Antelope Creek.

Cumulatively, there would be no overlap with groundwater pumping in the Vinini Formation at Hollister and dewatering at other mines. Past, present, and reasonably foreseeable future actions are summarized in Section 3.2.

3.5.1 Affected Environment

The existing Hollister underground operations are described in detail in Section 2.2. The existing underground exploration workings begin at the existing portal at an elevation of 5,500 feet amsl and extend to a bottom elevation of 5,060 feet amsl.

As discussed in Section 2.2.5, Waste Rock Management, waste rock removed during bulk sampling is transported and placed in the existing RCG WRSF. Material used as backfill may be stored temporarily in the underground workings. The existing West Pit has been partially backfilled. It contains water on a seasonal basis with depths up to 4 feet; this seasonal pit water can be acidic (Brown and Caldwell 2003). The existing Newmont-reclaimed WRSFs contain potentially acid generating (PAG) waste rock; acidic effluent occasionally seeps from the Newmont-reclaimed WRSF during periods of heavy precipitation or snowmelt.

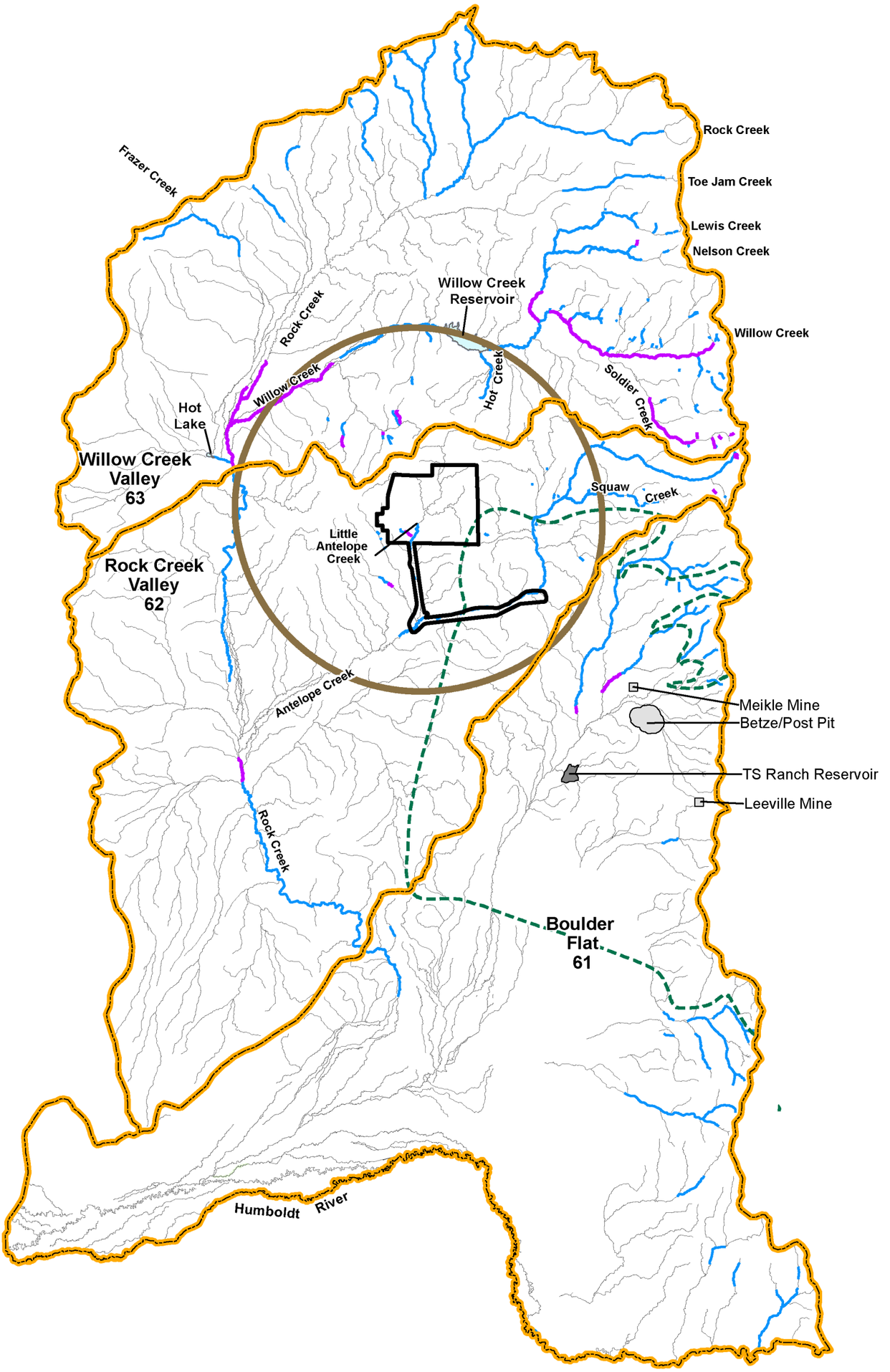
As described in Section 2.2.6, Water Management, RCG grouts water-bearing fractures to reduce water inflow to the underground workings. Water currently is removed from the underground workings at an approximate rate of 400 gpm with a maximum capacity of 700 gpm. Groundwater is pumped to the surface, where it is gravity fed in a pipeline to the existing East Pit water treatment facilities. RCG uses 100 to 150 gpm of the discharge water in operations. Following treatment, excess water is discharged to the existing RIBs.

3.5.1.1 Geologic Setting

The Hollister project area is located within the Carlin Trend mineralized zone of northeastern Nevada, as shown in **Figure 3.2-1**. The geology of the project area is described in Section 3.4, Geology and Minerals, and is shown in **Figure 3.4-1**. The geology of the greater project vicinity is shown in **Figure 3.5-2**. This figure is a composite of several geology maps with varying levels of geologic detail. A cross-sectional view of the geology is shown in **Figure 3.4-4**.

As discussed in Section 3.4 (Geology and Minerals) the geology within the project area comprises Tertiary igneous rocks overlying the Paleozoic Vinini Formation. The volcanic rocks consist of tuffs, tuffaceous sedimentary rocks, andesite, and rhyolite. These rocks cover most of the surface of the study area and form a layer over the Ordovician Vinini Formation that is up to 600 to 700 feet thick (Oelofse et al. 2009). Outside of the Hollister Site, other Paleozoic units, such as the Pennsylvanian/Permian Strathearn Formation, overly the Vinini Formation and are in turn overlain by volcanics. In the Hollister operations area, the volcanic rocks are thinner, approximately 200 to 300 feet thick, and the top of the unconformity between the Vinini Formation and the overlying volcanic rock is exposed in the mine pit (**Figure 3.4-4**). As a result of extensive hot spring activity and hydrothermal alteration, the volcanic rock in the project mine area and the area to the east and southeast has been altered extensively to clay and silica (Brown and Caldwell 2011a), which inhibits the vertical flow of groundwater in the volcanic rock. Horizontal groundwater flow in the volcanic rock primarily is controlled by fractures, faults, and locally by more permeable unaltered volcanic units.

The underlying Vinini Formation, the location of the existing and proposed expansion of the underground mine workings, is composed of quartzite, chert, and argillite (Wallace 2003a); the Vinini Formation is thrust over the Devonian Rodeo Creek unit by the Roberts Mountain Thrust. The estimated thickness of the Vinini Formation in northern Nevada ranges from 500 to 6,000 feet (Western Cordillera 2006). In the project area, the Vinini Formation may be up to 2,000 feet thick (Oelofse et al. 2009; Wallace 2003a). There is a sheeted Breccia zone approximately 1 to 2 miles upgradient from the Hollister Site, and was apparently formed at the time of thrusting of the Vinini Formation. There do not appear to be any characteristics that would differentiate the Breccia zone hydraulically from the Vinini Formation near the Hollister Site or in other locations (Hart 2012; Wallace 2003a). The geologic contact between the volcanic rock and the underlying Vinini Formation is an unconformable contact consisting of re-worked Vinini quartzite and clay (Brown and Caldwell 2010a). The contact zone ranges in thickness from 2 to 50 feet in the project area. The clays in the contact zone and also the hydrothermal clays in the volcanic rock restrict vertical groundwater movement within the volcanic rock and between the Vinini Formation and the overlying volcanic rock. Thick clay zones have been found in groundwater monitoring wells and exploration bore holes at the Hollister Site (**Figure 3.5-3**) (Brown and Caldwell 2011a). In areas more distant from the Hollister Site, substantial clay intervals were documented in the borehole logs of monitoring wells that are part of the Boulder Valley Monitoring Plan associated with the monitoring of dewatering activities at the gold mining operations of Barrick and Newmont. Brown and Caldwell (2011a) summarize the logs for these boreholes that indicate widespread occurrence of clay within the volcanic rock. The data from these wells provide insight to the extent of the clay zones in the project region.



Legend

- Project Area Boundary
- Cumulative Effects Study Area and Direct/Indirect Effects Study Area
- Groundwater Basin Boundary
- Maximum Extent of Cumulative 10-foot Drawdown Contour (2007 Barrick Model)
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinuous Flowing Stream Reach (interrupted flow that stops and starts)

N

0 2.5 5 Miles

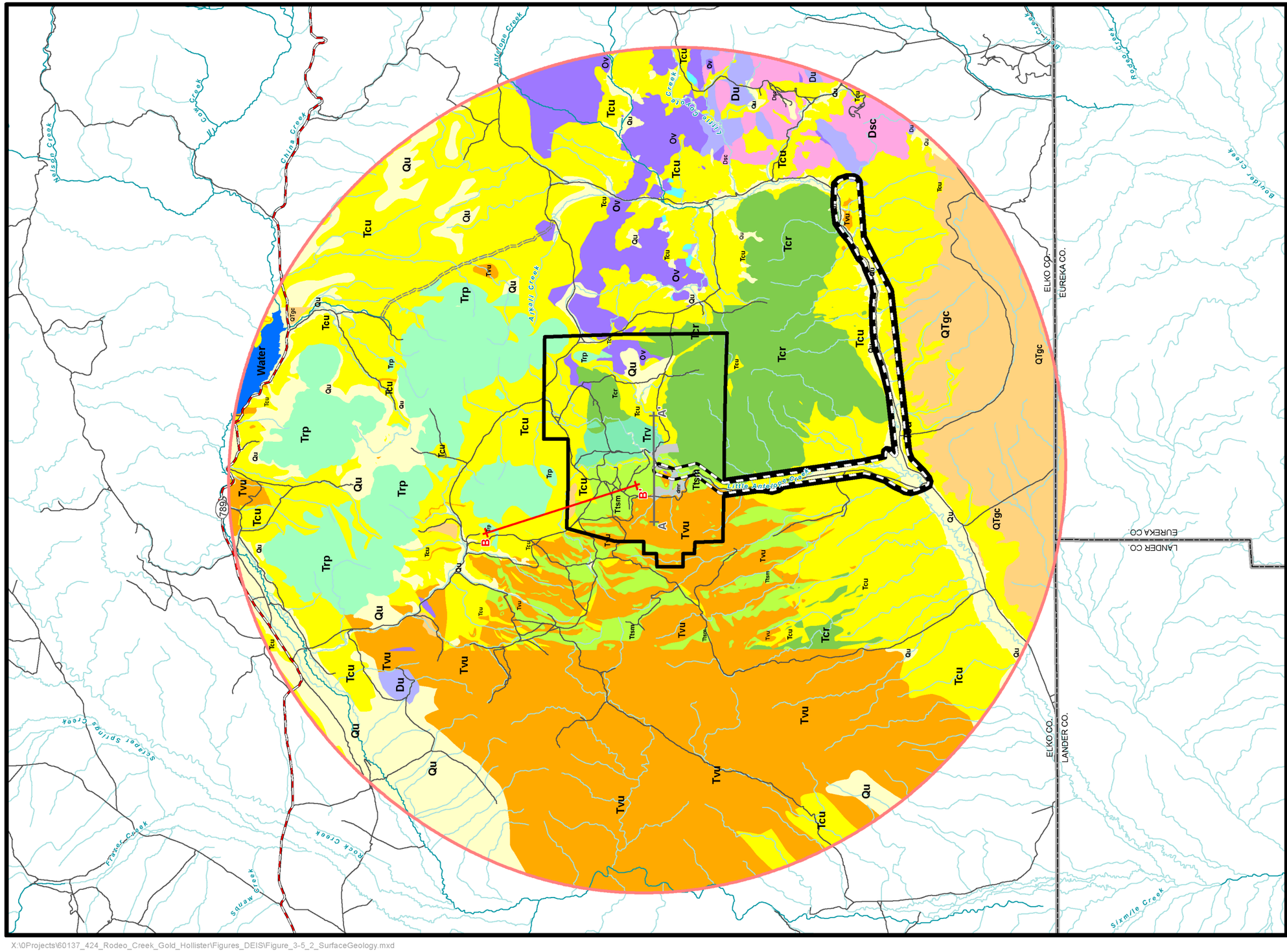
Note: Hydrographic area boundary locations are approximate.
Source: BLM 2000b,c; Brown and Caldwell 2010a.

Figure 3.5-1

Groundwater Resources and Geochemistry Direct/Indirect Effects and Cumulative Effects Study Areas

Hollister Underground Mine Project EIS

3/23/2012



Cross Section A-A' is shown on figure 3.4-4
Cross Section B-B' is shown on figure 3.5-7

Geologic Units

- Qu - Alluvium, undivided
- QTgc - Gravel terraces and poorly exposed Carlin Formation
- Tvu - Tertiary volcanics, undivided
- Tcr - Craig Rhyolite (Miocene)
- Trp - Rhyolite Porphyry (Miocene)
- Tri - Rhyolite intrusions (Miocene)
- Trv - Rhyolite Velvet Area (Miocene)
- Tdh - Dacite (Eocene)
- Ttsm - Tuffs and tuffaceous sedimentary rocks
- Tcu - Carlin Formation, sedimentary and volcanic rocks, undivided
- Dsc - Slaven Chert (Ordovician)
- Du - Devonian rocks, undivided
- Ov - Vinini Formation (Ordovician)
- PIPs - Pensylvanian-Permian Strathearn Formation
- dmr - Mining disturbance
- Water

Legend

- Project Area Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- State Highway
- Rural Road
- Vehicular Trail (4WD)
- Perennial Stream
- Intermittent Stream

N

0 1 2 Miles

Sources: Coats 1986; Theodore et al. 2006; Wallace 2003a,b.

Hollister Underground Mine Project EIS

Figure 3.5-2

Surficial Geology in the Project Vicinity

3/19/2012

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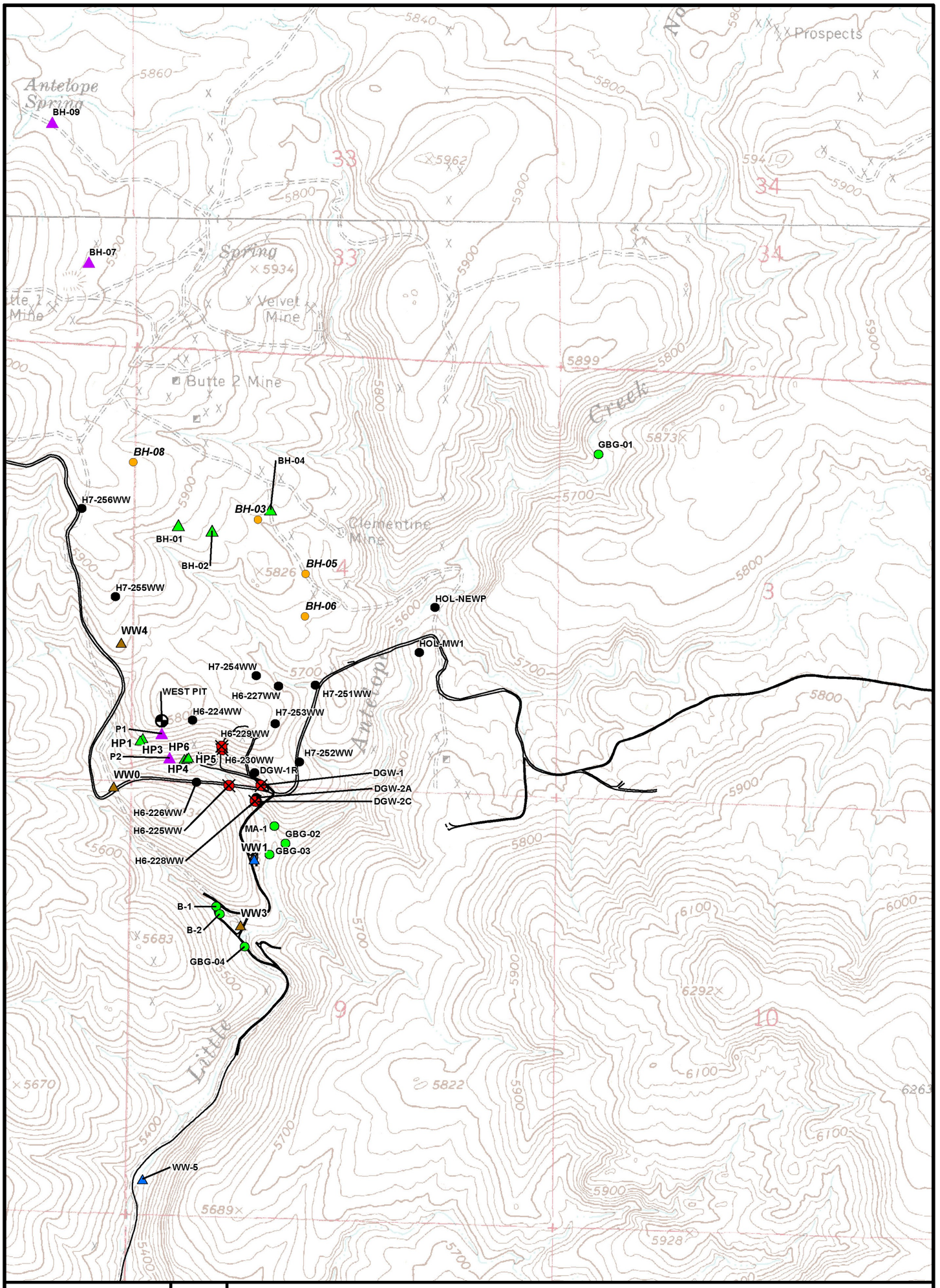


Legend

Roads

Boreholes (Brown and Caldwell 2003)

- 2002 Piezometer and Groundwater Level Elevation
- 2002 Hydrogeologic Test Borehole and Groundwater Level Elevation

Wells (Brown and Caldwell 2003)

- West Pit Monitoring Well (HP)
- Water Production Well (WW)
- Abandoned Water Production Well (WW)

Monitoring Sites (Montgomery and Associates 2010)

- Abandoned Monitor Well
- Monitor Well
- Piezometer, Vinini Aquifer
- Piezometer, Tertiary Volcanic Aquifer
- Stream Sample
- West Pit Staff Gauge

Source: Brown and Caldwell 2010a, 2003; Montgomery and Associates 2010a.

Hollister Underground Mine Project EIS

Figure 3.5-3

Groundwater and Suface Water Monitoring Sites

3/19/2012

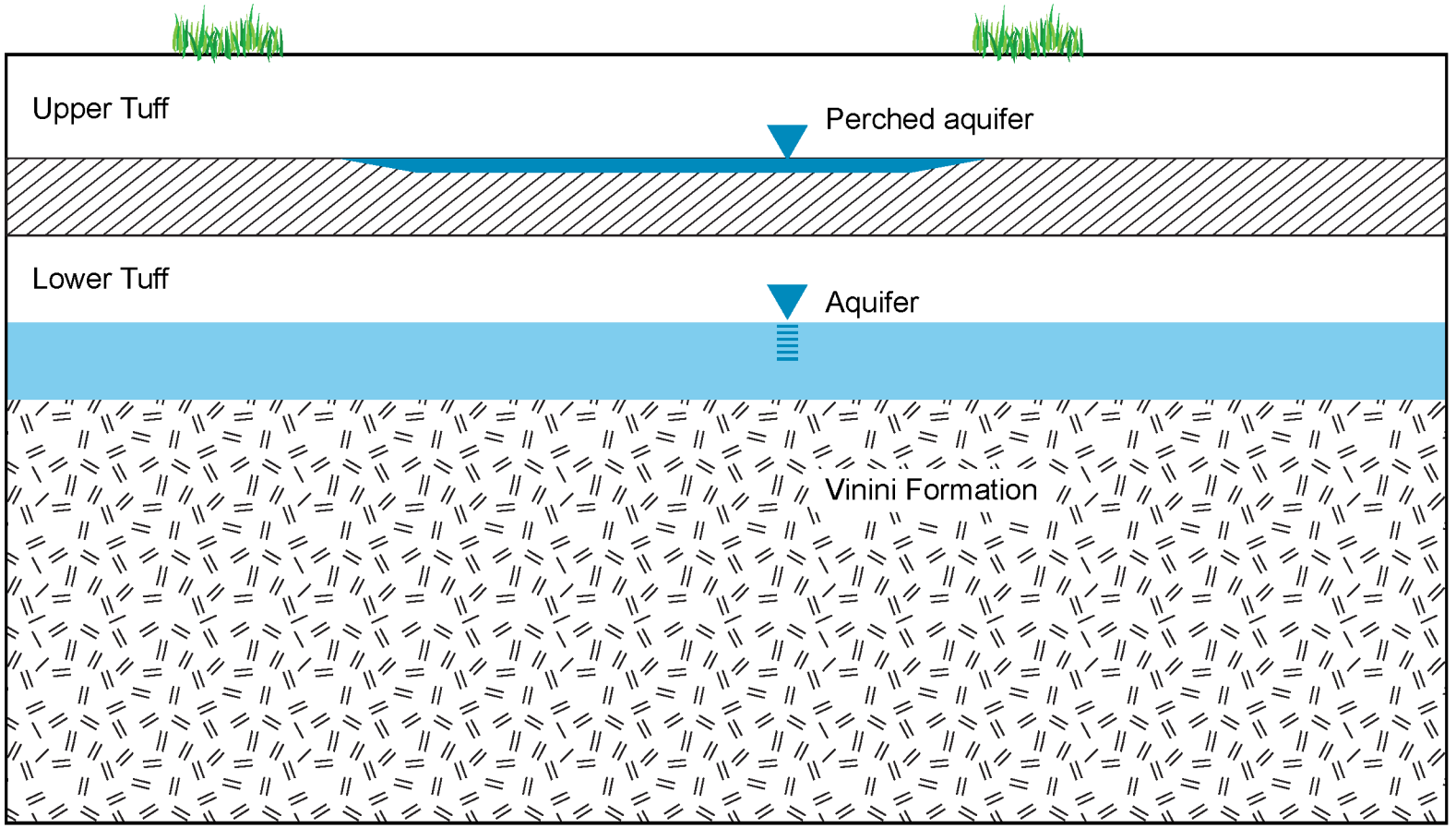
3.5.1.2 Hydrogeology

There are two main aquifers in the project area and a third local "perched" aquifer in the area of former open-pit mining (Brown and Caldwell 2010a). The aquifer in the volcanic rock is separate from the aquifer in the Vinini Formation, and vertical flow between these two aquifers is restricted by a clay alteration in the lower volcanic rock that separates it from the underlying Vinini Formation. The perched aquifer consists of altered and mineralized volcanic rock and overlying alluvial material and is limited mainly to the area of former open-pit mining. **Figure 3.5-4** shows schematically the relationship between the perched aquifer and the Vinini Formation aquifer (Hart 2012). The geotechnical water removal occurs in the Vinini Formation.

Hydro-Search, Inc. installed five water production wells (WW series wells) for the open- pit mining operation in the 1990s; the WW-0, WW-3, and WW-4 wells have been abandoned. HCI installed a series of monitor wells in the area of the West Pit (HP series wells), and Brown and Caldwell installed borehole test wells at the Hollister Site into the Vinini Formation (BH series wells) (Brown and Caldwell 2003), as shown in **Figure 3.5-3**. The results of aquifer testing in these wells showed that water in both the volcanic rock and the Vinini Formation comes mostly from fractures, joints, and faults. Water production in WW-1 increased from 15 to 60 gpm when a fault was intersected. Aquifer testing of the WW series wells showed that the Vinini Formation aquifer has transmissivity values ranging up to 50 to 60 square feet per day (feet^2/day). In the HP series wells, transmissivity in the Vinini Formation ranged from 0.4 to 8.0 feet^2/day, while transmissivity in the volcanic rock ranged from 0.3 to 1.0 feet^2/day. The reworked Vinini quartzite found at the base of the volcanic rock had a transmissivity of 10 to 14 feet^2/day. The BH series wells in the Vinini Formation gave a range of 0.7 to 812 feet^2/day. Transmissivity is the ability of an aquifer to transmit water. The higher the transmissivity, the more volume of water an aquifer can transmit per unit area of the aquifer. The reworked Vinini quartzite, for example, transmits water at a rate about 10 times that in the volcanic aquifer, based on these aquifer tests. But the Vinini Formation, can transmit large quantities of water in the fractures (areas with high transmissivity), and yet transmit much less water in the matrix of the aquifer where the transmissivity is considerably lower.

HCI (1997) estimated, based on aquifer tests, that the hydraulic conductivity of the lower tuff in the volcanic rock ranged from 0.03 to 0.10 feet/day. Brown and Caldwell (2011a) have shown that based on 16 single well tests, the average value for hydraulic conductivity in the volcanic rock is approximately 0.45 feet/day with a mean value of 0.22 feet/day. The Vinini Formation has a hydraulic conductivity ranging from 0.03 to 2.4 feet/day, and the reworked Vinini quartzite has a hydraulic conductivity of approximately 1.0 feet/day. **Figure 3.5-3** shows the location of the monitoring wells and boreholes tested by Brown and Caldwell (2003), and **Table 3.5-1** shows the aquifer parameter data from Brown and Caldwell (2003) measured at the monitoring wells and boreholes. Hydraulic conductivity is the rate at which groundwater can be transmitted and is similar in concept to electrical conductivity. Aquifers with higher hydraulic conductivity values transmit water faster, Hydraulic conductivity is related to transmissivity in that hydraulic conductivity is the transmissivty divided by the saturated thickness of the aquifer. As these aquifer test results show, the Vinini Formation transmits groundwater somewhat faster than the volcanic rock.

RCG installed the H6 and H7 series of wells, and the results of their aquifer tests are shown in **Table 3.5-2** (RCG 2010c); the locations of the wells are shown in **Figure 3.5-3**. The aquifer tests gave a transmissivity for the volcanic rock ranging from 3 to 95 feet^2/day and a transmissivity for the Vinini Formation of 95 feet^2/day. The volcanic rock appears to have a transmissivity up to 44 feet^2/day but it can have a much lower value of approximately 1.0 feet^2/day, except in the reworked Vinini quartzite that lies at the base of the volcanic rock (RCG 2010c). The Vinini Formation can have transmissivity values up to 95 feet^2/day in faults and fracture systems, but often shows a value below 20 feet^2/day (RCG 2010c). Exceptional values can be as high as 320 feet^2/day in large fracture systems (RCG 2010c).



Legend

- Water Level
- Ground Surface
- Low Permeability Zone
- Aquifer
- Perched Aquifer
- Vinini Formation

Source: Hart 2012.

Hollister Underground Mine Project EIS

Figure 3.5-4

Conceptual Diagram of Aquifers in the Hollister Area

01/19/2012

Table 3.5-1 Aquifer Parameter Data

Monitor Well	Geologic Unit	Test Type	Discharge Rate (gpm)	Transmissivity (feet^2/day)	Hydraulic Conductivity (feet/day)
HP-1	Vinini Formation	Drawdown	7.0	--	--
		Recovery	--	0.4	0.03
		Drawdown	1.2	--	--
		Recovery	--	0.7	0.05
HP-3	Lower Tuff	Drawdown	3.3	--	--
		Recovery	--	0.3	0.03
		Drawdown	1.0	--	--
HP-4	Vinini Formation	Drawdown	2.4	4	0.3
		Recovery	--	--	--
		Drawdown	10.6	8	0.5
		Recovery	--	--	--
HP-5	Reworked Vinini Quartzite	Drawdown	1.8	--	--
		Recovery	--	12	1
		Drawdown	11.9	14	1
		Recovery	--	10	1
HP-6	Lower Tuff	Drawdown	3.0	--	--
		Recovery	--	1	0.1
		Drawdown	3.0	--	--

2002 Drilling Information

Borehole	Transmissivity (feet^2/day)	Saturated Thickness (feet)	Hydraulic Conductivity (feet/day)
BH-01	320	411	0.78
BH-02	52	257	0.20
BH-03	0.7	317	0.002
BH-04	812	345	2.4

cm/sec = centimeter per second.

Source: Brown and Caldwell 2003.

Table 3.5-2 Summary of Hydrologic Data from Constant-rate Pumping Tests for Monitor Wells

Well Identifier	Casing Perforated Interval (feet, bgs)[1]	Date Pumping Test Started	Duration of pumping Period (hours)	Average Pumping Rate (gpm)[2]	Pre-Pumping Water Level (feet, bgs)	Maximum Water Level Drawdown Near End of Pumping Period (feet)	Specific Capacity (gpm/ft)[3]	Temperature (°F)[4]	Specific Electrical Conductance (µS/cm)[5]	pH (standard units)	Cooper-Jacob (1946) Drawdown Method Transmissivity (feet²/day)[6]	Theis (1935) Recovery Method Transmissivity (feet²/day)[6]	Lithology Tested[7]
H6-224WW	166-221	10-Dec-2006	8	0.8	179.5	17.93	0.045	57.7	1,141	5.69	---24.2	24.1	Tv
H6-225WW	62-127	6-Dec-2006	8	2.0	83.53	8.86	0.23	51.6	1,270	6.10	21.4	53.6	Tv
H6-226WW	75-130	4-Dec-2006	8	7.0	84.66	9.62	0.73	57.7	1,559	6.81	84.4	95.1	Tv
H6-227WW	18-133	12-Dec-2006	8	0.7	28.77	59.25	0.0012	57.7	5,824	3.24	5.3	NA	Tv
H6-228WW	129-184	8-Dec-2006	8	4.0	134.44	13.00	0.31	55.6	3,273	6.56	96.5	NA	Ov
H6-229WW	50-85	14-Dec-2006	8	2.7	24.32	19.34	0.14	56.5	15,060	2.87	23.4	NA	WR/Tv
H6-230WW	15-35	15-Dec-2006	1.8	9.0	22.98	0.05	**	52.0	8,665	2.74	NA	NA	Ov
H6-251WW	172-227	25-Oct-2007	8	1.1	186.91	16.76	0.066	70.0	1,039	6.46	8.0	13.4	Fill
H6-252WW	208-268	23-Oct-2007	6	1.0	216.48	25.14	0.040	69.6	5,325	3.66	4.7	3.1	Tv
H6-254WW	25-85	22-Oct-2007	3	6.2	37.8	39.71	0.15	60.0	1,439	3.97	12.1	44.2	Tv
H6-255WW	230-540[8]	18-Oct-2007	8	8.7	243.52	30.1	0.289	63.0	653	7.19	46.9	42.9	Tv
H6-256WW	22-430	19-Oct-2007	8	4.3	199.65	84.69	0.051	61.2	392	7.31	6.0	24.1	Tv

[1] bgs = below ground surface.

[2] gpm = gallons per minute.

[3] gpm/ft = gallons per minute per foot of drawdown.

[4] °F = degrees Fahrenheit.

[5] µS/cm = microSiemens per centimeter.

[6,7] Tv =Tertiary volcanic; Ov = Paleozoic Vinini quartzite/argillite; WR = waste rock.

[8] Alternating blank and perforated sections.

NA – Not Analyzed ** – Not Computed

Source: RCG 2010c.

In summary, the aquifer test results from various investigators conducted at different times show that the range in transmissivity of the Vinini Formation is from low values around 0.4 to 8.0 feet^2/day to high values associated with faults and fractures in the range of 52 to 812 feet^2/day. For the volcanics, the range in transmissivity is from 0.3 to 95 feet^2/day with many values falling in the range of 1.0 to 50 feet^2/day. In the fractured areas, the volume of water transmitted by the Vinini Formation can be 10 times the volume in the unfractured part of the formation.

Regional composite groundwater elevations and flow in the Boulder Valley area are shown in **Figure 3.5-5**. In this figure, groundwater elevations in all aquifers ranging from bedrock Paleozoic units to Quaternary alluvium are lumped together and contoured as if they represent one single aquifer. In the Hollister project area, these regional groundwater elevations are associated with the Vinini Formation because the monitor wells used for the water levels are screened in the Vinini Formation. Groundwater flow in the Vinini Formation in the project area is towards the southwest. Local groundwater elevations and flow in the volcanic rock, the uppermost aquifer in the project area, are shown in **Figure 3.5-6**. Because of limited data, the contours are truncated and limited to the immediate area around the monitor well in this figure. Groundwater flow in the volcanic rock is towards the southeast. Hydrogeologic cross-sections showing the water table in both the volcanic rock and the Vinini Formation are shown in **Figure 3.5-7**. The cross-section location is shown in **Figure 3.5-2**. The water table in the volcanic rock is 100 to 200 feet bgs and thus lies below Antelope Spring (**Figure 3.5-7**). Antelope Spring and both Ivanhoe and Buttercup springs (**Figure 3.5-7**) are above the water levels in both the volcanic rock and the Vinini Formation. In general, the shallowest groundwater in the project area is at an elevation of approximately 5,400 to 5,500 feet amsl (Brown and Caldwell 2003). Groundwater in the Vinini Formation is recharged from the Tuscarora Mountains to the east of the project area. Groundwater flow is controlled by fractures and faults, and the estimated flow into the proposed underground workings by Brown and Caldwell (2003) using an analytical groundwater model was approximately 335 to 385 gpm. Current measured flow rates to the underground workings are approximately 400 gpm.

The third aquifer in the project area is a perched aquifer in the volcanic rock that exists in the area of past open-pit mining and provides groundwater flow to the West Pit and to Little Antelope Creek, as suggested by the groundwater elevation data depicted in **Figure 3.5-8** (MWH Americas, Inc. 2007). This aquifer exists in the area of fractured volcanic rock and overlying alluvial material, mainly between the East and West pits, that was disturbed by past mining. **Figure 3.5-8** shows the projected piezometric surface (water levels) and flow lines for 2007 in this perched aquifer. Groundwater generally flows towards the east in the perched aquifer. The West Pit serves as a hydraulic sink, and groundwater in this aquifer flows to the pit at a rate of approximately 5 gpm (MWH Americas, Inc. 2007). Just east of the eastern rim of the West Pit, there is a groundwater divide in the perched aquifer, and groundwater east of that divide flows eastward toward Little Antelope Creek. Oxidized sulfides in the walls of the West Pit contribute acidic groundwater to the West Pit during periods of intense precipitation, due to both groundwater inflow and surface water flushing materials from the pit walls. This water seeps into the perched aquifer.

The West Pit had a pit bottom elevation at the end of mining of 5,505 feet amsl (MWH Americas, Inc. 2007). This pit was backfilled between 1992 and 1997 to an elevation of 5,543 feet amsl with 380 tons of lime and local oxide material and capped with 2 feet of topsoil. Seasonal inflow of groundwater and surface water sometimes produces a pond of water up to 2 feet in depth that lasts from November to July with a near neutral pH (MWH Americas, Inc. 2007). In 2005, exceptionally heavy precipitation resulted in increased flow to the West Pit. Between June 2006 and April 2007, the West Pit pond was approximately 4 feet in depth and turned acidic with a pH of approximately 4.0 standard units. The acidic water in the West Pit pond had total dissolved solids (TDS) ranging from 2,620 to 3,730 milligrams per liter (mg/L) and a sulfate content from 1,680 to 2,450 mg/L. During February and March of 2007, monitor well WP-P1 had a pH of 5.39 standard units and a TDS of 2,190 mg/L with sulfate at 1,510 mg/L. Monitor well WP-P2, which is farther to the south and thus at a greater distance from the West Pit, had a pH of 6.93 standard units and a TDS of 1,225 mg/L with sulfate at 376 mg/L. This suggests that the

majority of the acidity in the West Pit may be derived from the flushing of the oxidized sulfide material in the pit walls (MWH Americas, Inc. 2007). If the water level in the West Pit rises too high, due to exceptionally high rainfall, the West Pit could become a flow-through pit, and water could flow out of the pit and into the perched aquifer (HCI 1997).

Geotechnical groundwater removal from the current underground workings at the Hollister Site using mine sumps has resulted in drawdown in the water levels of monitor wells screened in the Vinini Formation, but not in the overlying volcanic rock. **Figure 3.5-9** shows the extent of current drawdown in the Vinini Formation due to underground water removal at the current Hollister Site (Brown and Caldwell 2011a). **Figure 3.5-10** shows the change in water levels with time in both the Vinini Formation monitoring wells and the monitoring wells in the overlying volcanic rock. The water levels in the volcanic rock show only seasonal fluctuations and have not been affected by drawdown in the Vinini Formation due to geotechnical water removal, further supporting the concept based on geology that the Vinini aquifer is separate from the volcanic aquifer (Brown and Caldwell 2011a).

3.5.1.3 Groundwater Quality

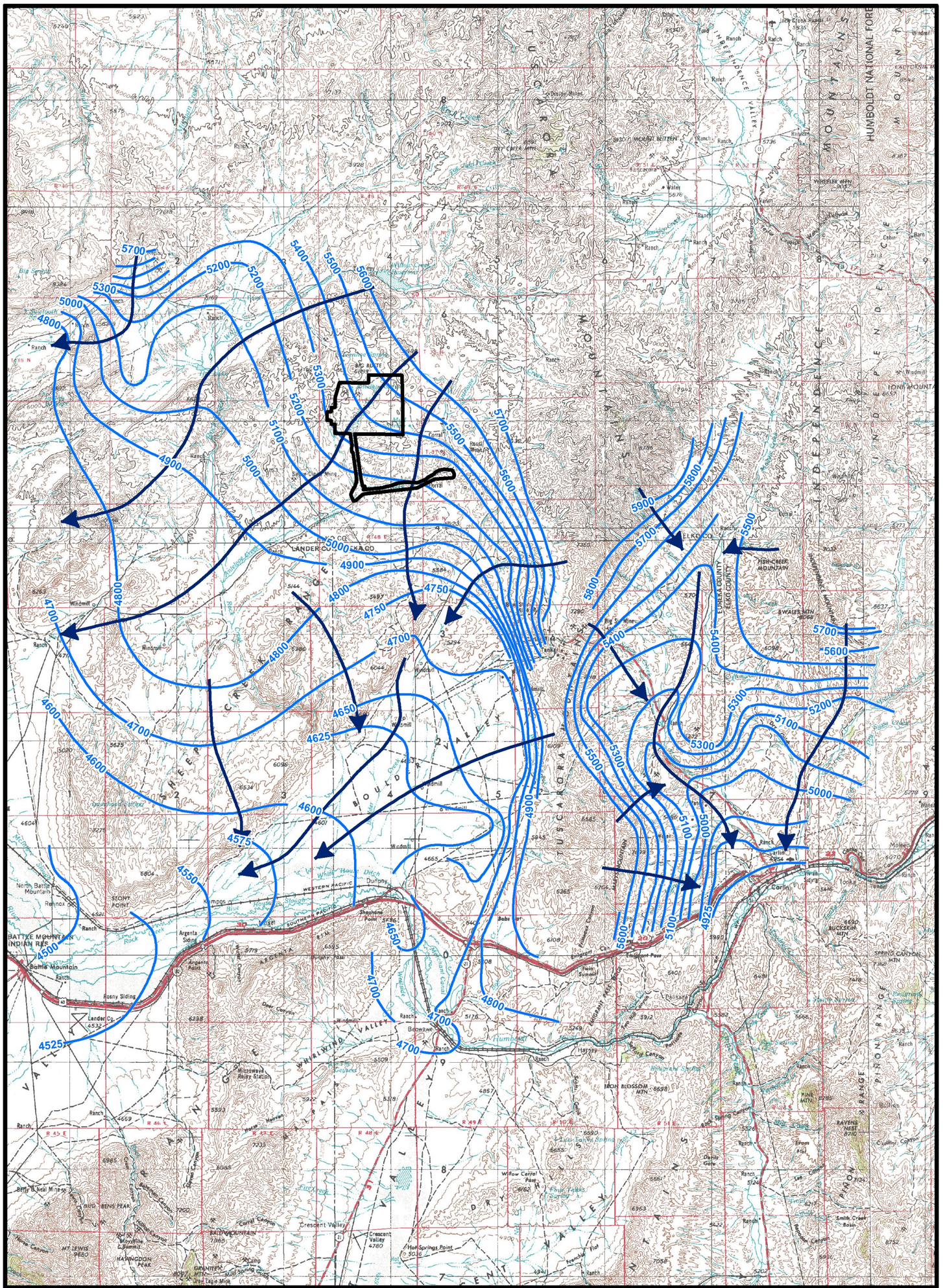
The Nevada Administrative Code (NAC) 445A establishes primary and secondary water quality standards. Nevada water standards applicable to this EIS are summarized in **Appendix B1, Table B1-1**. Primary standards are based on the potential use of groundwater for drinking water and are established to protect human health; secondary standards are for aesthetic qualities. Because groundwater in the project area has the potential to be used for drinking water and by wildlife (Bureau of Land Management [BLM] 2010c), the Nevada primary standards would apply to mine-related activities that affect groundwater.

Water quality data from Brown and Caldwell (2003) and Montgomery and Associates (2010a) are summarized in **Appendix B1, Table B1-2**. **Figure 3.5-11** illustrates the variation in water quality using Stiff diagrams. The majority of exceedences of Nevada water quality standards are found in the wells screened in the perched aquifer in the area of historic open-pit mining.

The WW series of water wells, shown in **Figure 3.5-3**, are located mostly south and southeast of the West Pit and the Newmont-reclaimed South WRSF. Well WW-1 is screened in the Vinini Formation and has TDS in the range of 300 to 400 mg/L with sulfate ranging from 140 to 160 mg/L. Arsenic and iron are the main exceedences in the Vinini Formation in this well. Well WW-5 is screened in the volcanic rock and show TDS ranging from 230 up to 898 mg/L with sulfate in the range of 136 to 392 mg/L. Arsenic, iron, and manganese are the main exceedences in these wells for the volcanic rock. Abandoned well WW-4, screened across both the Vinini Formation and the volcanic rock, showed similar ranges for TDS and sulfate and the same exceedences as WW-1 and WW-5.

The BH series of wells shown in **Figure 3.5-3** are located in the area of the underground workings and are screened in the Vinini Formation (wells BH-1, BH-2, BH-4) and the volcanic rock (wells BH-7 and BH-9). The TDS in the Vinini Formation near the workings is less than 500 mg/L, with the water being dominated by calcium-sodium bicarbonate. The BH wells in the volcanic rock show TDS less than 200 mg/L, sulfate less than 100 mg/L, and the water is dominated by calcium-sodium bicarbonate.

The HP series of wells are all located south and downgradient of the West Pit, as shown in **Figure 3.5-3**. HP wells screened in the Vinini Formation show TDS in the range of 250 to 458 mg/L with sulfate up to 181 mg/L. Exceedences of Nevada water quality standards are for arsenic and the water in the Vinini Formation is calcium-sodium bicarbonate dominated in HP-1, which is a background well in the Vinini Formation, and calcium-magnesium sulfate water in HP-4, which is downgradient of the West Pit and screened in the Vinini Formation. HP wells screened in the volcanic rock have TDS values up to 304 mg/L, and sulfate up to 127 mg/L. Both the upgradient background well HP-1 and the well downgradient of the West Pit (HP-6) show good water quality in the volcanic rock.



Legend

- Project Area Boundary
- Water Table Contour
- Regional Groundwater Flow

N

0 2.5 5 Miles

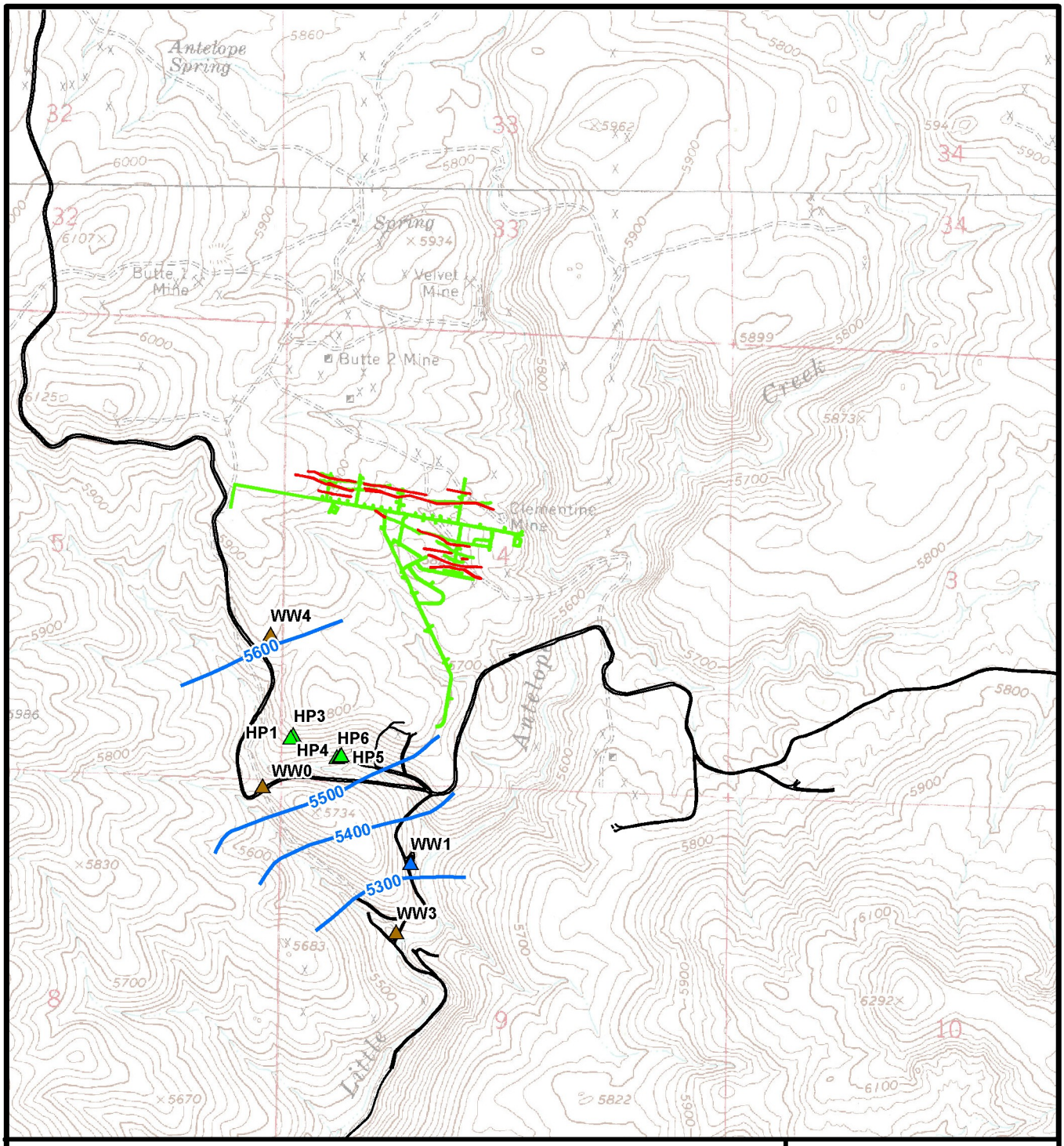
Source: BLM 2000b; Brown and Caldwell 2003.

Hollister Underground Mine Project EIS

Figure 3.5-5

Regional Groundwater Elevation Contours Prior to Dewatering at Carlin Trend Mines

3/19/2012



Legend

- Existing HP Monitoring Well
- Existing Production Well
- Abandoned Production Well
- Vein
- Existing Underground Exploration Workings
- Groundwater Elevation Contour

Note: Contour interval 10 feet.
Source: Brown and Caldwell 2003.

N

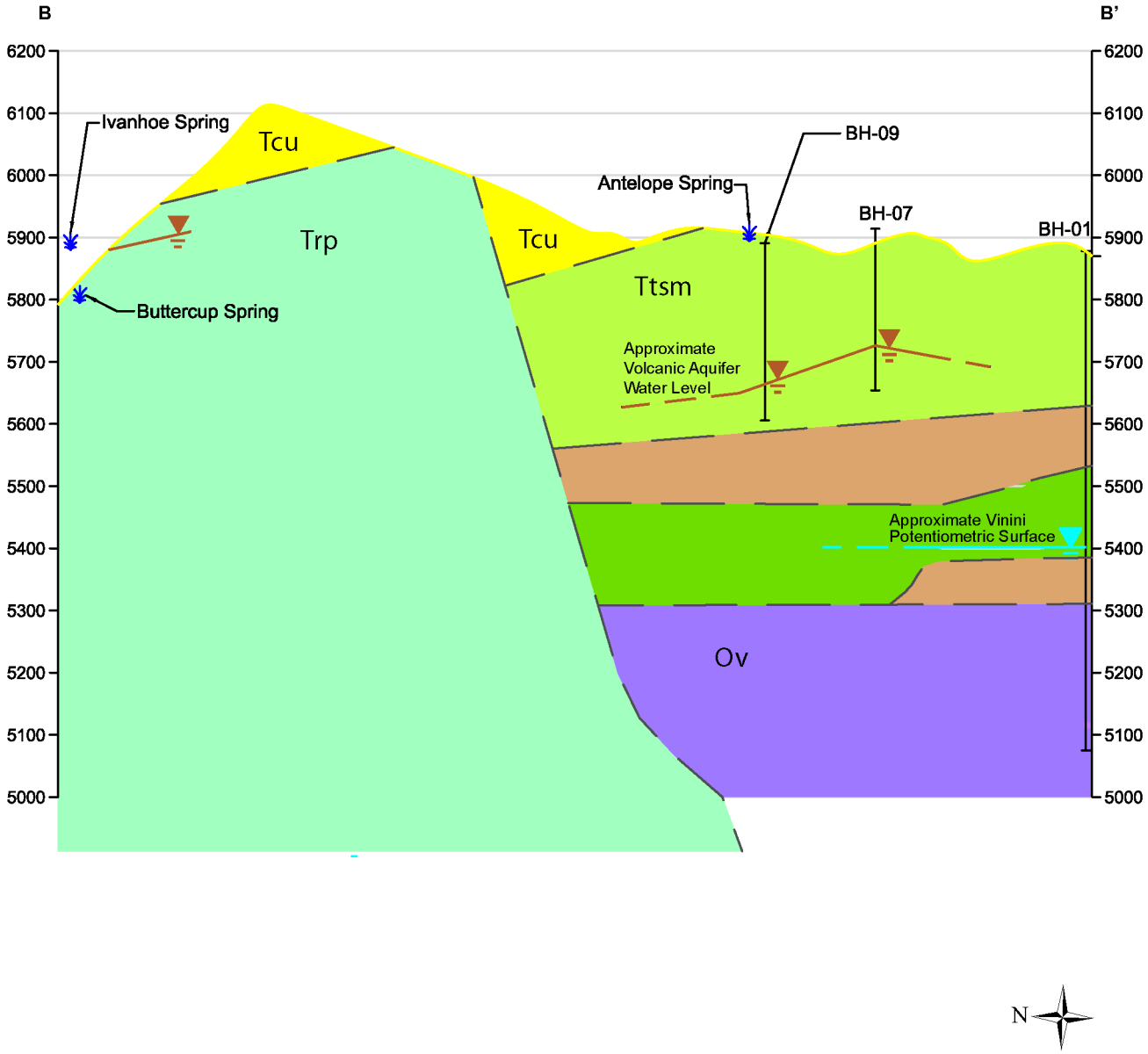
0 1,000 2,000 Feet

Hollister Underground Mine Project EIS

Figure 3.5-6

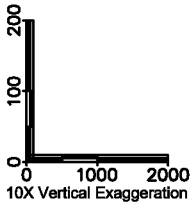
Groundwater Elevation Contours in the Volcanic Rock

3/19/2012



Legend

- Tcu - Carlin Formation, sedimentary and volcanic rocks, undivided
- Trp - Rhyolite Porphyry (Miocene)
- Ttsm - Tuffs and tuffaceous sedimentary rocks
- Basaltic Andesite
- Clay Zone/Lower Tuff (from exploration and piezometer drilling)
- Ov - Vinini Formation (Ordovician)
- Water Table Level in Volcanic Rock
- Potentiometric Surface in Vinini Formation
- Approximate Contacts



Source: Brown and Caldwell 2003.
Note: The cross-section B-B' is shown on Figure 3.5-2.

Hollister Underground Mine Project EIS

Figure 3.5-7

Hydrogeologic Cross-sections from the Exploration Decline to Buttercup and Ivanhoe Springs

East Pit Facilities

North Newmont-reclaimed Waste Rock Storage Facility

West Pit

West Newmont-reclaimed Waste Rock Storage Facility

Historic Ore Stockpile

South Newmont-reclaimed Waste Rock Storage Facility

East Newmont-reclaimed Waste Rock Storage Facility

H6-227WW 5486.73

H6-224WW 5548.15

WP-WP 5548.1

WP-P1 5550.4

WP-P2 5549

DGW-1R 5522.93

DGW-1

EW-1 5531.54

H6-226WW 5529.75

H6-230WW 5525.42

H6-225WW 5523.02

WW-1

H6-228WW 5497.14

Little Antelope Creek

Clementine Mine

5550 5540 5530 5520 5510 5500 5490 5480 5470

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Storm Water Diversion Channel
- Road
- Existing Underground Exploration Workings
- Newmont-reclaimed WRSF Stockpile
- Historic Ore Stockpile
- Monitoring Well
- Piezometer
- Piezometer/Staff Gauge
- Water Supply Well
- Inferred Groundwater Flow Direction
- Piezometric Surface Contour

Sources: MWH Americas, Inc. 2007; RCG 2009a.

N

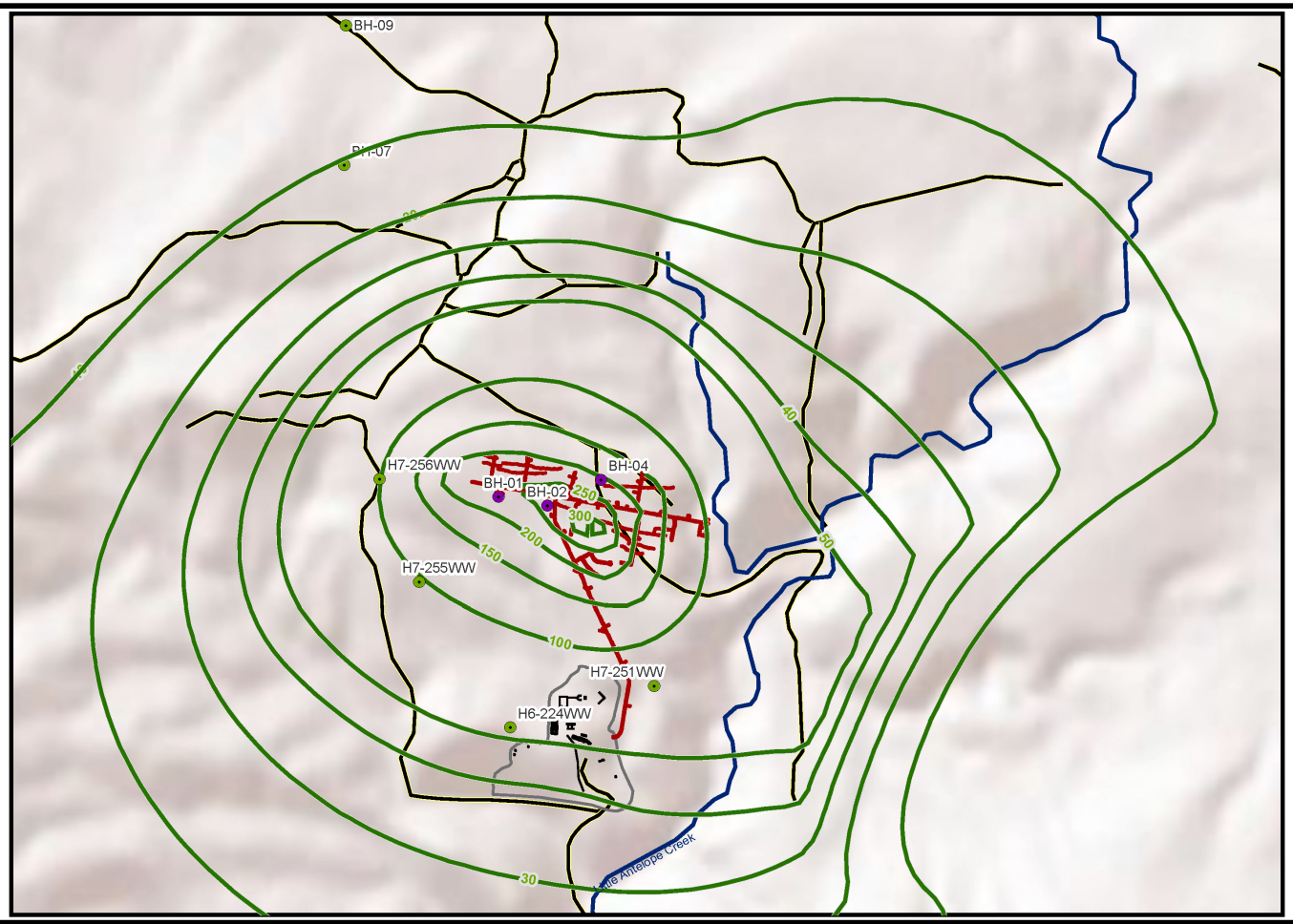
0 500 1,000 Feet

Hollister Underground Mine Project EIS

Figure 3.5-8

Perched Aquifer Flow

2/28/2012



Legend

- Monitor Well - Vinini Formation
- Monitor Well - Volcanic Rock
- Drawdown in the Vinini Formation (Simulated, December 2009)
- Existing Underground Exploration Workings
- Roads
- Little Antelope Creek

N

0 500 1,000 2,000 Feet

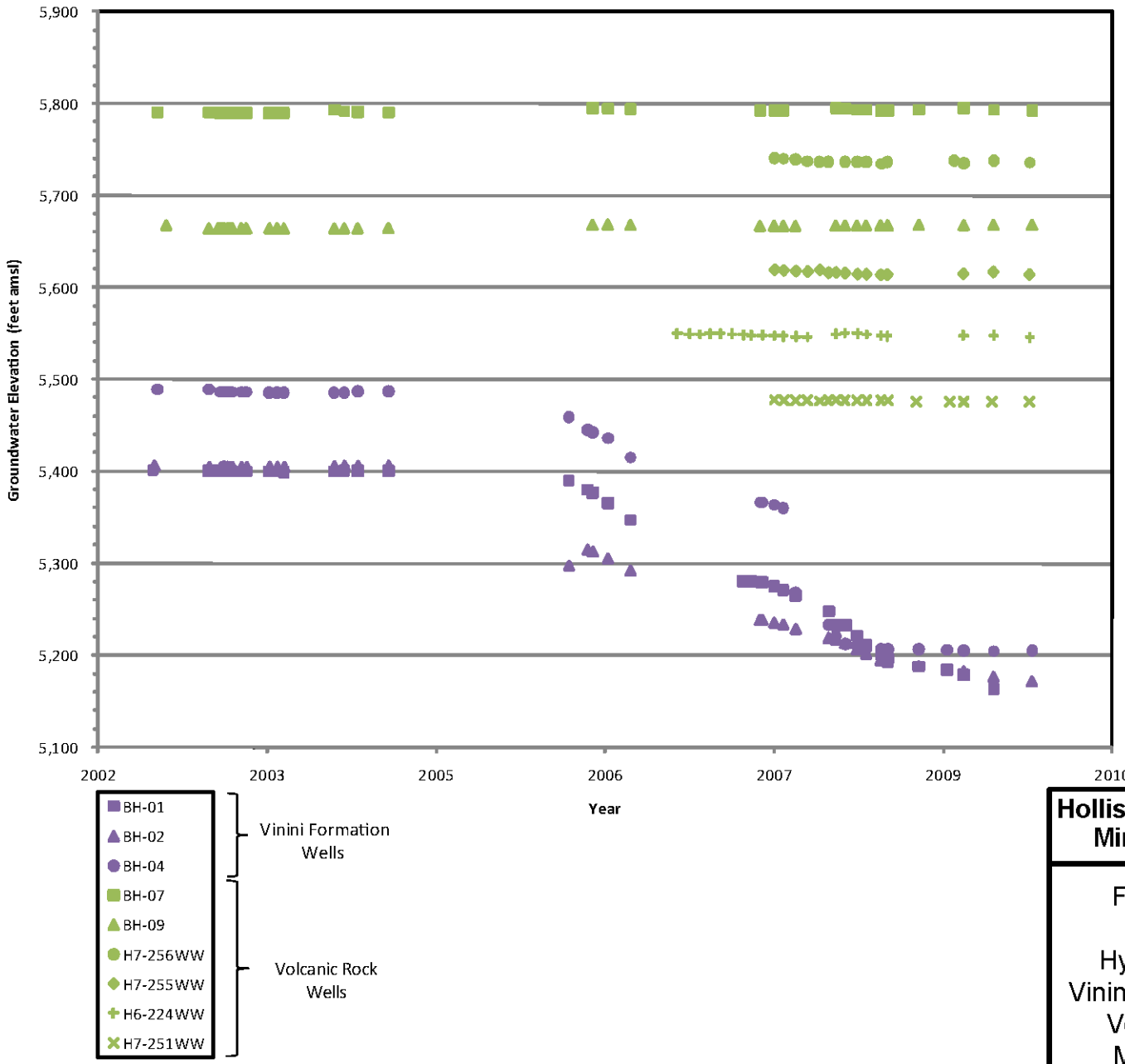
Source: Brown and Caldwell 2011a.

Hollister Underground Mine Project EIS

Figure 3.5-9

Current Vinini Formation Drawdown

03/20/2012



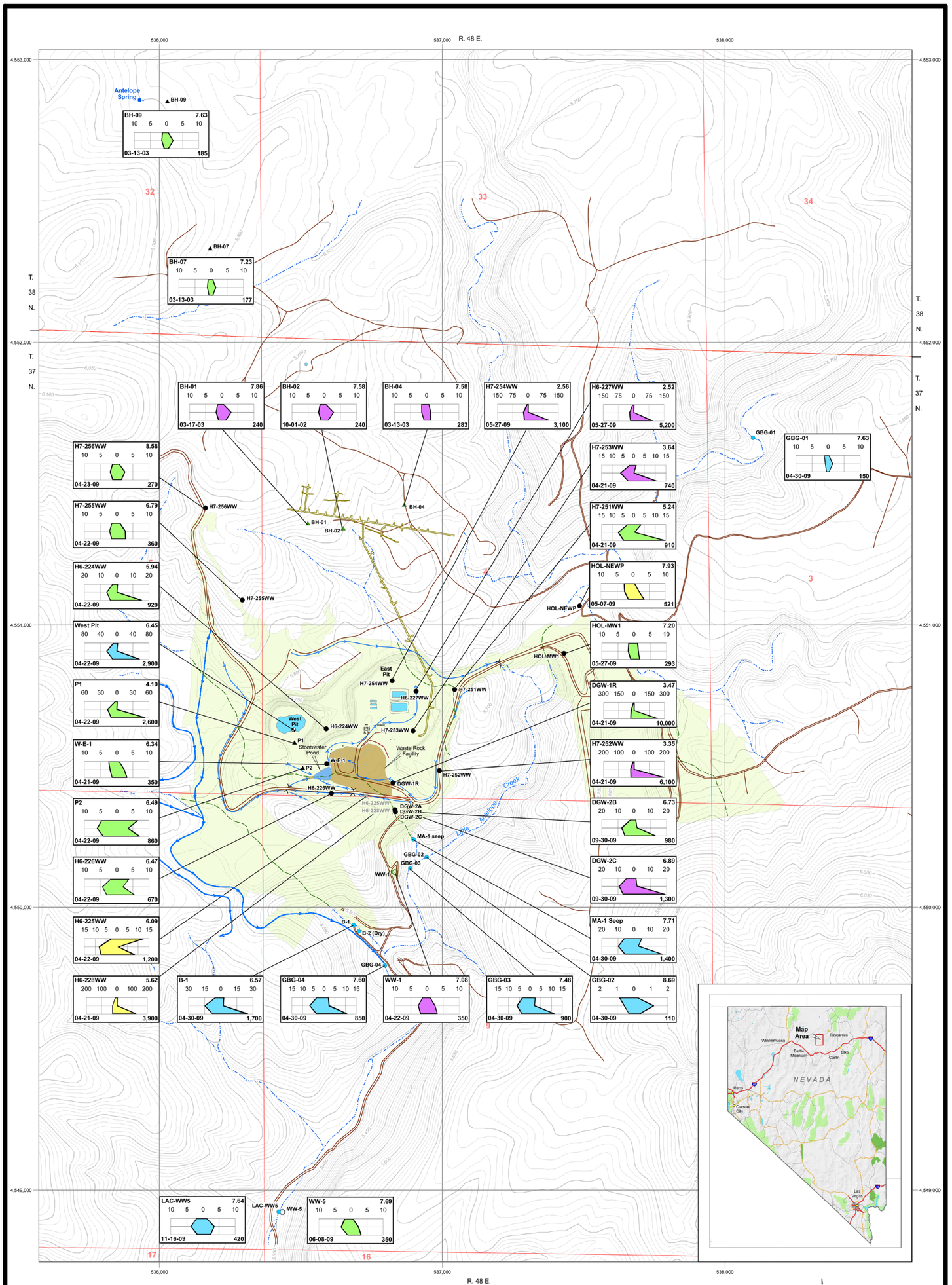
Source: Brown and Caldwell 2011a.

Hollister Underground Mine Project EIS

Figure 3.5-10

Hydrographs of Vinini Formation and Volcanic Rock Monitor Wells

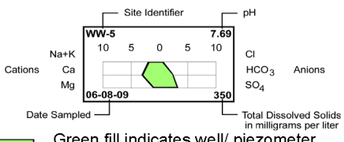
03/21/2012



Legend

- Water Supply Well Location, Vinini Aquifer
- Water Supply Well Location, Tertiary Volcanic Aquifer
- Piezometer Location, Vinini Aquifer
- Piezometer Location, Tertiary Volcanic Aquifer
- Monitor Well Location
- Abandoned Monitor Well Location
- West Pit Staff Gauge Location
- Stream Sample Location
- Surface Water Diversion Channel
- Surface Water
- Pre-mining Stream Channel (Covered By Waste Rock)
- Previous Disturbance by Historic Surface Mining (Approximate Location)

Stiff Diagram



- Green fill indicates well/ piezometer completed in Tertiary Volcanic units
- Purple fill indicates well/ piezometer completed in Ordovician sedimentary units
- Yellow fill indicates well/ piezometer completed in waste rock and/ or waste rock and Tertiary volcanic units
- Blue fill indicates surface water sample

Source: Montgomery and Associates 2010a.

Hollister Underground Mine Project EIS

Project Area Water Quality

Figure 3.5-11

03/20/2012

Overall, wells screened in the Vinini Formation away from the area of past mining show water quality generally within Nevada water quality standards with occasional exceedences of primary standards for arsenic and iron. Wells screened in the unaltered volcanic rock away from the area of past historic mining also show water quality generally within Nevada water quality standards with occasional local exceedences of primary standards for arsenic, iron, and manganese.

Groundwater quality in the area of past historic mining, both in the volcanic rock and the Vinini Formation has elevated TDS and sulfate. The groundwater in the area of past mining has been referred to as the perched aquifer (MWH Americas, Inc. 2007). The H6 and H7 series of wells are located mainly within and adjacent to the historic mined area of the West Pit and the East Pit along with the waste rock piles developed during that period of open-pit mining. Two wells screened in the volcanic rock, H7-255 and H7-256, serve as background wells and are located north and upgradient of the former mined area, as shown in **Figure 3.5-3**. These two wells have TDS less than 500 mg/L with calcium and sodium dominating the cations and sulfate and bicarbonate being about equal in concentration, making the water calcium-sodium sulfate/bicarbonate water. Iron is elevated above Nevada primary standards and arsenic ranges up to 0.4 mg/L (**Appendix B1, Table B1-2**). These background wells are within Nevada water quality guidelines for wildlife propagation.

The H6 and H7 wells screened in the area of past historic open-pit mining show the influence of pyrite oxidation on groundwater quality. TDS ranges from 800 to 39,000 mg/L, with most values between 800 and 5,000 mg/L. The groundwater is calcium sulfate water with exceedences of Nevada primary water quality standards for aluminum, arsenic, iron, manganese, and fluoride. Locally in a few wells, exceedences for thallium, mercury, cadmium, nickel, and selenium are found. The pH ranges from 2.6 to 8.0, with many values in the range of 4.0 to 7.0 standard units. These pH values are mostly below Nevada water quality guidelines for wildlife propagation. Overall, these wells indicate that groundwater in the previously mined area in both the volcanic rock and the Vinini Formation has been affected by the oxidation of pyrite.

Groundwater in the volcanic rock in the area of the West Pit, as shown in wells P1 and P2, has TDS well above 1,000 mg/L, is dominated by calcium sulfate, and has exceedences of Nevada primary water quality standards for aluminum, arsenic, iron, manganese, nickel and mercury. The pH ranges from 4.0 to 6.9 standard units and thus is below Nevada guidelines for wildlife propagation. When water is present, water quality in the West Pit pond has a TDS ranging from 1,800 to 5,800 mg/L and is calcium sulfate water with a pH ranging from 4.0 to 7.0 standard units. This area is part of the altered volcanic rock in the area of past historic mining. Sulfate and pH concentrations in the perched aquifer water are shown in **Figure 3.5-12**.

The HOL-MW-1 well screened in the volcanic rock by the reclaimed leach pad shows good water quality with TDS below 500 mg/L and no exceedences of Nevada water quality standards. The MA-1 seep located downgradient to the southeast from the area of past historic mining shows elevated TDS in the range of 1,100 to 1,360 mg/L, with sulfate slightly greater than bicarbonate and neutral pH.

In summary, groundwater in the Vinini Formation and the volcanic rock away from the area of past historic mining between the West Pit and the East Pit is generally within Nevada primary water quality standards, with local exceedences for arsenic, iron, and manganese. Within the area of past open-pit gold mining, the groundwater in the volcanic rock and the Vinini Formation shows elevated TDS, sulfate, and exceedences for many metals. This water does not meet Nevada water quality guidelines for wildlife propagation.

3.5.1.4 Waste Rock Geochemistry

Walker and Associates (2003) completed static acid-base accounting (ABA) tests, Nevada meteoric water mobility procedure (MWMP) tests, and humidity cell tests (HCTs) on lithologies from the Vinini Formation that are expected to be involved in the proposed expansion of the underground workings. No tests were conducted in the volcanic rock because RCG was not planning to conduct mining in the volcanic rock. The lithologic types tested were quartzite, siltite, argillite, and andesite that are found in the Vinini Formation. All rock tested showed hydrothermal alteration in the form of silicification, pervasive alteration to clays and chlorite, and locally alunite and pyrite up to 3 percent. Gold occurs in the Vinini Formation as gold-quartz veins surrounded by hydrothermally altered wall rock. The samples tested came from drill holes and ranged in depth from 128 feet to 1,050 feet bgs.

Different combinations of the three basic lithologies, quartzite, argillite, and siltite, were found in the drill hole samples. Quartzite contained 0.02 to 2.5 percent pyrite, while the quartzite/siltite combination contained 1.63 to 2.99 percent pyrite. The Quartzite/argillite combination contained an average of 2.04 percent pyrite. Argillite alone contained 0.3 to 1.16 percent pyrite, while argillite/siltite combination contained 1.07 to 1.43 percent pyrite. Siltite alone contained 0.4 percent pyrite (Walker and Associates 2003). Thus, pyrite is quite common in all potential waste rock types, but most common in the lithologies that have interbedded quartzite and siltite or quartzite and argillite.

Table 3.5-3 summarizes the results of the static ABA tests completed by Walker and Associates (2003) on expected waste rock for the Hollister Development Block Project. Sixty-four samples of all rock types were analyzed for ABA testing. Net neutralizing potential (NNP) is the difference between the acid neutralizing potential (ANP) and the acid generating potential (AGP) of a rock and is the measure of whether the rock has the potential to generate acidic effluent when exposed to water and oxygen. An NNP less than +20 tons of calcium carbonate/Kiloton of rock (t/Kt) is suggestive of the potential for generation of acidic effluent (BLM 2010b).

Andesite is a minor component of the waste rock at Hollister and is the only lithology with a positive average NNP. This lithology has an average NNP of 3.05 t/Kt and an average content of 0.03 percent pyrite. The average NNP of the andesite is below 20 t/Kt, making the rock type potentially acid generating. The argillite has an average NNP of –35.2 t/Kt and an average pyrite content of 1.13 percent. The quartzite has an average NNP of –29.4 t/Kt and an average pyrite content of 0.92 percent. The siltite contains the most pyrite at an average of 2.0 percent and has an average NNP of –60.5 t/Kt. Thus, all of the rock types expected to be mined and comprise part of the waste rock for the Hollister project have the potential to be acid generating and can be classified as PAG rock. This was confirmed by Walker and Associates (2003) in HCT tests on 14 samples, which showed rapid oxidation of the pyrite after the first week in tests that were conducted for 11 weeks in some samples and for 3 weeks in others, with pH values for the effluents starting below 5.0 standard units and usually ending below 3.0 standard units.

The Nevada Division of Environmental Protection (NDEP) and the BLM (BLM 2010b) require that all potential waste rock be tested using the Nevada MWMP test methodology to determine the potential for generation of effluent elevated in metals and sulfate if rain or snow melt contacts the waste rock and potentially infiltrates into the waste rock pile. **Appendix B1**, **Table B1-3** contains summary results from the MWMP tests on expected waste rock from the underground operations. The pH in these tests ranged from 3.13 to 6.58 standard units. Most pH values were below 6.0 standard units, indicating the acid generating nature of the waste rock. Overall, pH was generally below NDEP Profile I standards.

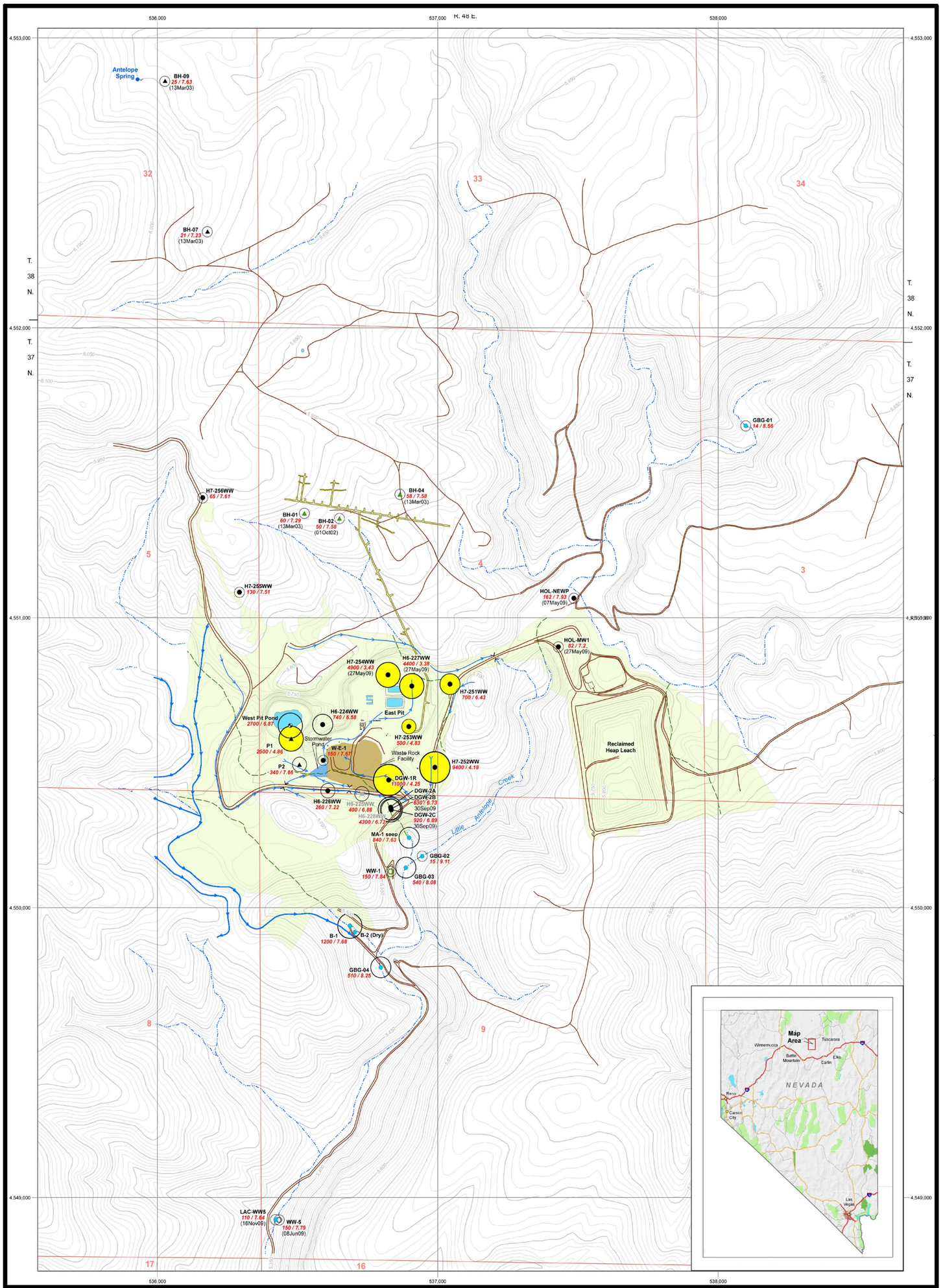


Figure 3.5-12

Sulfate and pH Values in Perched Aquifer

Hollister Underground Mine Project EIS

Legend

- Water Supply Well Location, Vinini Aquifer
- Water Supply Well Location, Tertiary Volcanic Aquifer
- Piezometer Location, Vinini Aquifer
- Piezometer Location, Tertiary Volcanic Aquifer
- Monitor Well Location
- 1200 / 7.68 — pH; Concentration of Sulfate, in milligrams per liter, April 2009, unless indicated otherwise
- Abandoned Monitor Well Location
- West Pit Staff Gauge Location
- Stream Sample Location
- Surface Water Diversion Channel
- Pre-mining Stream Channel (Covered By Waste Rock)
- Surface Water
- Previous Disturbance by Historic Surface Mining (Approximate Location)

Sulfate Concentrations (milligrams per liter)

- <250
- 251 - 500
- 501 - 1000
- 1001 - 5000
- >5000

Yellow where pH is <6.50

0 500 1,000 1,500 2,000 Feet

Source: Montgomery and Associates 2010a.

03/19/2012

Table 3.5-3 ABA Summary by Rock Type

Sample Site Units	Rock Type	NNP tons $CaCO_3$/kiloton Rock	Pyritic Sulfur (S) weight %
IH020 330-335	Quartzite	-52.8	1.69
IH020 285-295	Quartzite	-79.1	2.53
IH020 340-350	Quartzite	-6.6	0.21
IH149 198-206	Quartzite	-0.6	0.02
IH149 128-138	Andesite	8.3	-0.01
IH149 181-186	Andesite	-2.2	0.07
DDH88071 A 440-445	Quartzite	-35.9	1.15
DDH88071 A 459-463	Argillite	-36.3	1.16
IH209 1016-1026	Quartzite	-24.8	0.88
IH209 1040-1050	Quartzite	-1.7	0.3
IH-208 514-522-4	Quartzite	-42.2	1.35
IH-208 530-537	Argillite	-50.3	0.71
IH-208 547.9-556	Argillite	-11.6	0.85
IH157 1016-1026	Quartzite	-2	0.53
IH-112 308-318	Quartzite	-63.8	1.36
IH-083 587-596	Quartzite	-81.6	0.31
IH-083 596-605.7	Siltite	-93.4	0.54
IH-070 695-705	Quartzite	-44.7	0.39
IH-059 641-651	Argillite	-33.4	1.07
IH-059 651-661	Argillite	-44.4	1.42
IH-057 528-538	Quartzite	-12.6	0.41
IH-013 700-710	Siltite	-50.4	1.63
IH 013 690-700	Quartzite	-42.8	1.37
BH02 650-655	Siltite	-43.1	1.42
BH02 660-665	Siltite	-48.2	1.7
BH02 665-670	Quartzite	-19.1	0.62
BH02 675-680	Quartzite	-24.2	0.83
BH02 670-675	Quartzite	-21.5	0.83
BH02 680-685	Siltite	-56.8	1.92
BH02 655-660	Siltite	-33.2	1.14
BH03 600-605	Quartzite	-30.3	0.97
BH03 605-610	Quartzite	-20	0.64
BH03 610-615	Quartzite	-15.9	0.51
BH03 615-620	Quartzite	-15.9	0.51
BH03 620-625	Quartzite	-49.7	1.59

Table 3.5-3 ABA Summary by Rock Type

Sample Site Units	Rock Type	NNP tons $CaCO_3$/kiloton Rock	Pyritic Sulfur (S) weight %
BH03 625-630	Quartzite	-26.2	0.95
BH03 630-635	Quartzite	-16.4	0.54
BH05 510-515	Siltite	-71.2	2.55
BH05 515-520	Siltite	-69.6	2.37
BH05 520-525	Siltite	-63.1	2.02
BH05 525-530	Siltite	-73.8	2.36
BH05 530-535	Sillite	-63.5	2.04
BH05 535-540	Siltite	-83.2	2.67
BH05 540-545	Siltite	-95.9	3.07
BH06 400-405	Quartzite	-22.2	0.71
BH06 405-410	Quartzite	-26.6	0.85
BH06 410-415	Quartzite	-16.6	0.53
BH06 415-420	Quartzite	-42.5	1.36
BH06 420-425	Quartzite	-7.44	0.31
BH06 425-430	Quartzite	-10.9	0.54
BH06 430-435	Quartzite	-12.2	0.39
BH08 945-950	Quartzite	-19.9	0.88
BH08 950-955	Siltite	-24.4	0.96
BH08 955-960	Siltite	-31	1.22
BH08 960-965	Quartzite	-48.3	1.78
BH08 965-970	Quartzite	-41.9	1.49
BH08 970-975	Quartzite	-29.7	1.17
BH08 975-980	Quartzite	-21.3	0.95
BH08 980-985	Quartzite	-63.2	2.36

$CaCO_3$ = calcium carbonate.

Source: Walker and Associates 2003.

Arsenic occasionally exceeded the standards, while iron and antimony frequently exceeded the standards. Nevada wildlife propagation standards and stock water standards were exceeded for pH (**Appendix B1, Table B1-1**). Stock water standards also were exceeded occasionally for fluoride. A study completed by Hecla Ventures (2004) evaluated the effectiveness and addition rate of dolomite, which was the material determined to be the most effective in neutralizing the acid generation of Hollister waste rock. These tests were conducted using equal amounts of quartzite and argillite/siltite, which is representative of the Hollister waste rock. Humidity cell tests were run for 20 weeks using various ratios of dolomite additions. All results indicated that the ANP:AGP ratio of 1:2 was sufficient in preventing acid generation. Further, the results indicated there was no additional benefit to increasing the ANP:AGP ratio to greater than 1:2. It also was determined through this test work that the addition of dolomite essentially

eliminated constituent mobility from the waste rock. However, the BLM guidance requires an ANP:AGP ratio of 3:1, which would require dolomite additions to increase from approximately 4 percent by weight to approximately 9.7 percent by weight of dolomite. This policy requires sufficient neutralization potential from carbonate material in the rock to offset the AGP and allows for the carbonate material to be consumed faster than the acid generating material, thus ensuring that the rock would not be acid generating.

3.5.1.5 Existing Open-pit Project Waste Rock Storage Facilities

There are currently four existing Newmont-reclaimed WRSFs from past open-pit mining activities by other operators located at the Hollister Site. These are the Newmont-reclaimed North, South, East, and West WRSFs (**Figure 2-1**). In addition, there is a rinsed and reclaimed spent heap leach facility (MWH Americas, Inc. 2007). The Newmont-reclaimed East WRSF comprises approximately 6 acres and contains mostly oxidized material with an NNP ranging from 4.8 to 19.4 t/Kt (MWH Americas, Inc. 2007). The ANP:AGP ratio is 3:1, so the rock is considered to be non-acid generating. The WRSF is covered with 6 inches of vegetated topsoil. Following a very wet year in 2005, seepage from the Newmont-reclaimed South WRSF was elevated in sulfate in 2006 but had a neutral pH (MWH Americas, Inc. 2007). This seepage drained to Little Antelope Creek, approximately 500 feet from the Newmont-reclaimed South WRSF.

The Newmont-reclaimed South WRSF, also located near Little Antelope Creek, comprises 26 acres and contains both oxide and sulfide waste rock. The NNP for waste rock in this WRSF ranges from –58 to +271 t/Kt (MWH Americas, Inc. 2007). The average NNP is about 1.36, and the average ANP:AGP ratio is about 1.18:1, making this WRSF potentially acid generating (MWH Americas, Inc. 2007). In 1996, acidic water was found seeping from the Newmont-reclaimed South WRSF and was pumped to the West Pit. Limestone was added to the top 12 feet of the WRSF, and this upper limed cap was covered with 12 inches of topsoil and vegetated. The Newmont-reclaimed South WRSF continued to produce seepage with a pH between 4.0 and 6.5 standard units and elevated sulfate, so a passive bioreactor was constructed to intercept and neutralize the seepage before it reached Little Antelope Creek (MWH Americas, Inc. 2007). This bioreactor did not work as planned and is currently not operational. Seepage from the Newmont-reclaimed South WRSF flows through an upland/wetland area. Little Antelope Creek (LAC) downstream from the Newmont-reclaimed South WRSF is currently elevated in sulfate (**Table 3.6-4**).

The reclaimed heap leach pad covers 31 acres and has a 60-mil geocomposite liner underlain by compacted soil (MWH Americas, Inc. 2007). The heap leach pad was rinsed from 1993 to 1996 and is covered by 6 to 12 inches of vegetated topsoil. The long-term draindown rate is 1.0 to 1.6 gpm. The spent material in the reclaimed heap leach pad is potentially acid generating but monitoring data indicates neutral pH and slowly increasing alkalinity over time (MWH Americas, Inc. 2007). The draindown water contains elevated sulfate, selenium, arsenic, mercury, nitrate, and TDS with a neutral pH (MWH Americas, Inc. 2007). In 1999, the draindown water was mixed with organics in an infiltration leach field to reduce the potential influx of contaminants to groundwater. The leach field is monitored by well HOL-NEWP with well HOL-MW-1 as the background well. The HOL-NEWP monitor well samples show elevated pH, TDS, chloride, cyanide, nitrate, sulfate, calcium, potassium, magnesium, sodium, arsenic, boron, barium, and selenium compared to the background monitor well.

3.5.1.6 Existing RCG Waste Rock Storage Facility

There currently is an active RCG WRSF at the Hollister Site that is being used for storage of waste rock generated by the underground workings for exploration. The permitted facility is located in the East Pit (see Chapter 2.0). The design capacity of this facility is 612,000 cubic yards (yd^3) covering 7.2 acres. The facility is lined with a high-density polyethylene liner system and synthetically lined wet well sumps to capture seepage from the facility. Dolomite was placed above the liner to neutralize the acidity of any seepage. Water collected in the wet well sumps is treated in the Hollister reverse osmosis plant or the

de-silting facility, as needed, before the water is discharged to the existing RIBs. Operation of the facility and discharge of treated water is in accordance with NDEP Water Pollution Control Permits, as discussed in Chapter 2.0. Groundwater monitoring wells have been installed downgradient of the facility.

3.5.2 Environmental Consequences

The environmental consequences of the Proposed Action and alternatives relative to water quantity for the proposed project involve the impacts associated with geotechnical water removal from the expanded Hollister underground workings and the proposed Hatter Expansion. To estimate the potential impacts of groundwater removal by the expanded underground workings, RCG contracted with Brown and Caldwell to develop a three-dimensional numerical groundwater flow model for the Hollister Mine and vicinity. The model covers an area of approximately 590 square miles centered on the Hollister Mine workings, as shown in **Appendix B2, Figure 3-2**. The principal geologic unit affected by groundwater removal is the Vinini Formation. Principal surface water features within the model domain are Rock Creek, Willow Creek, Little Antelope Creek, and Antelope Creek. The groundwater model is discussed in detail in **Appendix B2**. Potential impacts to seeps and springs associated with groundwater withdrawal are addressed in Section 3.6.2, Surface Water Resources, Environmental Consequences.

Environmental consequences relative to water quality for the Proposed Action and alternatives consist of: 1) the water quality of the proposed Hollister Mine and Hatter Expansion underground workings as the workings refill with water after cessation of mining; 2) potential water quality impacts related to disposal of PAG waste rock on the surface in the Hollister Mine area; and 3) potential water quality impacts to Little Antelope Creek due to disposal of waste rock on the surface. Water quality impacts due to refilling of the underground workings were assessed with geochemical modeling; this model is described in Section 3.5.2.2, Geochemical Model. Water quality impacts due to waste rock disposal were assessed using standard NDEP- and BLM-required ABA, HCT, and MWMP tests.

3.5.2.1 Groundwater Model

Conceptual Hydrogeologic Model

Groundwater models are designed and constructed based on a conceptual understanding of the geology, hydrogeology, and groundwater flow in the area of the proposed model domain. Details on the geology can be found in Section 3.4.1, Affected Environment. The hydrogeology and groundwater elevations for the hydrostratigraphic units at the Hollister Mine are discussed in Section 3.5.1, Affected Environment. This section focuses on the conceptualization of the hydrogeology for the groundwater model.

There are three main geologic units in the Hollister Mine area: 1) volcanic rock; 2) the Vinini Formation, which contains the gold veins of the Hollister Mine; and 3) the Rodeo Creek unit. The Vinini Formation is thrust over the Rodeo Creek unit by the Roberts Mountain Thrust. The volcanic rock unconformably overlies the Vinini Formation and is separated from the Vinini Formation in the project area by clays and re-worked quartzite that form a low hydraulic permeability layer between groundwater in the volcanic rock and groundwater in the Vinini Formation. The carbonates of the Rodeo Creek unit lie approximately 6,500 feet below the surface and approximately 4,500 feet below the lowest part of the proposed underground workings in the expanded Hollister and the Hatter Expansion areas (Brown and Caldwell 2010a). Slow seepage from the saturated Vinini Formation into the underground workings requires geotechnical groundwater pumping to allow underground access to the gold-bearing Clementine, Gwenivere, and Hatter Expansion area veins. Water levels in the Vinini Formation have declined up to 300 feet due to local geotechnical groundwater removal by mine sumps during underground exploration in the Hollister area, while water levels in the overlying volcanic rock have shown only seasonal fluctuations (**Figure 3.5-10**). The Hatter Graben, which would contain the proposed Hatter Expansion area, is separated from the Hollister area by the Little Antelope Creek Fault

(**Appendix B2, Figure 2-1**), although the two areas are hydraulically connected. On the west, the veins of the Hollister area are bounded by the Butte Fault.

Regional groundwater elevations and flow directions for the bedrock and alluvial aquifers in the Carlin Trend, prior to initiation of dewatering, are shown in **Figure 3.5-5**. These elevations are a composite of water levels in all formations, including alluvial valley fill. In the mountainous areas, the composite water levels reflect the uppermost bedrock units. In the valleys, the water levels reflect groundwater elevations in alluvial valley fill. Recharge for the regional bedrock aquifers is along the Tuscarora Mountains, which are northeast and upgradient from the Hollister Site. In the vicinity of the project area, Vinini Formation groundwater flows southwest with the ridge that contains the Hollister Site acting as a groundwater divide (**Figure 3.5-5**). Groundwater flow in the volcanic rock around the Hollister Site is controlled by local topography and flows to the southeast toward Little Antelope Creek (Brown and Caldwell 2011a). The maximum extent of the 10-foot groundwater drawdown contour in the Vinini Formation in the project area is shown in **Figure 3.5-9**.

Groundwater flow in the Vinini Formation is controlled by faults, fractures, bedding planes and lithology, with the quartzites of the Vinini Formation being more conductive to groundwater flow, especially in the underground workings (Brown and Caldwell 2010a). The Little Antelope Creek Fault is a mixture of shattered rock and areas of ductile deformation, suggesting that it may not be a barrier to groundwater flow (Brown and Caldwell 2010a).

Hydraulic conductivity estimates for the Vinini Formation from constant-rate discharge tests range from approximately 0.10 feet/day for tests conducted with water wells to 2.4 feet/day for estimates from airlift tests. The storage coefficient estimated from the pumping tests is approximately 0.008 (Brown and Caldwell 2010a).

Groundwater Model Development

A detailed description of the numerical groundwater model developed for the proposed Hollister Mine and Hatter Expansion area is included in **Appendix B2**.This model was based on earlier screening-level models used to estimate groundwater flow into the existing underground exploration workings and anticipated additional groundwater flow associated with currently approved operations. These models showed that hydraulic conductivity values for the Vinini Formation of approximately 0.1 feet/day with higher values of approximately 1.12 feet/day in the exploration decline segments were appropriate for estimating the current inflow rates of approximately 335 to 385 gpm. Storage coefficients of approximately 0.008 and a specific yield of approximately 0.01 also were used in the screening-level models to match current groundwater inflow rates into the underground workings (Brown and Caldwell 2010a). Specific details regarding the groundwater model development and calibration are described in **Appendix B2**.

The groundwater model developed for the Proposed Action (Hollister mine area and the Hatter Expansion area) has the expressed purpose of estimating groundwater removal requirements and associated drawdown in the Vinini Formation. Its calibration to existing monitoring wells is limited to a few wells in the Vinini Formation near the current Hollister underground workings. The transient calibration to water levels in these wells and the matching of historic geotechnical water removal requirements in the current underground workings suggest that the model, although limited in nature, is suitably calibrated and sufficient for estimating groundwater drawdown in the Vinini Formation due to projected future mine groundwater removal.

3.5.2.2 Geochemical Model

The underground workings at the proposed Hollister Mine and Hatter Expansion areas would fill with water after the cessation of mining. Water levels eventually would reach a steady-state level close to pre-mining levels. For the proposed project, mining would cease around 2030. For the Hollister Mine, the

underground workings are predicted to be approximately 92 percent filled with water by 2050 and 99 percent recovery of groundwater levels would occur around year 2130 (Enchemica 2010). For the Hatter Expansion area, the underground workings are predicted to be more than 90 percent filled with water by 2060 and 99 percent recovery of groundwater levels would occur around 2115 (Enchemica 2010). The underground workings would be backfilled with waste rock, and the volume of the waste rock would be approximately 25 to 30 percent of the total volume of the underground workings at Hollister and the Hatter Expansion areas by the end of mining. The waste rock would be stabilized with concrete approximately every 6 feet (Enchemica 2010). (Note: the geochemical model assumed that mining would begin in 2010. Therefore, the various dates used through this document should be interpreted as the number of years that have passed since the hypothetical start of mining – 2010.)

Conceptual Geochemical Model

Groundwater from the Vinini Formation seeping into the underground workings at the Hollister and Hatter Expansion areas at the end of mining would react with sulfides and other minerals in the wall rock of the underground workings and the waste rock left in the underground workings, and would react with the concrete used to stabilize the waste rock. These reactions would result in the release of constituents from the wall rock, waste rock, and concrete. Constituents for which solubility has been exceeded would precipitate in the water. Some constituents would adsorb onto ferrihydrite (iron oxyhydroxide) as it precipitates. **Appendix B3, Figure 4-1** summarizes the conceptual reactions that are expected as the underground workings refill with water.

Geochemistry Model

A detailed description of the geochemistry model developed for the proposed Hollister Mine and Hatter Expansion area is included in **Appendix B3**. The geochemical modeling approach used the U.S. Geological Survey equilibrium geochemical modeling code PHREEQC (version 2.17) (Parkhurst and Appelo 1999) to conduct the batch mixing, estimate the reactions that would occur under equilibrium conditions between the inflowing groundwater, wall rock, waste rock, and concrete, and then determine the final water chemistry by precipitating allowed phases and modeling adsorption onto precipitating ferrihydrite.

The approach taken to modeling the post-mining final water quality in the underground workings was that of a fully mixed batch reactor (Enchemica 2010). The inflowing groundwater contains constituents found naturally in the Vinini Formation. This water then reacts with the wall rock of the underground workings. A mass of constituents is released and dissolved by the inflowing water based on the exposed surface area of the wall rock and the reactivity of the minerals in the wall rock. The waste rock left in the underground workings and the concrete also would react with water filling the underground workings due primarily to sulfate in the mine water. The addition of constituents from the wall rock, waste rock, and concrete results in chemical reactions within the inflowing water, and select solid phases precipitate, removing some constituents from solution. Iron precipitates as ferrihydrite (iron oxyhydroxide) and many metals adsorb onto the surface of the ferrihydrite and are removed from solution by precipitation of the ferrihydrite. The final chemistry of the water filling the underground workings is thus determined by chemical reactions between the inflowing groundwater and the wall rock, waste rock, and concrete as well as chemical reactions that occur in the water resulting in removal of some constituents by precipitation and adsorption.

Details regarding the geochemical model approach and background information are provided in **Appendix B3**. The geochemical and groundwater flow models would be updated a minimum of every 5 years throughout the life of the project. As the mining progresses and information from mining operations is obtained, actual data would be utilized in the model recalibrations as applicable to update the models and modeling information. The modeling results per each model would be reported to the BLM. Monitoring and mitigation is discussed in Section 3.5.4.

3.5.2.3 Proposed Action

Water Quantity Impacts

Hollister Mine – Hatter Expansion Area Impacts

Water quantity impacts associated with the Proposed Action were modeled using the given parameters discussed above and in **Appendix B2**. To model the required geotechnical groundwater removal needed to keep the underground mine workings dry as they advance over the course of the proposed development of the Hollister and Hatter Expansion areas, Brown and Caldwell (2010a) utilized the drain package of MODFLOW-SURFACT to simulate the underground workings. **Appendix B2, Figure 5-1** shows the arrangement of the drains used to model water removal by the underground workings. **Appendix B2, Table 5-2** gives the schedule of implementation of the drains in the predictive modeling of groundwater withdrawal. These drains have a length equal to the model cell length (100 feet), a width comparable to the expected underground mine width (20 feet), and a thickness of 1 foot. The hydraulic conductivity used in estimating the conductance of the drains was the same as the hydraulic conductivity used for the layer in which the drain exists.

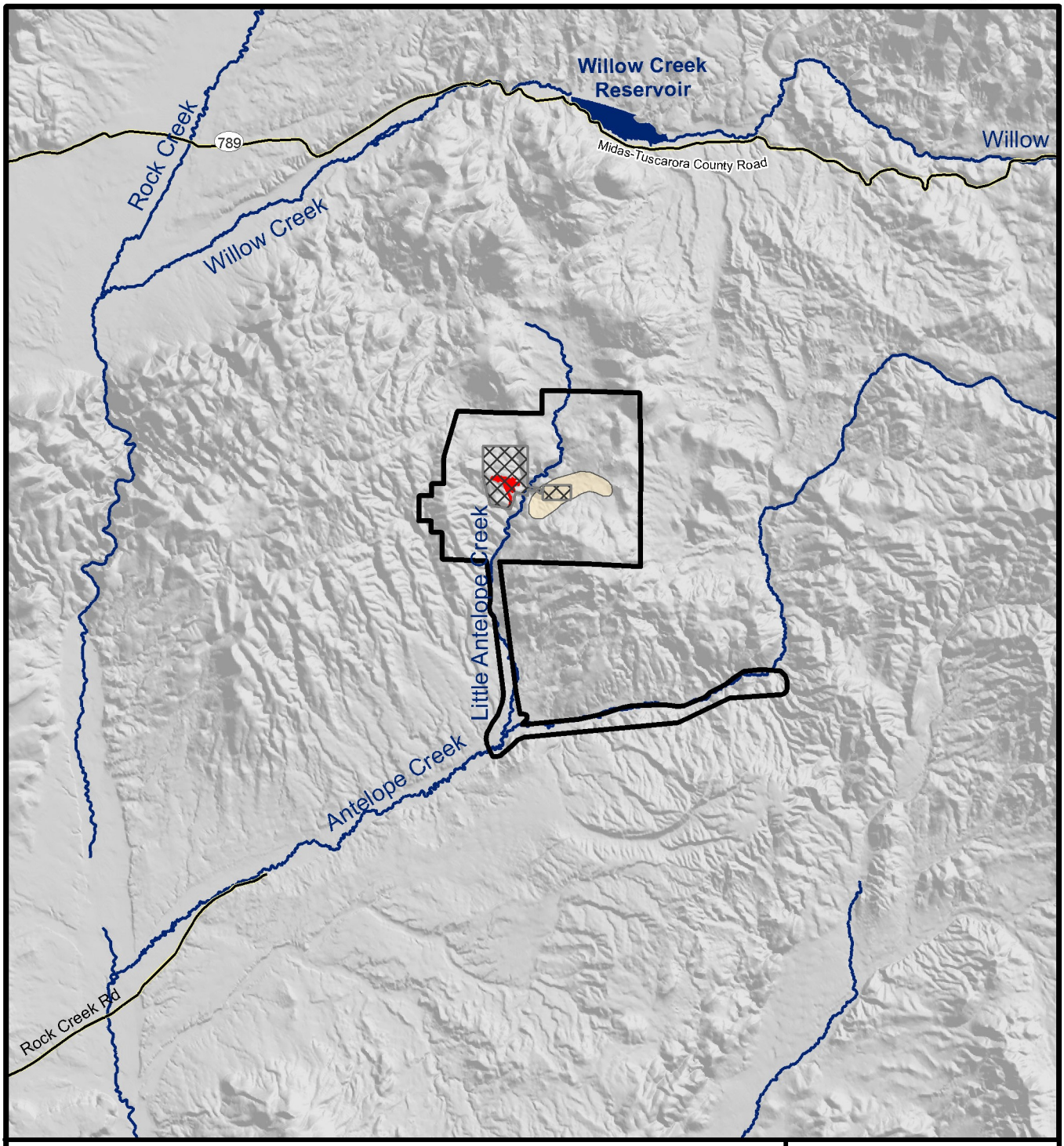
The modeled groundwater removal rate for the life of the proposed Hollister Mine and Hatter Expansion areas is shown in **Appendix B2, Figure 5-8**. The maximum rate of groundwater seepage withdrawal would be approximately 1,100 gpm, and this would occur in approximately year 2015. After that, the rate would drop and stabilize at approximately 600 to 700 gpm for the remainder of the proposed mine life. Currently, groundwater removal is at a rate of approximately 400 gpm.

The simulated drawdown in the Vinini Formation at the end of 2016 is shown in **Appendix B2, Figure A-6**. The predicted drawdown at the end of 2 016 in the Hatter Expansion area is approximately 600 feet. The maximum predicted drawdown in the Hollister Mine area is approximately 550 feet. Simulated water levels in the Vinini Formation at 2016 are shown in **Appendix B2, Figure A-3**. Groundwater would seep into the mine workings rather than continue downgradient to the southwest. The simulated drawdown in the Vinini Formation at the end of mining in 2030 is shown in **Figure 3.5-13**. By the end of mining, drawdown in the Hatter Expansion area is predicted to be approximately 1,400 feet, and drawdown in the Hollister area is predicted to be approximately 200 feet due to refilling of the Hollister workings. Simulated groundwater levels in the Vinini Formation in 2030 are shown in **Figure 3.5-14**. By the end of mining in 2030, groundwater would be seeping into the Hatter Expansion area from a broad area around the project. The Hatter Expansion area would act as a regional sink for groundwater flow in the Vinini Formation.

The maximum extent of the groundwater drawdown contour is predicted to occur in year 2070, approximately 40 years after the cessation of mining, as shown in **Figure 3.5-15**. Water levels in the Vinini Formation at the predicted maximum extent of drawdown in 2070 are shown in **Figure 3.5-16**. The maximum extent of the 10-foot groundwater drawdown contour is predicted to extend just beyond Antelope Creek to the southeast and just beyond Willow Creek to the northwest.

A screening methodology was used to evaluate potential impacts to seeps and springs associated with groundwater drawdown. The following steps were involved in this screening process.

As a first step in the analysis, springs located within the maximum extent of the 10-foot groundwater drawdown contour area within the Vinini Formation were identified. These springs, including an indication of their surface location and geology, are listed in **Appendix C, Table C-1**. Their locations are shown in **Appendix C, Figure C-1**.



Legend

- Project Area Boundary
- 2030 Simulated Drawdown (feet)
- Streams
- Roads
- Intrusive Area (Model Low Permeability Area)
- Existing Underground Exploration Workings
- Proposed Action Conceptual Underground Workings Areas

Note: Mining activities for the Proposed Action are simulated to end in 2030.
Source: Brown and Caldwell 2010a.

N

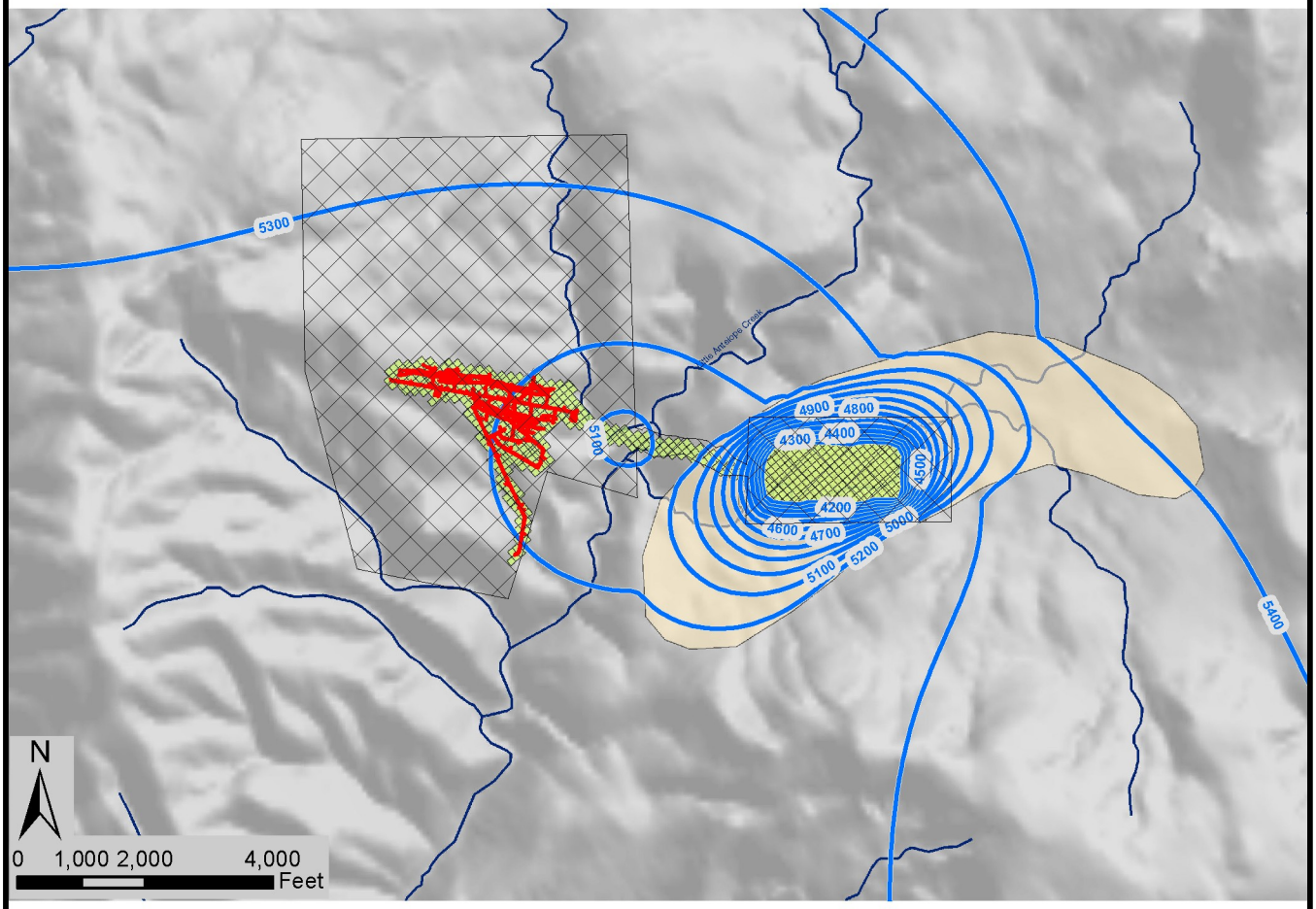
0 1.25 2.5 Miles

Hollister Underground Mine Project EIS

Figure 3.5-13

Proposed Action Simulated Drawdown in the Vinini Formation in 2030

2/29/2012



Legend

- 2030 Simulated Water Levels (feet amsl)
- Simulated Drain Cells
- Existing Underground Exploration Workings
- Intrusive Area (Model Low Permeability Area)
- Proposed Action Conceptual Underground Workings Area
- Streams

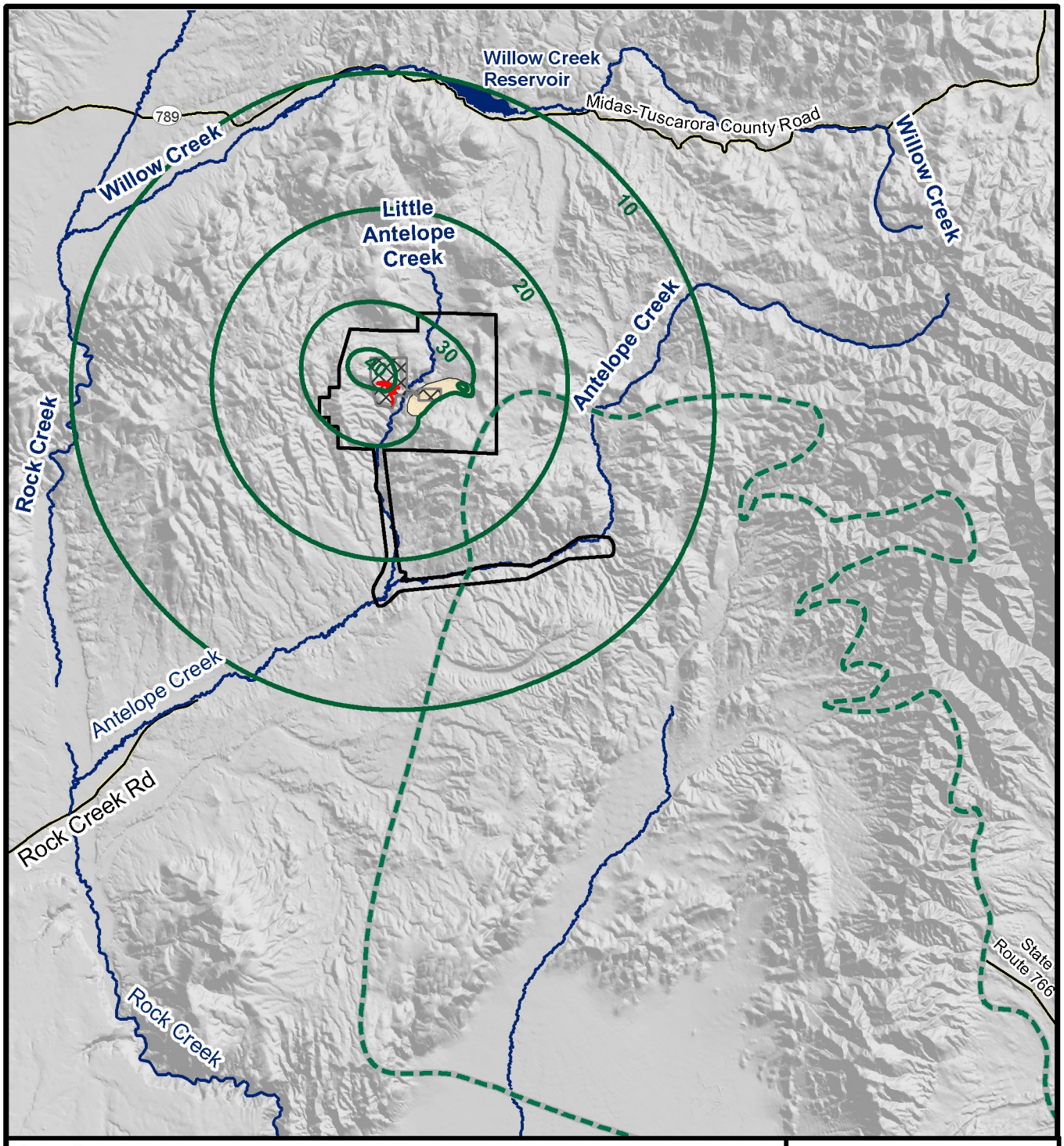
Note: Mining activites for the Proposed Action are simulated to end in 2030.
Source: Brown and Caldwell 2010a.

Hollister Underground Mine Project EIS

Figure 3.5-14

Proposed Action Simulated Water Levels in the Vinini Formation in 2030

12/30/2011



Legend

- Project Area Boundary
- Maximum Extent of Drawdown (drawdown in feet)
- Existing Underground Exploration Workings
- Intrusive Area (Model Low Permeability Area)
- Proposed Action Conceptual Underground Workings Areas
- Maximum Extent of Barrick Cumulative 10-foot Drawdown Contour (Barrick 2007 Model)
- Roads

Note: Mining activities at the Hatter Expansion area simulated to stop in 2030.
Source: Brown and Caldwell 2010a.

N

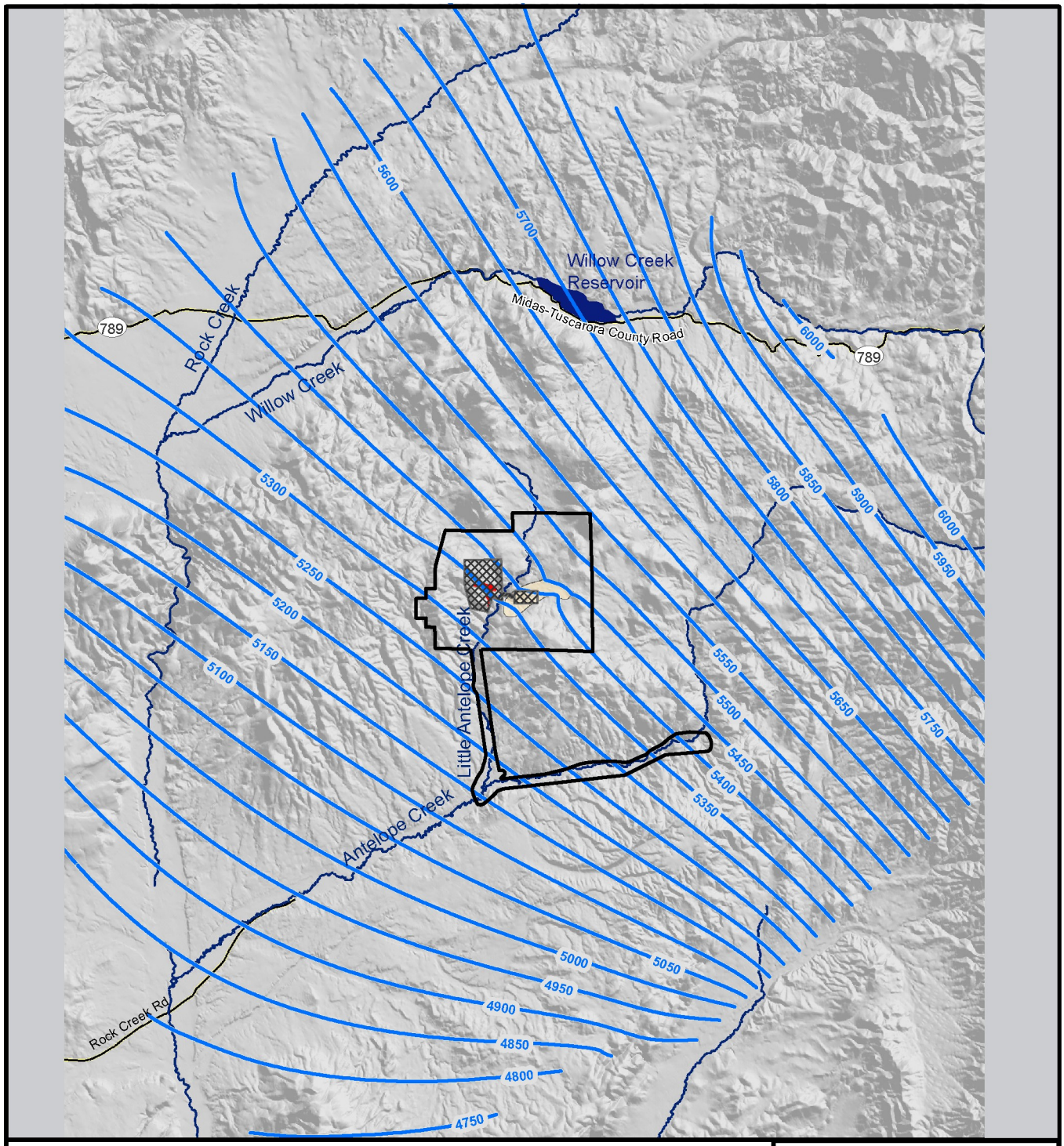
0 2 4 Miles

Hollister Underground Mine Project EIS

Figure 3.5-15

Proposed Action Simulated Maximum Extent of 10-foot Drawdown (2070)

2/29/2012



Legend

- Project Area Boundary
- 2070 Simulated Water Levels (feet amsl)
- Existing Underground Exploration Workings
- Intrusive Area (Model Low Permeability Area)
- Proposed Action Conceptual Underground Workings
- Streams
- Roads

Source: Brown and Caldwell 2010a.
Note: Mining activites for the Proposed Action were simulated to end in 2030.

N

0 1.5 3 Miles

Hollister Underground Mine Project EIS

Figure 3.5-16

Proposed Action Simulated Water Levels in the Vinini Formation at Time of Maximum Extent of Drawdown (2070)

02/29/2012

In the next step, springs within the predicted maximum extent of the 10-foot groundwater drawdown contour were evaluated relative to the geology of the water source. Springs sourced in the Vinini Formation within the maximum extent of the 10-foot groundwater drawdown contour potentially could be affected by drawdown in the Vinini Formation. Springs in Pennsylvanian/Permian units (Strathearn Formation) above the Vinini Formation within the maximum extent of the 10-foot groundwater drawdown contour may be affected by drawdown in the Vinini Formation if there is a hydraulic connection between these geologic units and the Vinini Formation. Springs in volcanic rock are not expected to be affected by drawdown in the Vinini Formation because of the extensive clay and silica alteration in the volcanic rock (Brown and Caldwell 2011a). Springs in the Tertiary Carlin Formation are not anticipated to be affected by drawdown in the Vinini Formation because the Carlin Formation is not likely to have hydraulic connection to the Vinini Formation due to clay in the Carlin Formation. **Appendix C, Table C-1** summarizes the geologic information of the springs, and **Appendix C, Figure C-2** shows all springs in the project vicinity and their geologic associations.

In the third step, springs within the maximum extent of the 10-foot groundwater drawdown contour were classified according to their specific geologic formation, groundwater elevation, and spring elevation. Springs sourced in the Vinini Formation with a spring elevation less than 50 feet above the groundwater elevation potentially would be affected by groundwater drawdown in the Vinini Formation. There also is a potential for springs sourced in the Strathearn Formation to be affected by groundwater drawdown in the Vinini Formation if there is a hydraulic connection between the Vinini and Strathearn formations. The 50-foot criterion (spring elevation less than 50 feet above the groundwater elevation) was selected based on the potential error in projecting the groundwater elevation contours in the Hollister area.

There are four spring complexes with some potential for impact by groundwater drawdown in the Vinini Formation (Section 3.6, Surface Water Resources and Watersheds, **Figures 3.6-4** and **3.6-5**). A spring complex is a local, geographically distinct area that contains one or more springs. A discussion of the specific seeps and springs potentially affected by groundwater drawdown associated with groundwater removal from development of the proposed Hollister Mine and Hatter Expansion area is provided in Section 3.6, Surface Water Resources and Watersheds.

Mining would end around 2030, and groundwater rebound would commence as the pumping is shut down. The simulated rebound of the water table shows recovery to within approximately 100 feet of the pre-mining water levels by 2050 at the Hollister area and by 2060 at the Hatter Expansion area. Ninety-five percent recovery of the water table would occur around 2060 at the Hollister area and 2065 at the Hatter Expansion area. Nearly full recovery of the water table (99 percent) would take until approximately year 2115 for the Hatter Expansion area (Enchemica 2010). Modeled groundwater refilling curves for the Hollister Mine and the Hatter Expansion areas are shown in **Appendix B2, Figures 5-9** and **5-10**, respectively.

Groundwater modeling results predict impacts to water levels in the Vinini Formation in the vicinity of the Hollister Mine with potential impacts to seeps, springs, and other water dependant resources as a result of geotechnical water removal under the Proposed Action.

Potential impacts to water rights are discussed in Section 3.6, Surface Water Resources and Watersheds.

West Pit WRSF Impacts

Under the Proposed Action, waste rock from underground mining at the Hollister and the Hatter Expansion areas would be disposed of by: 1) backfilling the underground workings, 2) surface disposal in the existing WRSF, and 3) surface disposal in the proposed West Pit WRSF. Because waste rock at both Hollister and the Hatter Expansion areas is PAG, the proposed WRSF in the existing West Pit would need to be a zero discharge facility. As discussed in Section 2.4.4.2, the West Pit WRSF would

have a geosynthetic liner on top of a base composed of non-PAG aggregate covered by compacted silt-sized material, and a wet well above the liner to remove any seepage to a facility where the seepage can be routed through the water treatment facility at the Hollister Mine. In addition, the sides of the West Pit would be lined with shotcrete (concrete sprayed onto a surface) over a height of 40 to 50 feet. Dolomite would be mixed with the PAG waste rock in a ANP:AGP ratio of 3:1 following BLM guidelines. The proposed West Pit WRSF would be reclaimed with a soil evapotranspiration cover and 6 to 12 inches of growth media (Section 2.4.4.2). This design would prevent seepage from the West Pit WRSF from reaching groundwater and would thus be protective of the perched aquifer water quantity and quality. No impacts to the perched aquifer are expected from the West Pit WRSF.

Currently, the West Pit serves as a groundwater sink for the perched aquifer in the volcanic rock (Brown and Caldwell 2010c). Evaporative loss from the pit was estimated at approximately 192,545 cubic feet per year (feet^3/year) (approximately 2.7 gpm) (Brown and Caldwell 2010c). When the pit is backfilled, evaporation from the pit would cease, and groundwater in the perched aquifer would flow through and past the pit, rather than being diverted toward the pit. The estimated flow-through rate for groundwater in the perched aquifer would be approximately 106,000 to 130,000 feet^3/year (Brown and Caldwell 2010c). This would result in an increased flux of groundwater flowing southeastward toward Little Antelope Creek of up to 1.8 gpm.

RIBs Impacts

Continued discharge of water to the RIBs located near the confluence of Little Antelope and Antelope creeks would result in localized mounding in the alluvial material beneath the RIBs. This increase in alluvial water levels would be limited to the immediate area of the RIBs.

Water Quality Impacts

Hollister and Hatter Expansion Area Impacts

The Hollister and the Hatter Expansion areas would fill with groundwater after cessation of mining. It would take approximately 200 years for both areas to completely fill with groundwater and reach steady-state water levels. Water quality in the underground mine water at steady-state is provided in **Table 3.5-4**. Under the total exposed surface area for waste rock backfill and wall rock of 5.411 square meters per liter (m^2/L), the mine water after 200 years is predicted to be alkaline with a pH of 10.2 and would exceed NDEP Profile I reference standards for aluminum, antimony, chromium, selenium, sulfate, thallium, and TDS. Geochemical modeling was also performed for the higher 54.11 m^2 of surface area to account for possible uncertainties in the particle sizes of the backfilled material. The results of this modeling were essentially the same as for the 5.41-m^2 particle size modeling with similar exceedences of the NDEP Profile I standards. Beryllium would exceed the NDEP Profile I standards in the case of the higher surface area of 54.11 m^2, but not in the case of the lower 5.41 m^2 of surface area. Sulfate would be approximately 1,600 mg/L, and the water would be calcium sulfate dominated. The level of sulfate in the mine water would be controlled by the precipitation of gypsum, and precipitation of ferrihydrite (iron oxyhydroxide) would limit the concentration of many metals due to adsorption onto the ferrihdyrite. Calcite precipitation would limit calcium and bicarbonate in the mine water.

Precipitation of silica as chalcedony, fluorite, kaolinite, sepiolite and torbermorite would limit the values of silica, fluoride, aluminum, magnesium, and calcium in the mine water. Barium and arsenic would be controlled by precipitation of a barium arsenate solid, and copper would be controlled by precipitation of tenorite (Enchemica 2010). Although the mine water would exceed NDEP Profile I reference values for some constituents, mainly pH, aluminum, antimony, beryllium, chromium, selenium, sulfate, thallium, and TDS, the mine water would not be accessed by wildlife or humans. Potentially, the mine water would migrate in fractures downgradient (southwest) from the mine workings.

Table 3.5-4 Mine Wall Rock and Waste Rock Surface Area Predicted Aqueous Concentrations

Water Quality Constituents	Mine Wall Rock and Waste Rock Surface Area		NDEP Profile I Reference Value
	Expected Average Surface Area (5.411 m^2/L)	Expected Maximum Surface Area (54.11 m^2/L)	
pH (standard units)	**10.24**	**10.32**	6.5 to 8.5
Pe (dimensionless)	10.32	3.04	--
Aluminum (mg/L)	**0.2164**	**0.2641**	0.2
Antimony (mg/L)	**0.02222**	**0.1381**	0.006
Arsenic (mg/L)	5.477×10^{-7}	4.100×10^{-6}	0.01
Barium (mg/L)	0.001997	6.134×10^{-4}	2.0
Beryllium (mg/L)	0.002037	**0.01684**	0.004
Boron (mg/L)	0.34651	2.516	--
Total inorganic carbon (as CO_3^{2-})	1.491	5.111×10^{-9}	--
Cadmium (mg/L)	1.427×10^{-4}	0.001451	0.005
Calcium (mg/L)	638.6	548.8	--
Chloride (mg/L)	30.17	75.12	400
Chromium (mg/L)	**0.2253**	**0.4303**	0.1
Copper (mg/L)	2.685×10^{-4}	2.880×10^{-4}	1
Fluoride (mg/L)	1.964	2.367	4
Iron (mg/L)	4.929×10^{-4}	5.948×10^{-4}	0.6
Lead (mg/L)	9.402×10^{-7}	1.055×10^{-5}	0.015
Magnesium (mg/L)	0.004043	0.003428	150
Manganese (mg/L)	3.004×10^{-8}	6.367×10^{-4}	0.1
Nickel (mg/L)	0.02087	0.05370	0.1
Nitrate as N (mg/L)	1.782	5.241	10
Potassium (mg/L)	43.48	414.1	--
Selenium (mg/L)	**0.3231**	**0.08062**	0.05
Silica (mg/L)	68.80	80.27	--
Sodium (mg/L)	56.83	298.2	--
Sulfate (mg/L)	**1,602**	**2,277**	500
Thallium (mg/L)	**0.03141**	**0.3158**	0.002
Zinc (mg/L)	1.935×10^{-5}	0.05634	5
Total Dissolved Solids (mg/L)	**2,473**	**3,736**	1,000
Ionic Strength (moles/L)	0.04528	0.06398	--

All units mg/L unless otherwise noted.

-- indicates no NDEP Profile I standard.

Bold = NDEP profile/reference value exceedences.

Source: Enchemica 2010.

Dilution of such constituents is expected to occur as native groundwater replaces the mine volume. Downgradient attenuation of water quality constituents is expected to occur due to dilution, hydrodynamic dispersion, and chemical processes (Brown and Caldwell 2012).

Because estimates of total exposed surface area require assumptions, there is a level of uncertainty associated with any estimate of exposed reactive surface area. To evaluate the possible maximum range of concentrations of constituents in the mine water, predictions of mine water chemistry also were run using an estimated exposed surface area of 54.11 m^2/L, which is 10 times that used in the base case predictions. These results also are given in **Table 3.5-4**. The main differences are a lower oxidation level (pe value of 3.04 vs 10.3), higher antimony, higher beryllium, higher boron, higher chloride and fluoride, higher chromium, much higher potassium and sodium, and considerably higher sulfate and TDS. Exceedences of the NDEP Profile I reference standards are the same as in the base case, with the addition of beryllium. As with the base case, the mine water would not be accessible to humans or wildlife.

Water that fills the post-mining underground workings when groundwater returns to steady state would have a TDS value well above Nevada drinking water standards (**Appendix B, Table B1-1**). The pH would be more alkaline than any Nevada standards, including stock water and wildlife propagation standards, because of the concrete used in the mine backfill. Antimony, thallium, and chromium would exceed drinking water standards, and beryllium would exceed those standards for the expected maximum surface area case. Selenium would exceed Nevada drinking water standards and stock water standards. Sulfate would exceed drinking water standards. The underground post-mining water quality would not meet drinking water standards or stock water standards for some constituents.

When post-mining groundwater levels reach steady-state, in excess of 130 years after cessation of mining, groundwater would then begin to flow through the refilled underground workings and transport the elevated constituents found in the refilled underground workings downgradient to the southwest. Brown and Caldwell (2012) estimated the concentration of key elevated constituents at the southwest project boundary using three-dimensional transport modeling with MODFLOW-SURFACT (Hydrogeologic 1996) and two-dimensional equilibrium reaction path modeling with PHREEQC (Parkhurst and Appelo 1999).

The estimated transport time from the underground workings to the southwest project boundary for the first flush of mine water is about 400 years. At the project boundary (approximately 2 miles southwest of the underground workings), after mixing with background groundwater, geochemical modeling predicts that the plume of first flush mine water would be elevated above NDEP Profile I standards for antimony, iron, sulfate, and thallium (**Appendix B, Table B1-4**). The results of the geochemical modeling (**Appendix B, Table B1-4**) represent the highest predicted constituent concentrations in groundwater at the project boundary, because the calculations were performed using the initial underground workings water composition and only two-dimensional dispersion was considered. Transport modeling was conducted on the four chemical constituents (iron, thallium, sulfate, and antimony) that geochemical modeling predicted to exceed Profile l standards at the project boundary to account for three-dimensional hydrodynamic dispersion. Transport modeling results indicate that at the project boundary at approximately 400 years: 1) iron is predicted to reach a maximum concentration of approximately 0.053 mg/L, which is lower than the 0.60 mg/L Profile l standard; 2) thallium is predicted to reach a maximum concentration of 0.00143 mg/L, which is less than the Profile l standard of 0.002 mg/L; 3) sulfate is predicted to reach a maximum concentration of approximately 101 mg/L, which is less than the Profile 1 standard of 500 mg/L ; and 4) antimony is predicted to reach a maximum concentration of 0.0104 mg/L , which exceeds the Profile l standard of 0.006 mg/L, but background concentrations are 0.010 mg/L and exceed the standard (Brown and Caldwell 2012). Although aluminum, chromium, and selenium concentrations in the underground workings water exceed their NDEP Profile I reference levels, the effects of dilution and moderating pH values during groundwater transport to the project boundary would result in concentrations below the NDEP Profile I reference value. In summary, when

three-dimensional hydrodynamic dispersion is considered in addition to geochemical reactions, only antimony is likely to exceed Profile I standards at the project boundary, but background concentrations of antimony already exceed the Profile I standard. Over time, continued flow of groundwater through the mine workings would result in lower concentrations of constituents being flushed from the mine workings.

West Pit WRSF Impacts

As discussed above under Water Quantity Impacts, the proposed West Pit WRSF would be designed to prevent seepage of effluent to groundwater, and would thus be protective of groundwater quality. No impacts to the perched aquifer groundwater quality are expected from the West Pit WRSF. Because backfilling of the pit would result in an increased flux of the perched aquifer groundwater in the volcanic aquifer toward Little Antelope Creek, the flux of high TDS water with elevated sulfate in the perched aquifer flowing toward Little Antelope Creek would be expected to increase by up to 1.8 gpm. Geochemical analysis using sulfate/chloride ratios (Brown and Caldwell 2010c) suggests that there is not a direct geochemical pathway from the West Pit area to the MA-1 seep in Little Antelope Creek. However, the changes in groundwater flow pathways that may result from the backfilling of the West Pit cannot be anticipated with certainty at this point. Therefore, continued monitoring of the MA-1 seep is recommended.

RIBs Impacts

No groundwater quality impacts are anticipated because current water discharge to RIBs from underground exploration meets water quality permit requirements and would be expected to continue to meet permit requirements under the Proposed Action.

Surface Exploration Impacts

Potential groundwater impacts would include localized aquifer water quality degradation from exploration drilling operations. Impacts would be minimized as all drill holes would be plugged and abandoned according to NAC 534 regulations. Water bearing zones would be sealed to prevent possible contamination between different aquifer zones (i.e., volcanic rock and Vinini Formation) in the drill holes. As a result of these groundwater protection measures, impacts to groundwater resources from surface exploration would be minimal.

3.5.2.4 Mud Springs Road Transmission Line Alternative

Removal of groundwater from mining operations would be the same under this alternative as under the Proposed Action. Therefore, estimated impacts to groundwater quantity and quality would be the same as under the Proposed Action.

3.5.2.5 Mud Springs Waste Rock Storage Facility Alternative

This alternative would allow for the placement of potentially acid-generating waste rock in a new WRSF located along Mud Springs Road east of the historic heap leach facility, as discussed in Chapter 2.0. The Mud Springs WRSF would contain approximately 1.1 million yd^3 of PAG waste rock intermixed with sufficient dolomite to ensure a 3:1 neutralizing capacity to reduce the potential for generation of acidic seepage. To meet the BLM guidance for neutralizing AGP from the 1.1 million cubic yards projected to be contained in the Mud Springs WRSF, an estimated 105 tons of dolomite must be mixed with every 1,000 tons of waste rock (see Section 2.4.4, Waste Rock Management, for how this tonnage rate was calculated). The facility would be lined and have a collection sump to collect any seepage. The site for the proposed facility would require considerable preparation to ensure long-term stability of the facility. Surface water diversion channels would be constructed around the facility. The waste rock would be covered during reclamation with a 36-inch soil and rock cover similar to the existing RCG WRSF and designed to minimize infiltration of precipitation and snowmelt (Section 2.2.10.3, Reclamation of Existing

RCG Waste Rock Storage Facility). Approximately 79,000 yd^3 of material would be imported for construction of the Mud Springs WRSF cover. No surface water or groundwater impacts are expected.

3.5.2.6 Backfill Alternative

Water Quantity Impacts

Under this alternative, RCG would backfill the Hatter production shaft, ramp, or raise (HPS) and the East and West escape raises with waste rock. The shaft and raises would be constructed with concrete liners for stability; over time this concrete can be expected to deteriorate and allow the entrance of groundwater into the shaft and raises. The waste rock backfill would allow passage of groundwater laterally through the shaft and raises due to its blocky, and thus porous, nature. This condition would be expected to enhance groundwater flow laterally through the shaft and raises once the groundwater table has recovered to steady state and pre-mining groundwater flow patterns have been restored. Thus, sections of the shaft and raises that are below the post-mining steady state groundwater level would be expected to experience lateral groundwater flow. A mound of non-PAG rock and soil would cover the backfilled openings to facilitate reclamation and diversion of surface drainage off the mound. The cover would be designed to minimize infiltration of meteoric water.

Water Quality Impacts

Under this alternative, the HPS and the East and West escape raises would be backfilled with PAG waste rock. To offset potential acid generation, the waste rock would be mixed with dolomite such that a minimum neutralizing potential of approximately 3:1 is achieved. The backfilled waste rock likely would release constituents during the oxidation of the PAG waste rock and mobilization of these constituents by groundwater. Some of these constituents may reach levels that exceed Nevada groundwater standards within the shaft or raises. Groundwater flowing laterally through the shaft and raises after a post-mining steady-state condition is reached may transport some constituents beyond the shaft and raises and thus degrade waters of the state for a short distance.

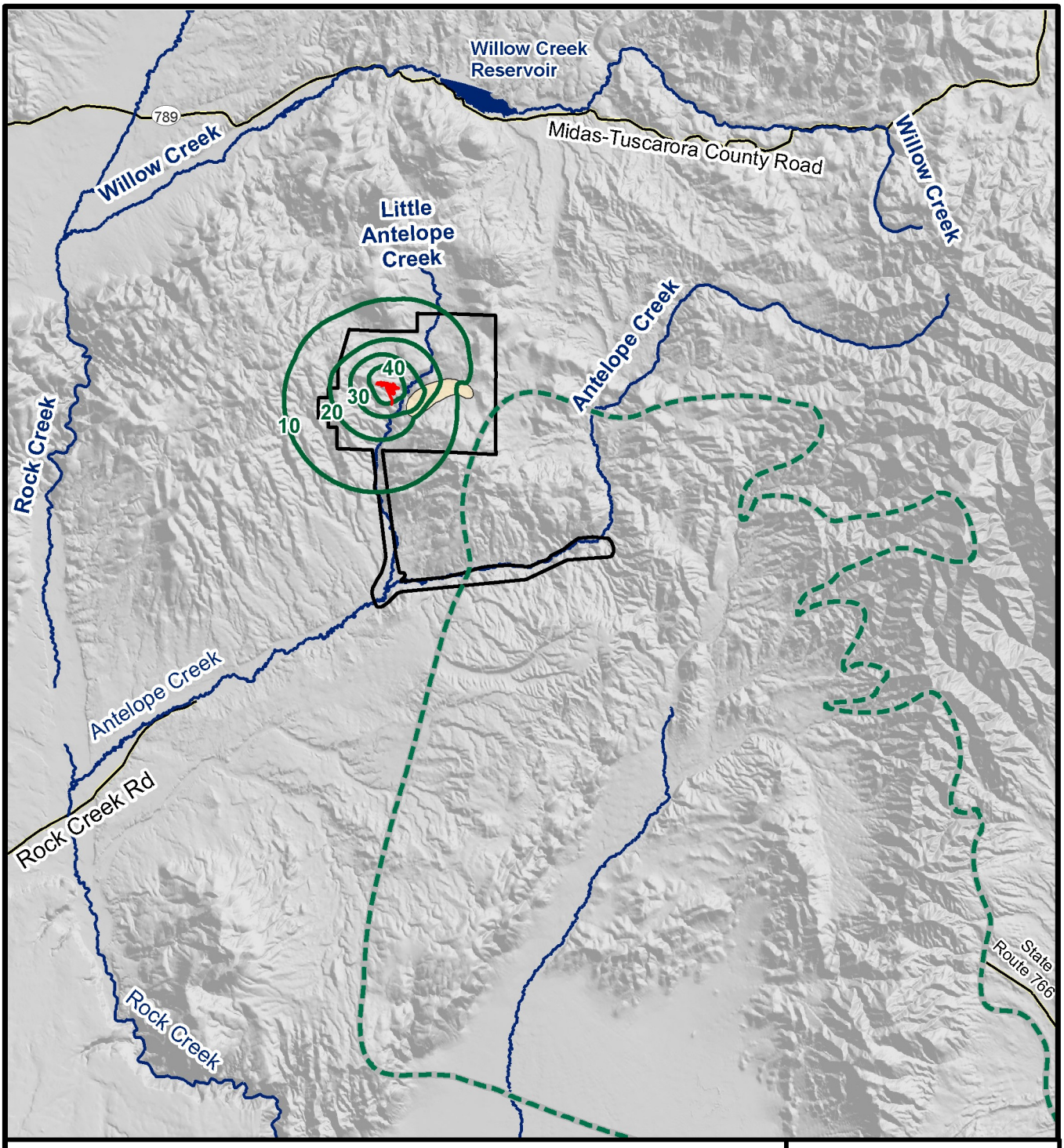
Dilution of such constituents is expected to occur as native groundwater replaces the mine volume. Downgradient attenuation of water quality constituents is expected to occur due to dilution, hydrodynamic dispersion, and chemical processes (Brown and Caldwell 2012).

3.5.2.7 No Action Alternative

Under this alternative, the Hollister Mine would continue to remove groundwater at the 2010 rate of up to 700 gpm. The Hollister underground workings would be backfilled in the same manner as discussed under the Proposed Action. Refilling of the underground workings would begin when operations cease under current authorizations and is predicted to be 99 percent complete within 22 years thereafter (Brown and Caldwell 2010a). The maximum extent of the 10-foot drawdown contour for the No Action Alternative is shown in **Figure 3.5-17**. The maximum drawdown is expected to be reached in approximately 2020-2025. The maximum decline in water levels in the Vinini Formation near the mine workings would be approximately 500 feet. Refilling of the underground workings would be approximately 95 percent complete by 2023 and return to steady state should be reached after 2034. Because the underground workings would be backfilled in a manner similar to that discussed under the Proposed Action, the underground mine water quality after year 2034 should be similar to that discussed for the Proposed Action.

3.5.3 Cumulative Impacts

Cumulative impacts for water quantity and quality under the Proposed Action would be the removal of approximately 26,000 acre-feet of groundwater from the Vinini Formation over the mine life, the maximum drawdown of groundwater in the Vinini Formation as shown in **Figure 3.5-18**, and the development of alkaline sulfate mine water after the mine workings refill. The proposed project's water



Legend

- Project Area Boundary
- Maximum Extent of Drawdown (drawdown in feet)
- Maximum Extent of Barrick Cumulative 10-foot Drawdown Contour (Barrick 2007 Model)
- Roads
- Existing Underground Exploration Workings
- Intrusive Area (Model Low K Area)

N

0 2.5 5 Miles

Source: Brown and Caldwell 2010a.

Hollister Underground Mine Project EIS

Figure 3.5-17

No Action Alternative Simulated Maximum Extent of 10-foot Drawdown Contour

3/2/2012

quality and quantity impacts would be in addition to mining impacts in the CESA that have resulted in groundwater drawdown in the Paleozoic rocks as well as the formation of mine pit lakes, some of which do not meet Nevada water quality standards.

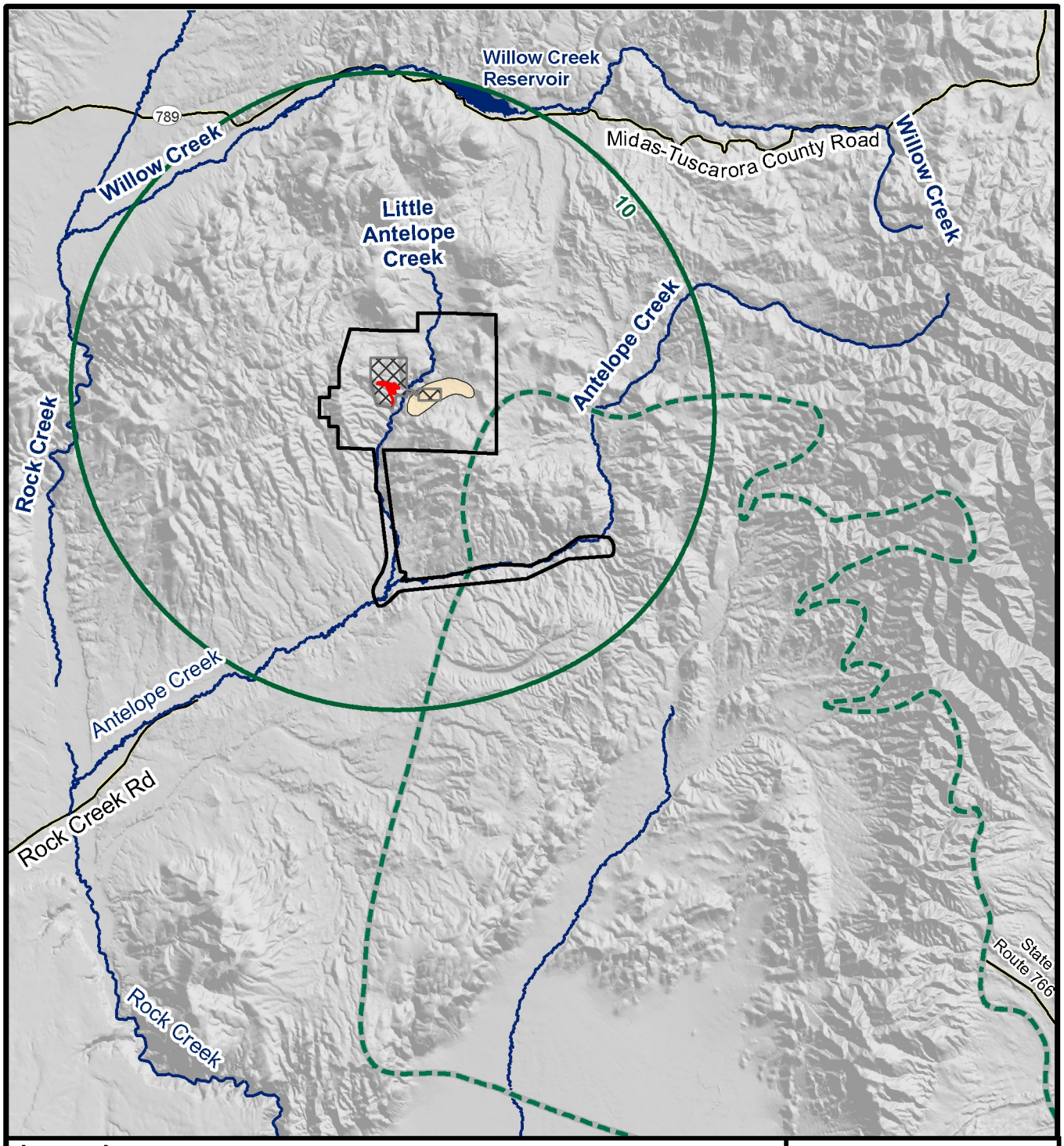
Currently (BLM 2010e), the average pumping rate for major mines in the Carlin Trend near Hollister is approximately 23,000 gpm for Gold Quarry, 18,000 gpm for Leeville, and approximately 18,000 gpm for Betze/Post. Hollister is currently removing about 400 gpm and expects a maximum of approximately 1,100 gpm during expansion of the underground workings. Projected pumping rates for Gold Quarry through 2016 are approximately 17,500 gpm and 24,000 gpm for Leeville. Betze/Post would be decreasing pumping rates from 2010 through 2016. Overall, Hollister contributes very little to the cumulative impact of groundwater removal by mines in the Carlin Trend north of the Humboldt River.

The cumulative maximum extent of the 10-foot groundwater drawdown contour from dewatering by Barrick at the Betze Mine (BLM 2008b) is predicted to enter the Hollister project area in approximately 2130 at a time when drawdown in the Vinini Formation due to Hollister groundwater pumping is in the process of recovering. The locations of the predicted Hollister maximum extent of the 10-foot groundwater drawdown contour and the projected Barrick cumulative maximum extent of the 10-foot groundwater drawdown contour are shown in **Figure 3.5-18**. Although **Figure 3.5-18** shows overlap between these two 10-foot drawdown contours in the area between Little Antelope Creek and Antelope Creek, drawdown from Hollister groundwater removal would be limited to the Vinini Formation, and cumulative drawdown from Barrick pumping would be primarily in the carbonate rocks located approximately 6,000 feet below the aquifer in the Vinini Formation. Although, in the Leeville area, drawdown due to mine dewatering and pumping in the carbonate and clastic rocks has resulted in up to 200 feet of drawdown in the overlying siltstone rocks, this drawdown is not expected to affect the Vinini Formation in the Hollister area (Olsen 2011). Thus, there is a low potential for cumulative impact associated with the Vinini Formation where the Hollister maximum extent of the 10-foot drawdown contour and the Barrick cumulative maximum extent of the 10-foot drawdown contour overlap.

The proposed project would result in groundwater quality impacts within the underground workings vicinity with elevated concentrations of aluminum, antimony, chromium, selenium, sulfate, thallium, and TDS with alkaline pH when compared to Nevada Profile l standards after the mine workings refill. In addition, underground workings would be backfilled with cemented rock aggregate causing a neutral or acid-neutralizing effect. These impacts would be in addition to the groundwater quality impacts in the CESA resulting from the development of mine pit lakes (e.g., Betze/Post pit) and saturation of underground mine workings (e.g., Leeville Mine) after cessation of mining. Concentrations of total dissolved solids, sulfate, nitrate, and some metals may be elevated, at least in the short term, for water that comes into contact with mine pit walls and underground workings (BLM 2010d). The Betze/Post pit lake is expected to be a long-term hydraulic sink due to high evaporation rates and relatively low groundwater inflow rates when filled, thereby preventing potential impacts to surrounding groundwater quality (BLM 2008b). For the CESA, inflowing groundwater to pit lakes typically has sufficient alkalinity to maintain neutral pH conditions for the long term (i.e., high buffering capacity). Evaporation from the pit lake surface generally would concentrate levels of total dissolved solids, sulfate, and other major ions in the water. Precipitation of ferric hydroxide in pit lakes, however, acts to continually remove some metals from solution.

Cumulative impacts for groundwater quantity and quality under the Mud Springs WRSF Alternative, Mud Springs Road Transmission Line Alternative, and the Backfill Alternative would be the same as described for the Proposed Action.

The No Action Alternative would remove approximately 2,000 acre-feet of groundwater over the life of the exploration project, would have a maximum 10-foot groundwater drawdown contour that would extend approximately 2.0 to 2.5 miles from the mine workings (Brown and Caldwell 2010a), and would have mine water quality similar to that of the Proposed Action once the mine workings fill with water.



Legend

- Project Area Boundary
- Maximum Extent of Drawdown (drawdown in feet)
- Maximum Extent of Cumulative 10-foot Drawdown Contour (Barrick 2007 Model)
- Roads
- Existing Underground Exploration Workings
- Intrusive Area (Model Low Permeability Area)
- Proposed Action Conceptual Underground Workings Areas

Note: Mining activities at the Hatter Expansion area simulated to stop in 2030.
Source: Brown and Caldwell 2010a.

N

0 2.5 5 Miles

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Figure 3.5-18

Proposed Action Maximum Extent of the Hollister 10-foot Drawdown Contour (2070) and the Projected Barrick Cumulative 10-foot Drawdown Contour in 2130

2/29/2012

3.5.4 Potential Monitoring and Mitigation Measures

GW-1

Issue: The Proposed Action may have impacts to groundwater quantity and quality.

A groundwater monitoring program would be established by RCG in consultation with the BLM. This program would be developed to monitor and evaluate the potential impacts of groundwater drawdown on springs, seeps, and surface water. This program would include monitoring of springs and seeps in the fall. This program would include establishing groundwater monitoring via monitoring wells and piezometers in areas around the Hollister Mine in order to develop an understanding of the impact of groundwater drawdown in the Vinini Formation and overlying formations as mining progresses. The geochemical and groundwater flow models would be updated a minimum of every 5 years throughout the life of the project. Potential mitigation for impacts to seeps and springs could include water augmentation (e.g., well, pipeline, or hauling water to replenish seeps and springs).

Monitoring and mitigation measures relative to potential impacts to seeps and springs associated with the Vinini Formation are addressed in Section 3.6.4. Springs in formations directly above the Vinini Formation or associated with the Vinini Formation would be monitored to ensure that drawdown in the Vinini Formation within the maximum extent of the 10-foot groundwater drawdown contour does not affect flow in these springs.

Monitoring/Mitigation Measure: A groundwater monitoring program would be established by RCG in consultation with the BLM to monitor and evaluate the potential effects to groundwater from the proposed project. Piezometers or monitoring wells would be installed, as needed, in areas around the Hollister Site and within the maximum extent of the 10-foot drawdown contour to obtain more information on the groundwater quantity and quality from the proposed project. If necessary, piezometers or monitoring wells would be installed beyond the maximum extent of the 10-foot drawdown contour. This monitoring program would include monitoring seeps and springs on public lands. Monitoring seeps and springs on private lands would require permission from the land owner.

Effectiveness: This measure would ensure early detection and remediation of potential project-related impacts to groundwater quantity and quality in the project area and vicinity. Groundwater data would be used to refine the groundwater model. Monitoring of seeps and springs would provide data regarding possible early detection of potential project-related impacts to seeps and springs. Water augmentation would effectively mitigate any water quality losses.

3.5.5 Residual Impacts

Under the Proposed Action, the long-term residual impacts would be: 1) water in the underground workings that is alkaline and contains elevated sulfate and exceedences of some NDEP Profile I groundwater standards; and 2) the permanent removal of approximately 26,000 acre-feet of groundwater. Replacement of the lost groundwater by natural recharge would be expected to occur within a few hundred to thousand years, assuming no future groundwater withdrawals in the area. These same residual impacts would apply to all alternatives, including the No Action Alternative; the amount of groundwater removal would be considerably less under the No Action Alternative.

3.6 Surface Water Resources and Watersheds

3.6.1 Affected Environment

3.6.1.1 Surface Water

The surface water assessment includes two areas: the area of potential direct and indirect impacts (which is the same as the estimated maximum extent of the 10-foot groundwater drawdown contour described in Section 3.5, Groundwater Resources and Geochemistry), and the cumulative effects study area (CESA). These areas are depicted in **Figure 3.6-1**. The CESA includes designated groundwater basins, 62 (Rock Creek Valley), and 63 (Willow Creek Valley), as identified by the Office of the State Engineer, Nevada Division of Water Resources (NDWR) (NDWR 2005). The study area and CESA were determined on the basis of the Proposed Action's relationship to the watershed effects from grazing, fire, and mining, as well as potential cumulative impacts to Little Antelope Creek, Antelope Creek, and Rock Creek. Potential impacts at stream crossings and from road maintenance associated with ore transport alternatives are included in these study areas. Past, present, and reasonably foreseeable future actions (RFFAs) are described in Section 3.2.

Elevations within the CESA range from approximately 8,300 feet above mean sea level (amsl) in the Tuscarora Mountains, to approximately 4,700 feet amsl where Rock Creek flows from the Sheep Creek Range into Boulder Valley. Annual precipitation varies widely within the region, generally increasing with elevation. On average, total annual precipitation is 10 inches or less at lower elevations in Rock Creek Valley and is 16 to 24 inches at higher elevations in the Tuscarora Mountains (United States Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS] 1998). Most precipitation falls from early winter through late spring, typically as winter snow in the mountains or as rain in May or June (Rodeo Creek Gold Inc [RCG] 2008b). On average, the least amount of precipitation falls in July and August. Precipitation typically increases in September and October, transitioning to the higher monthly averages in winter and spring (Western Regional Climate Center 2010).

The most representative precipitation data for the project vicinity are from the nearby Carlin Mine, with 36 years of record at an elevation of 6,530 feet amsl, and from the Tuscarora Weather Station, with 53 years of record at an elevation of 6,170 feet amsl (Montgomery and Associates, Inc. 2010b). These data are summarized in **Table 3.6-1**, and represent elevations somewhat higher than the Little Antelope Creek drainage. For comparison, the average annual precipitation was approximately 8.3 inches at Battle Mountain (elevation 4,530 feet amsl) between 1960 and 2009 (Western Regional Climate Center 2010).

3.6.1.2 Watersheds

The watershed areas for Rock Creek Valley and Willow Creek Valley are approximately 447 and 412 square miles, respectively, for an overall land area within the CESA of 859 square miles. The watershed area for the Little Antelope Creek (LAC) tributary is 25.9 square miles, or 3 percent of the CESA, and the larger watershed area for Antelope Creek overall is 144.4 square miles, or approximately 17 percent of the CESA.

Table 3.6-1 Average Monthly and Annual Precipitation (inches)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Carlin Mine	1.13	0.95	1.23	1.09	1.26	1.10	0.41	0.46	0.96	0.94	1.13	1.43	12.09
Tuscarora	1.28	0.97	1.12	1.00	1.3	1.13	0.49	0.46	0.73	0.89	1.40	1.54	12.43

Source: Western Regional Climate Center 2010.

3.6.1.3 Surface Water Features

Surface water features in the study area and CESA include perennial to ephemeral stream segments, seeps and springs, small stockwater impoundments, and constructed drainage controls for existing mining disturbance. These features, plus irrigation ditches, Hot Lake, and Willow Creek Reservoir are included in the study area and the CESA in **Figure 3.6-1**.

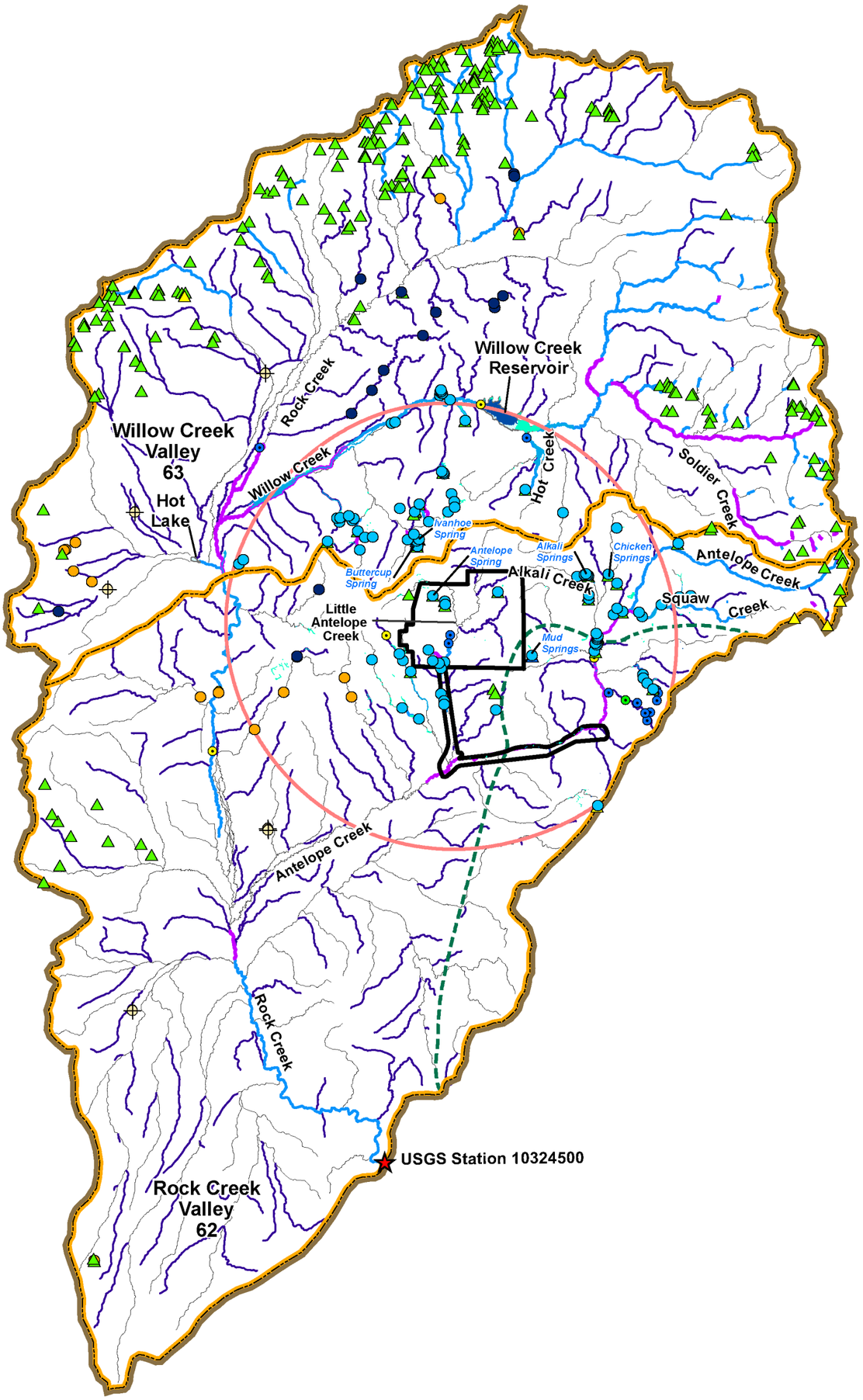
Most of the irrigated lands in the CESA are at or near the Squaw Valley Ranch, located along Willow Creek approximately 4 miles upstream of its confluence with Rock Creek. Additional irrigated areas occur farther downstream along Rock Creek, approximately 7 miles west-southwest of the project area. Within the study area, Little Antelope Creek, Antelope Creek, Willow Creek and their tributaries form the major naturally occurring flow channels. Little Antelope Creek is most closely associated with the proposed project area. The average width (at the Ordinary High Water Mark) of the Little Antelope Creek channel is simplistically stated to be approximately 5 feet (JBR Environmental Consultants, Inc. [JBR] 2003a). Tabulated widths range from 4 to 7 feet, and photos indicate the downstream reach may be up to 15 or 20 feet wide. The low flow channel dimensions would generally be smaller. The Little Antelope Creek watershed generally drains southward, joining Antelope Creek approximately 5 miles south of the project area. In addition to Little Antelope Creek, major headwaters tributaries in the project vicinity include Soldier Creek, Squaw Creek, and Alkali Creek. Both Antelope Creek and Willow Creek are major tributaries to Rock Creek, which drains to the Humboldt River.

Field surveys along Little Antelope Creek, Antelope Creek, and headwater streams have been conducted by JBR and the Bureau of Land Management (BLM) (BLM 2011b; JBR 2010, 2003a). In combination, these surveys identified wetlands and waters of the U.S., springs and seeps in the general Hollister project locale, stream channel conditions, flow conditions, and the types and extent of riparian vegetation.

The U.S. Army Corps of Engineers (USACE) formally determined that Little Antelope Creek and tributary features in the project area are jurisdictional waters of the U.S. (USACE 2004). That determination was valid through April 2009, and no modifications to that jurisdictional status have been made. According to earlier field surveys in the project area, approximately 2.43 acres of waters of the U.S. occur along Little Antelope Creek, and approximately 1.01 acres of wetlands occur along this creek (JBR 2003a). An additional 0.87 acre of hydrophytic vegetation occurred along this stream at the time of the 2003 survey. It is assumed that the USACE maintains jurisdiction over the previously delineated and confirmed waters of the U.S. and wetlands. Further information regarding wetland characteristics, riparian vegetation species, and waters of the U.S. is presented in Section 3.9, Riparian and Wetland Areas.

Flow and Channel Conditions

Flow and channel conditions identified along Little Antelope Creek by JBR in 2003 were recently verified by the BLM (BLM 2011b). The latter effort indicates that perennial flow duration and associated riparian conditions generally exist along the middle reaches of the stream, for approximately 1 mile within the southern part of the project study area to approximately 0.5 mile south of the study area (**Figure 3.6-2**). The setting along Little Antelope Creek can be summarized by describing typical conditions along three primary stream reaches (**Figure 3.6-2**). In the uppermost reach (Reach 1), stable channel conditions exist, and the corridor is well-vegetated with riparian species. In numerous sections, the channel is well armored with cobbles and boulders. Flows are somewhat ponded but generally perennial in the upper portion of Reach 1 and transition to intermittent conditions in the lower part. Reach 1 also includes a grazing exclosure that covers approximately 0.5 mile of stream channel as well as a spring on the western hillslope (BLM 2011b).



Legend

- Project Area Boundary
- Hydrographic Boundary
- Cumulative Effects Study Area
- Direct/Indirect Effects Study Area (Estimated Maximum Extent of the 10-foot Groundwater Drawdown Contour)
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinuous Flowing Stream Reach
- Maximum Extent of Cumulative 10-foot Drawdown Contour (Barrick 2007 Model)

Points of Diversion (Brown and Caldwell 2010)

- Active Surface Water Right
- Active Spring Water Right
- Active Underground Water Right

Note: Hydrographic Area boundary locations are approximate.
Source: Barrick 2010; BLM 2008b,2000b.

Wetland/Riparian Features (AECOM 2010; JBR 2010; BLM 2004)

- Open Water
- Riparian Area
- Wetland

Springs (BLM 2006)

- Ranch/Stock Ponds
- Pond
- Windmill
- Spring Complex
- Spring
- Spring/Seep

Seeps/Springs (BLM 2000)

- Seeps/Springs
- Surface Water Monitoring Station (USGS)

N

0 2 4 Miles

Figure 3.6-1

Surface Water Direct and Indirect Effects Study Area and Cumulative Effects Study Area

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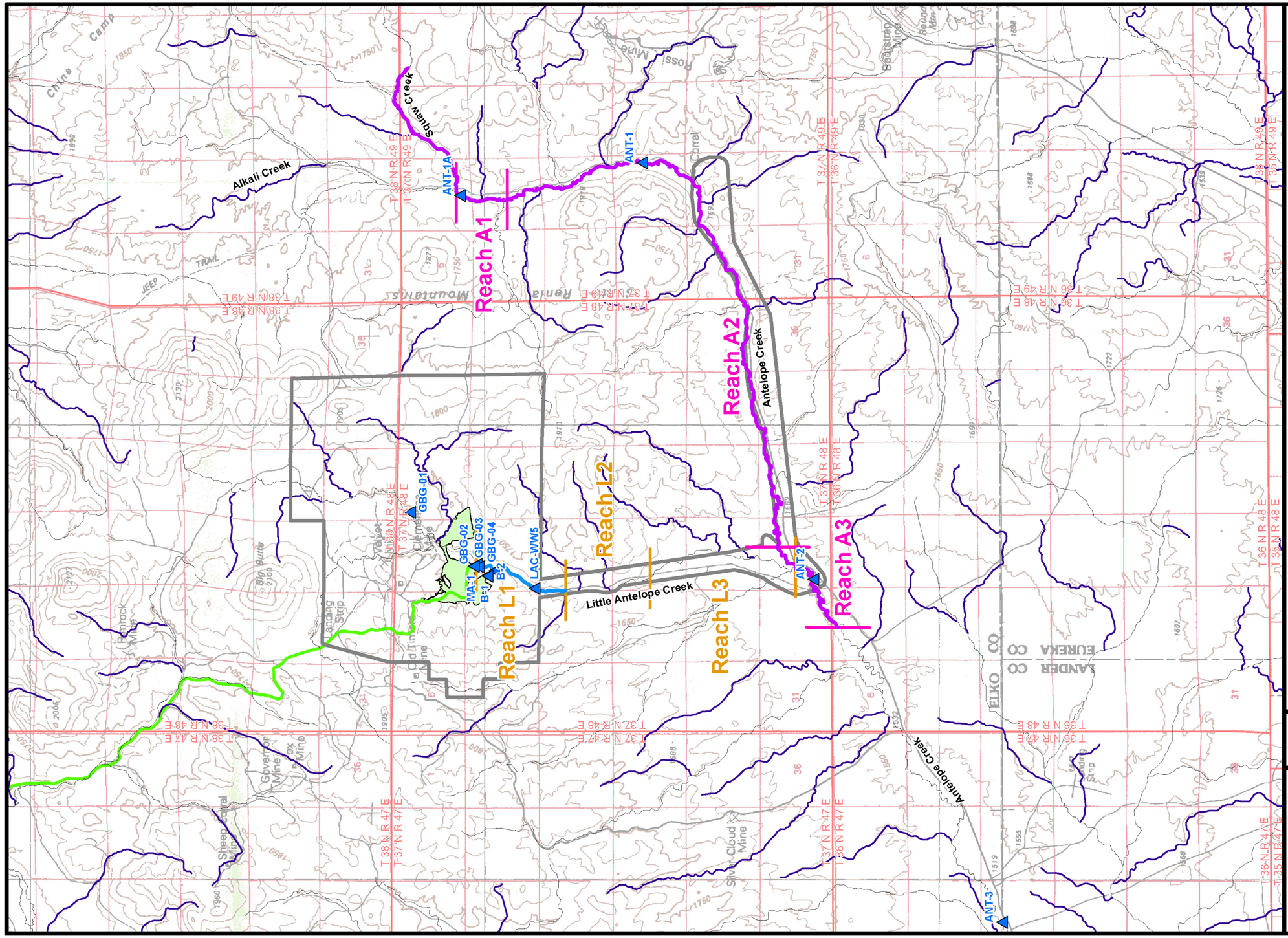

Legend

- Existing Mining Disturbance
- Existing Surface Water Monitoring Locations
- Project Area Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinuously Flowing Perennial Reach
- Ivanhoe Road

Sources: Barrick 2010; BLM 2011b; Montgomery & Associates 2010a.

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Figure 3.6-2

Existing Surface Water Monitoring Locations and Streamflow in the Antelope Creek Watershed

3/19/2012

Reach 2 (**Figure 3.6-2**) is mostly intermittent, but it is well-vegetated with riparian species. In addition to channel roughness from the vegetation, the channel surface contains large amounts of coarse alluvial rock. In combination with a relatively low gradient, this section dissipates commonly occurring flow energies well and also is naturally stabilized.

Reach 3 (**Figure 3.6-2**) is dominantly an intermittent section in the lower part of the Little Antelope Creek drainage (BLM 2011b). It is located primarily below the general bedrock-controlled hillslope portion of the watershed, on a broader, more porous, gently sloping surface that fans out into the valley. The channel is well-armored with rock; riparian vegetation is absent. This section of Little Antelope Creek also is a relatively low-gradient stream that is armored by a large proportion of coarse gravels and cobbles overlying porous alluvial deposits. It absorbs and dissipates flows from upstream.

Fieldwork conducted along Antelope Creek also distinguished three major zones on the basis of flow characteristics and riparian conditions (BLM 2011b). As headwater streams converge near the location of Site ANT-1A (**Figure 3.6-2**), a nearly 1-mile-long complex of springs and perennial flow conditions occur. This can be considered Reach A1 of Antelope Creek (BLM 2011b). The springs are grouped along a hillside adjacent to the confluence of Squaw and Antelope creeks. Fencing is in disrepair, allowing livestock to access the spring complex and adjacent stream banks, channel, and riparian zone.

Reach A2 of Antelope Creek consists of the main channel, banks, and floodplains between the upstream spring complex and the confluence with Little Antelope Creek (**Figure 3.6-2**). Flows are generally intermittent along the entire length of the channel, but shorter lengths of perennial pools or discontinuous perennial flow sections are common along this portion of Antelope Creek. This reach is approximately 8 to 8.5 miles long. Widespread evidence of past channel and bank instability can be seen along Antelope Creek in Reach A2 and other parts of Antelope Creek downstream from Reach A1. However, a new floodplain has been established between the historic cut-banks, and it is sufficiently wide to provide a base for growth and establishment of stabilizing riparian vegetation. Based on field observations, this new floodplain/riparian complex is re-stabilizing the stream reach and providing additional habitats.

Reach A3 of Antelope Creek extends downstream from the confluence with Little Antelope Creek. Flows are intermittent. Based on comparisons of aerial photos taken in different years, isolated perennial pools may be beginning to expand along this part of the stream. A well-developed riparian zone has established along the stream, which helps filter sediment loads from contributing tributaries such as Little Antelope Creek. Reach A3 extends between 1 to 2 miles downstream on Antelope Creek from the confluence with Little Antelope Creek.

There is evidence that the overall channel stability has been improving in recent years in the Little Antelope/Antelope creek segments near the project area. These changes are indicated by areas where riparian vegetation is being re-established or existing riparian conditions are improving (see Section 3.9, Riparian and Wetland Areas, for further information). These trends are related to, and closely interact with, improving floodplain stability within former zones of degraded cutbanks and active sediment transport. These upward trends within the stream corridors have several primary, interactive causes. Among these are the establishment of the grazing exclosure on Little Antelope Creek, improved seasonal grazing rotations, and the return of relatively normal precipitation from the dry conditions of the late 1990s/early 2000s.

Ranch/Stock Ponds and Springs

Numerous ranch/stock ponds and springs also occur within the CESA, as indicated in **Figure 3.6-1**. In addition, seeps and other zones of riparian vegetation and habitat are frequently associated with these water features. Seeps also are indicated in **Figure 3.6-1**. Seeps and other water-associated zones

and habitats are discussed in greater detail in Section 3.9, Riparian and Wetland Areas, and in Section 3.13, Aquatic Biological Resources.

In the direct/indirect study area, the major impoundment is Willow Creek Reservoir (**Figure 3.6-1**). Small impoundments in or near the project area include two stock ponds along the Silver Cloud Road southwest of the project boundary. Other small impoundments used for livestock watering are indicated within the CESA in **Figure 3.6-1**. Several named and unnamed springs (including Antelope Spring, Buttercup Spring, Ivanhoe Spring, Chicken Spring, Mud Spring, and others) also occur within the study area. Ivanhoe and Buttercup springs have flow sources likely associated with the Big Butte Rhyolite, whereas Antelope Spring is associated with an upper tuff unit in the Tertiary volcanic rock (volcanic rock) (Brown and Caldwell 2010a, 2003). Mud Spring and several other unnamed springs in the immediate project vicinity are associated with volcanic rock ash-flow tuff. The geologic settings of Antelope Creek, Antelope Spring, Ivanhoe Spring, and Buttercup Spring are discussed further in Section 3.5.1.2 (Hydrogeology). **Figure 3.5-7** depicts the three springs in a cross-sectional relation to their geologic setting.

A number of unnamed springs and seeps also occur along Antelope Creek and its major tributaries, Alkali Creek and Squaw Creek, in the project vicinity (see **Figure 3.6-1**). Several of these are supplied with groundwater discharge from the Vinini Formation or the volcanic rock. These groundwater sources are described by geologic investigations summarized in Section 3.5, Groundwater Resources and Geochemistry. Groundwater investigations (Section 3.5) indicate that other springs discharge from more limited, isolated zones in the near-surface volcanic rock and alluvium. Based on geology and groundwater studies of the area, a comprehensive list of springs and their geologic associations in the study area and within the maximum extent of the 10-foot groundwater drawdown contour is presented in **Table C-1**.These locations are indicated in **Figure C-1**. Although they have a geologic origin, springs and seeps are expressed as surface features that either provide flow (springs) or moisture (seeps) for beneficial uses in the watershed. Because of this, springs and seeps are discussed in this surface water section. Other sections of this environmental impact statement (EIS) also discuss springs and seeps with respect to their sources and uses.

Broad categories of surface management status (private, state, tribal, federal) also are depicted on **Figure C-1**. Within the maximum extent of the 10-foot groundwater drawdown contour, approximately 78 springs or seeps are identified on lands administered by the Bureau of Land Management. Most of these are not associated with the Vinini Formation. Approximately 48 springs or seeps occur on privately owned lands. No state or tribal lands occur within the maximum extent of the 10-foot groundwater drawdown contour. A few springs or seeps occur on private land southwest of the project area as indicated on **Figure C-1**. East of the project area, springs and seeps on private lands are more numerous. These include features in the Santa Renia Fields (along Antelope Creek due east of the project area), along Alkali Creek, and along Squaw Creek. In addition, most of the land is privately owned along Squaw Creek and Antelope Creek within the maximum extent of the 10-foot groundwater drawdown contour.

Disturbance Areas

Within the existing disturbance areas (**Figures 2-1** and **2-2**), overall infiltration and surface water flow conditions have been modified by contouring to improve runoff, containment of runoff in lined ponds, the development of mine pits and waste rock storage facilities (WRSFs), and the construction of diversion channels to control on-site water and prevent run-on from adjacent lands. These existing surface water management features are used to store or divert surface water. Diversion channels route runoff from undisturbed areas away from the project. Also within the project footprint, diversion channels convey runoff around the WRSF, to the storm water pond, or to the East and West pits (see **Figure 2-12**). Collected water is routed to one or two surge ponds (in the existing East Pit) for use in existing operations (RCG 2008b).

Under the Proposed Action, the electric power transmission line (transmission line) would parallel Little Antelope Creek along the existing road, and also cross and parallel Antelope Creek (**Figure 2-11**). Under the Mud Springs Road Transmission Line Alternative, the transmission line would cross a number of ephemeral drainages before crossing upper Antelope Creek along a perennial or discontinuously flowing reach. Little Coyote Creek, an ephemeral stream, would be crossed to reach the Coyote Creek Substation.

Floodplains occur in low-lying geomorphic positions along Little Antelope Creek and Antelope Creek, as well as at stream crossings of the Ivanhoe and Mud Springs roads. The Federal Emergency Management Agency (FEMA) has delineated flood hazard zones in unincorporated areas of Elko, Lander, and Eureka counties (FEMA 2010). However, current map sheets for the project area have not been compiled by FEMA, and historical map sheets are not presently available from the agency. In Lander County, an available historical map sheet (FEMA Panel 3200130050C) indicates the occurrence of Flood Hazard Zone A delineations along both Antelope Creek and Rock Creek (FEMA 2010). The Antelope Creek delineation is approximately 0.5 mile wide at the Elko/Lander county line. On available historical maps for Elko County, Rock Creek and Willow Creek have Flood Hazard Zone A delineations all along their stream courses. At its Ivanhoe Road crossing, the Willow Creek flood zone is approximately 0.25 mile wide. Based on these FEMA delineations, and the much narrower delineations that available FEMA mapping indicates along smaller nearby tributaries, it is likely that FEMA Zone A flood hazard positions would continue up Antelope Creek past the Mud Springs road crossing, and up Little Antelope Creek for approximately 1 mile from its confluence with Antelope Creek.

The Mud Springs WRSF Alternative would be located on a sloping bench intersected by ephemeral headwater streams. Based on an aerial photo review, the relatively narrow, steep-sided tributaries do not appear to support riparian zones, seeps, or springs. This review and its conclusions are further discussed in Section 3.8, Vegetation Resources, and Section 3.9, Riparian and Wetland Areas. Channels occurring within this alternative coalesce to drain generally west and northwest along an unnamed ephemeral tributary to Little Antelope Creek. The existing reclaimed heap leach pad and reclaimed pond resulting from historic operations are located along and adjacent to the unnamed tributary. Surface water drainage in other directions from the site would be restricted by higher topography to the south, east, and west.

Streamflows and Channel Conditions

Within the project vicinity, surface water primarily results from snowmelt and rainfall. Additional water is routed or stored as a result of existing mine operations. Flows in Little Antelope Creek and its tributaries depend mostly on the amount and distribution of precipitation within the watershed (Montgomery and Associates, Inc. 2010b). Typically, spring runoff creates temporary increases in streamflows. Flow durations largely depend on the amount of precipitation during preceding months, and may depend on conditions within the previous year or two. Considerable variation in seasonal and annual precipitation is normal in the project area and in the overall region. Under these conditions, streamflows and water levels in impoundments vary substantially.

Streamflow monitoring has been conducted in the project area since early 2007. Four stations are designated along Little Antelope Creek to monitor discharge and water quality conditions upstream, within, and downstream of the Hollister Site. These stations, from upstream to downstream, are numbered GBG-01 through GBG-04 (**Figure 3.5-12**). Locations GBG-02 and GBG-03 represent flow in Little Antelope Creek immediately upstream and downstream of an unnamed tributary. Discharge from Newmont's historic Ivanhoe Mine operations and the Newmont-reclaimed East WRSF potentially enters Little Antelope Creek below GBG-02 and above GBG-03. Additional recent surface water monitoring locations include Station MA-1, which is used to record conditions at a seep at the base of the Newmont-reclaimed East WRSF. Drainage in that locale proceeds down the unnamed tributary

and potentially enters Little Antelope Creek above GBG-03 (**Figure 3.6-2**). Other monitoring locations include Stations B-1 and B-2. Data from B-1 characterize flows from the base of the Newmont-reclaimed South WRSF, which drain down an unnamed wash to a constructed wetland. Location B-2 is about 500 feet downstream from B-1 and represents flow within the constructed wetland. The unnamed tributary drains to Little Antelope Creek above GB-04, which is the most downstream surface water monitoring station on the creek (**Figure 3.6-2**).

Recent monitoring interpretations have suggested that streamflows in upper Little Antelope Creek and its tributaries are ephemeral; however, several monitored years and seasons had below-average precipitation. Generally, the early part of the monitored period (from November 2006 through June 2008) received lower than average precipitation (Western Regional Climate Center 2010). Flows usually ceased by the end of June in the project area (Montgomery and Associates, Inc. 2010b). However, streamflows continued until November 2007 at Station GBG-04 in lower Little Antelope Creek. In 2009, flows resumed at most stations in late October, after abnormally high total precipitation since the previous May. These conditions imply that parts of Little Antelope Creek experience intermittent flows. Streamflows may result from groundwater baseflow in the lower reaches of Little Antelope Creek during part of the year.

Earlier survey work was conducted in the field by JBR (2003a). During the waters of the U.S. investigations for the Hollister Development Block project in early June 2003, JBR encountered discontinuous flows along Little Antelope Creek. In the narrower part of the canyon along the access road and pipeline corridor to the Rapid Infiltration Basin (RIBs), flows were 2 or 3 inches deep and ranged from 1 to 7 feet wide. No flows were observed at the northern or southern ends of the pipeline corridor. At the time of JBR's fieldwork in early June 2003, approximately 50 percent more precipitation than average had fallen in March, April, and May at Tuscarora, and approximately 40 percent more precipitation than average had fallen at Battle Mountain (Western Regional Climate Center 2010). For a comparative basis, the flows at the U.S. Geological Survey (USGS) gage on Rock Creek (Station 10324500 outside the study area) were well below average in early 2003.

Based on these data, it seems likely that parts of lower Little Antelope Creek gain groundwater baseflow contributions through the summer months during years of average or greater precipitation. A stable, well-vegetated, perennial reach emerges from a tributary in the northwest corner of Section 9 (Township 37 North [T37N], Range 48 East [R48E]), and extends downstream along Little Antelope Creek through a grazing exclosure to approximately the west quarter-corner of Section 16 (also T37N, R48E) (see **Figure 3.6-2**). The exclosure extends approximately 0.5 mile along the stream channel, and a spring occurs on the western hillside within it. In many locations, the channel is well armored with cobbles and boulders (BLM 2011b). Riparian plant species include Coyote willow, baltic rush and a number of species of riparian grasses and forbs. Flows are somewhat ponded but perennial in this portion of the drainage (BLM 2011b). Flow durations become intermittent downstream, but this lower portion of Little Antelope Creek also remains generally armored with cobbles and boulders as the channel passes below rocky hillslopes. Both upland and riparian herbaceous species occurs along intermittent channel portions, along with some willow stands (BLM 2011b). The channel then emerges from the steeper hills onto a broader, flatter surface comprised of colluvium and alluvial fan deposits. The stream becomes flatter, wider, and drier, and flows seep into the rocky, porous channel bed.

Antelope Creek ranges from perennial in its upper reaches and headwater tributaries, to intermittent in its lower reach near its confluence with Rock Creek. In the central part of the stream near the southern part of the project area, interrupted flow conditions occur (**Figure 3.6-2**). Discontinuous flowing sections or ponded channel portions occur along this reach, which extends for approximately 8 miles from a spring complex near Site ANT-1A in **Figure 3.6-2**, to the confluence with Little Antelope Creek near Site ANT-2 in **Figure 3.6-2**. A substantial riparian vegetation community now occurs along portions of Antelope Creek (BLM 2011b).

Within the larger CESA, flows in Willow Creek, Antelope Creek, and Rock Creek range from ephemeral to perennial in average years, depending on location (**Figure 3.6-1**). Most of the stream channel sections in the CESA have intermittent or ephemeral flow durations. Perennial reaches are most common in headwater locales, but also occur along most of lower Rock Creek. Discontinuous flowing reaches (**Figure 3.6-1**) consist of a series of generally short (tens to hundreds of feet long) perennial segments separated by intermittent segments. These areas are likely to have short stretches where water is stored beneath the surface in alluvial deposits, surfacing again at rock outcrops or other shallow, resistant zones. Again, flow durations vary widely with location, source, and weather conditions.

In the CESA near the project study area, flow monitoring has been conducted at four locations along Antelope Creek as part of the Boulder Valley Monitoring Plan (BVMP) conducted by Barrick Goldstrike Mines Inc. (Barrick 2010). These locations are indicated in **Figure 3.6-2**. Data are collected monthly, compiled quarterly, and submitted semi-annually to the BLM and Nevada State Engineer as a public record. The most upstream station, ANT-1A, is located just downstream of the confluence of Alkali Creek and upper Antelope Creek, Station ANT-1 is on Antelope Creek about 1.5 miles downstream of the confluence with Little Coyote Creek. Station ANT-2 is at the confluence with Little Antelope Creek, and the most downstream location, ANT-3, is just northeast of the Lander County line. Flow measurements at these locations indicate that Antelope Creek is ephemeral or intermittent throughout its monitored length from Alkali Creek to the Lander County line. After spring runoff, flows decline rapidly at all stations. Flow typically ceases in June at the upper stations (ANT-1A and ANT-1), and during April or May at Station ANT-2 downstream. These conditions likely result from the distribution and timing of snowmelt at the higher elevations, and losses to channel seepage in downstream alluvial settings. Small flow rates in November are frequently recorded at the upper two stations. These probably result from winter precipitation undergoing freeze-thaw cycles.

Many other streams occur in the CESA, as indicated in **Figure 3.6-1**. All are tributaries to Rock Creek or Willow Creek (**Figure 3.6-1**). Access routes within the CESA utilize stream crossings that would avoid or reduce traffic through streams. Improvements such as culverts are present on the existing Ivanhoe Road, which crosses several streams. Northeast of Golconda, State Route 789 crosses the Humboldt River on a substantial bridge in Emigrant Canyon. To the north and west, the existing Ivanhoe Road is an upgraded gravel road (Czarnowsky 2010b) that crosses Ivanhoe Creek and several small ephemeral tributaries. The Midas-Tuscarora Road crosses Willow Creek, Rock Creek, Frazer Creek, the Highline Canal, and Midas Creek. Ivanhoe Creek is intermittent. Willow Creek and Rock Creek at the road crossings are discontinuous flowing streams (BLM 2000b). All of the major creeks and the canal crossings along major routes used for equipment access or ore transport have existing improved crossing structures over the channels (Czarnowsky 2010b). Some channels that may be crossed less frequently by smaller-vehicle incidental traffic have fords or low water crossings through the streams (e.g., Rock Creek near its confluence with Antelope Creek).

Water Rights

Water rights in or near the study area that are on record with the NDWR are listed in **Table C-2** (**Appendix C**). Their locations are depicted in **Figure 3.6-3**. The area included in this summary consists of the estimated maximum extent of the 10-foot groundwater drawdown contour derived from project modeling. Listed water rights include six that support the Hollister project and approximately 21 others not associated with the project, as listed in **Table C-2**. Two certificated water wells and four permitted water rights for discharges support the present surface and underground exploration projects.

As can be seen in **Figure 3.6-3**, there are several surface water points-of-diversion along Rock Creek and Willow Creek, and a number of points-of-diversion associated with springs. Public Water Reserves No. 107 (PWR 107), an executive order issued by President Calvin Coolidge in 1926,

reserved certain water rights on public lands so as to provide water for animal and human consumption while simultaneously preventing the monopolization and control of large tracts of land. PWR 107 withdrew waters from "Every smallest legal subdivision of the public-land surveys which [was] vacant unappropriated unreserved public land and contain[ed] a spring or water hole, and all land within one quarter of a mine of every spring or water hole located on unsurveyed public land." In addition, PWR 107 applies only to those water resources that are considered "important" and have sufficient flow for consumption. No PWR 107 designations have been identified within the maximum extent of the 10-foot groundwater drawdown contour. Additionally, within the same area, no springs or water holes that could potentially meet PWR 107 criteria occur.

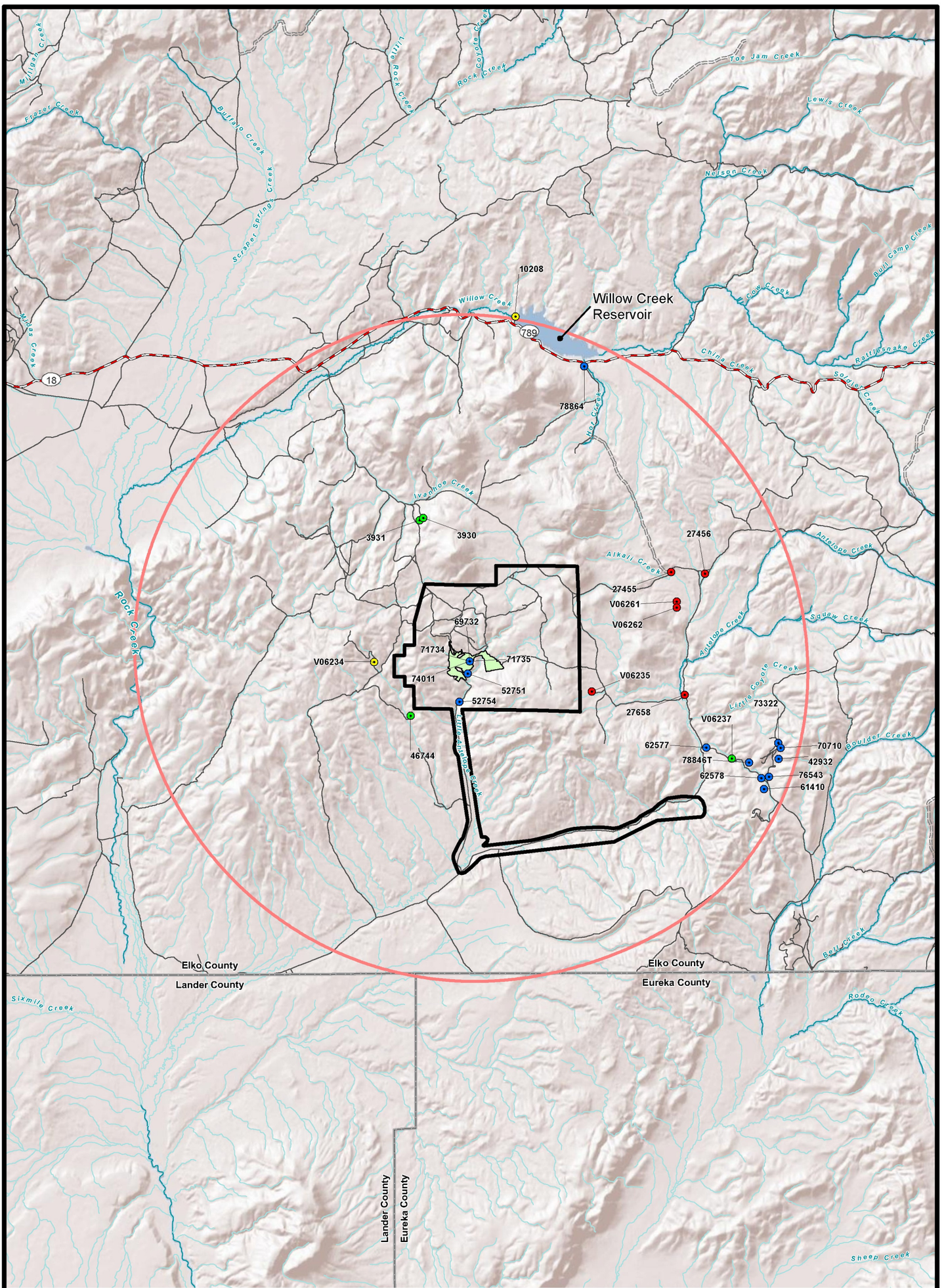
Surface Water Quality

Within the CESA, Rock Creek is categorized as a Class A water from its origin to the Squaw Valley Ranch north of Hot Lake (**Figure 3.6-1**) (Nevada Administrative Code [NAC] 2003). Class A waters, as defined in NAC 445A.124, are in areas with little human habitation, no industrial development or intensive agriculture, and where the watershed is relatively undisturbed by man. Beneficial uses of Class A waters include municipal or domestic supply or both (with treatment by disinfection only); aquatic life; wildlife uses; irrigation and livestock watering; and recreation that could include water contact.

Below the Squaw Valley Ranch, Rock Creek is a Class C water. Class C waters are in areas of moderate-to-urban human habitation, with moderate industrial development, intensive agriculture, and where the watershed has been considerably altered by man. Beneficial uses of Class C waters include municipal or domestic supply or both (following complete treatment); industrial supply; irrigation, and livestock watering; propagation of aquatic life; propagation of wildlife; and recreation that could involve water contact (NAC 445A.126). As tributaries to Rock Creek, Class C water quality standards currently apply to both Antelope Creek and Little Antelope Creek (Heggeness 2010). These class-specific surface water standards are indicated in **Table 3.6-2**.

A summary of Nevada water quality standards is presented in **Appendix B**, **Table B1-1**. Additional water quality parameters include drinking water standards used as "reference values" by Nevada Division of Environmental Protection (NDEP) in their Profile 1 constituent list for mines (Holmgren 2010; NDEP 2010a). These Profile 1 reference values are listed by bullets below. The values are not stream standards, but are used for comparisons between background water quality and discharges from mining sites (Holmgren 2010). The default water quality standards applicable to Rock Creek and its tributaries are presented in **Table 3.6-2**. For Profile 1 constituents not already identified in the Nevada Class C stream standards, the following additional permit conditions may be applied:

- Arsenic: 0.010 mg/L;
- Mercury: 0.002 mg/L;
- Selenium: 0.05 mg/L;
- Total Dissolved Solids (TDS): 1,000 mg/L;
- Magnesium: 150 mg/L;
- pH: 6.5 to 8.5 standard units;
- Sulfate: 500 mg/L; and
- Weak Acid Dissociable (WAD) Cyanide: 0.2 mg/L.



Legend

- Project Area Boundary
- Existing Mining Disturbance
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- State Highway
- Rural Road
- Vehicular Trail (4WD)

Points of Diversion (Brown and Caldwell 2010)

- Active Spring Water Right Potentially Affected
- Active Surface Water Right
- Active Spring Water Right
- Active Underground Water Right

N

0 1 2 Miles

Source: Brown and Caldwell 2010b.

Hollister Underground Mine Project EIS

Figure 3.6-3
Water Rights in the Study Area

3.6-11

3/19/2012

Table 3.6-2 Nevada Class C Water Quality Standards

Constituent	Standard
Floating solids, solids that will settle, or sludge deposits	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.
Sewage, industrial wastes, or other wastes	None, which are not effectively treated to the satisfaction of the department.
Toxic materials, oils, deleterious substances, colored or other wastes or heated or cooled liquids	Only such amounts as will not render the receiving waters injurious to fish and wildlife or impair the waters for any beneficial use established for this class.
pH	Range between 6.5 to 9.0 standard units.
Dissolved oxygen (DO)	For waters with trout, not less than 6.0 milligram per liter (mg/L); for waters without trout, not less than 5.0 mg/L.
Temperature	Must not exceed 20 degrees Celsius (°C) for waters with trout or 34°C for waters without trout. Allowable temperature increase above normal receiving water temperature: 3°C.
Fecal coliform	Most stringent of three specification alternatives.
Total phosphates	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).

Source: NAC 445A.126.

Surface water quality has been monitored by the USGS on Rock Creek at the mouth of the canyon where the stream flows out of the Sheep Creek Range (USGS station 10324500); **Figure 3.6-1**. These records are from the late 1970s to early 1990s. The NDEP Bureau of Water Quality Planning more recently sampled water quality on Rock Creek near that location (Station NV04-106-T-001), and analyzed a sample upstream of Antelope Creek (Station NV04-106-T-003). On Little Antelope Creek, both surface water and groundwater quality have been extensively sampled recently in the project vicinity (Montgomery and Associates, Inc. 2010b) (**Figure 3.6-2**).

Located at the CESA watershed outlet, USGS data at the Rock Creek gage (USGS 10324500) indicate that specific conductance ranges from 190 to 474 microSiemens per centimeter (µS/cm), with an average of 355. The range in pH was 8.2 to 9.5 standard units. The most complete USGS data represent two low-flow months: October 1990 and November 1991 (USGS- National Water Information System [NWIS] 2010). Common water quality constituent values recorded in USGS and NDEP data for Rock Creek at the gage are indicated in **Table 3.6-3**.

Surface water data from RCG are indicated in **Table 3.6-4**. These data represent flow conditions from upstream (GBG-01) to downstream (LAC near water well 5) monitoring locations along Little Antelope Creek. Available data for the MA-1 seep at the Newmont-reclaimed East WRSF and the B-1 location below the Newmont-reclaimed South WRSF also are indicated. Stations GBG-01 and -02 are on Little Antelope Creek upstream of the MA-1 seep and associated existing site disturbance, whereas

GBG-03, GBG-04, and LAC near water well 5 are downstream of tributaries that drain existing site disturbance (see **Figure 3.6-2**). The most downstream monitoring location, LAC near water well 5, is a site located approximately 1 mile downstream of all existing site disturbance.

Table 3.6-3 Surface Water Quality at the Rock Creek Gage (USGS 10324500)

Sampling Date	Constituents[1,2]									
	pH[2]	As	Ca	Mg	Hg	HCO_3	Se	SO_4	TDS	SpC[2]
Aug 1990 (a)	8.9	0.008	16	8.3	<0.0001	127	<0.0001	43	257	458
Nov 1991 (a)	8.4	0.006	34	7.5	<0.0001	166	<0.0001	31	293	427
Apr 1999 (b)	8.07	ND	ND	ND	ND	115	ND	23	187	290
Aug 1999 (b)	8.62	0.010	25	7	ND	115	0.003	34	233	408
Jun 2001 (b)	10.16	0.008	15	6	ND	44	ND	36	196	378
Sep 2001 (b)	8.77	ND	ND	ND	ND	151	ND	34	252	460
Apr 2002 (b)	8.41	ND	ND	ND	ND	132	ND	22	234	310
Sep 2002 (b)	8.73	0.005	27	8	ND	161	ND	34	300	440

[1] As = arsenic, Ca = calcium, Mg = magnesium, Hg = mercury, HCO_3 = hydrogen bicarbonate, Se = selenium, SO_4 = sulfate, TDS = Total Dissolved Solids.

[2] Values are in mg/L (dissolved) except for: pH in standard units and Specific Conductance (SpC) in µS/cm.

ND - no data.

Sources: (a) USGS-NWIS 2010; (b) USEPA STORET Database 2009.

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
GBG-01 (Upstream)	3-Apr-07	8.71	0.003	72	13	118	164	5.23
	4-May-07	***5.70***	0.004	102	10	136	162	6.92
	10-Apr-08	7.85	<0.0050	68	15	28	106	***2.16***
	7-May-08	7.92	0.0062	110	57	190	236	7.31
	30-Apr-09	7.63	<0.0050	82	14	150	244	10.46
GBG-02	3-Apr-07	8.73	0.006	79	31	156	215	6.72
	4-May-07	7.78	0.005	107	35	178	226	8.25
	8-Jun-07	7.79	0.008	332	***1,980***	***3,970***	4,130	8.79
	10-Apr-08	8.35	0.0053	63	19	130	135	***2.91***
	7-May-08	7.98	<0.025	100	110	310	342	5.38
	11-Jun-08	7.45	<0.025	340	***1,800***	***3,000***	3,980	5.27
	30-Apr-09	8.69	<0.0050	70	15	110	236	8.04

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
	28-Oct-09	6.76	<0.020	190	***1,100***	***2,100***	2,940	***3.87***
MA-1 Seep (On tributary)	2-Apr-07	7.75	0.026	217	***547***	***1,230***	1,760	***4.78***
	4-May-07	7.78	0.031	227	452	***1,110***	1,250	5.89
	8-Jun-07	7.70	0.028	239	***584***	***1,360***	1,580	5.82
	10-Apr-08	8.21	0.026	180	***530***	***1,100***	1,280	***3.45***
	7-May-08	7.76	<0.025	180	***540***	***1,100***	1,068	5.58
	30-Apr-09	7.71	0.033	160	***840***	***1,400***	399	***3.65***
GBG-03	3-Apr-07	7.98	0.014	142	***416***	***880***	1,228	9.10
	4-May-07	7.73	0.016	198	***502***	***1,120***	1,238	8.01
	8-Jun-07	7.81	0.018	244	***777***	***1,620***	1,830	7.77
	10-Apr-08	8.37	0.0072	68	***89***	250	91	***3.34***
	7-May-08	7.71	<0.025	170	***550***	***1,000***	1,258	6.64
	11-Jun-08	7.08	<0.010	210	***770***	***1,400***	2,080	6.78
	30-Apr-09	7.48	0.010	120	***540***	***900***	1,580	7.71
	28-Oct-09	7.20	0.013	200	***1,100***	***2,100***	3,010	6.45
B-1 (On Tributary)	2-Apr-07	6.95	0.004	171	***1,350***	***2,280***	2,610	***3.82***
	4-May-07	6.79	0.003	171	***1,280***	***2,220***	2,080	***4.72***
	8-Jun-07	6.92	0.003	171	***1,240***	***2,210***	2,210	***4.94***
	10-Apr-08	No data						
	7-May-08	6.55	<0.025	200	***940***	***1,700***	1,147	6.48
	11-Jun-08	***5.99***	<0.005	120	***1,300***	***1,900***	2,550	5.05
	30-Apr-09	6.57	0.0064	130	***1,200***	***1,700***	2,540	6.50
	27-Oct-09	6.82	<0.010	150	***1,000***	***1,700***	2,460	5.26
GBG-04 (Downstream)	3-Apr-07	7.71	0.009	183	***810***	***1,460***	1,900	6.38
	4-May-07	7.54	0.010	210	***926***	***1,770***	1,740	7.54
	8-Jun-07	7.31	0.013	239	***1,410***	***2,520***	2,500	6.04
	10-Apr-08	7.94	0.0071	88	130	310	230	***3.19***
	7-May-08	7.26	<0.010	180	***670***	***1,300***	964	6.12
	11-Jun-08	6.75	<0.0050	260	***950***	***1,800***	2,460	5.88

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
	30-Apr-09	7.60	<0.0050	140	***510***	***850***	1,520	6.55
	27-Oct-09	7.58	<0.0050	210	***1,100***	***2,000***	2,960	7.27
	16-Nov-09	7.07	<0.0050	230	***1,300***	***2,200***	3,200	5.67
LAC near water well 5	16-Nov-09	7.64	0.012	210	110	420	810	5.14

[1] As = arsenic, HCO_3 = hydrogen bicarbonate, SO_4 = sulfate, TDS = Total Dissolved Solids, DO = Dissolved Oxygen.

[2] Values are in mg/L (dissolved) except for pH in standard units; and Specific Conductance (SpC) in µS/cm.

Bold italicized values indicate exceedences of NDEP Class C stream standards.

Source: Montgomery and Associates, Inc. 2010b.

April and May data generally indicate water quality dominated by snowmelt or rainfall runoff. After runoff volumes decline in May, data indicate changes in water quality. Station GBG-01 represents an undisturbed headwater location approximately 1 mile northeast of site activities. Its data reflect undisturbed spring runoff; the creek typically goes dry at that location during May. Station GBG-02 is located downstream where the drainage passes alongside existing disturbance. April pH values at GBG-02 are consistently elevated. Although still upstream of tributaries leaving the Hollister Site, by June the water quality at GBG-02 shows a pronounced shift to greater concentrations of SO_4 and TDS, as well as greater salinity as indicated by specific conductance. This water quality shift also is apparent between the spring (April) runoff data and the October low-flow data for 2009 at GBG-02. It also occurs in seasonal data for other monitoring locations, as spring runoff declines. These surface water characteristics may be related to stronger aquifer influences later in the year, to lower flows exhibiting greater influence from bed and bank mineralogy, or to some other combination of factors.

Relatively consistent water quality occurs at the MA-1 seep (**Figure 3.6-2**). Data at that location indicate elevated concentrations of arsenic, sulfate, and TDS. Specific conductance at MA-1 is higher than those along the creek during spring runoff, as well. Downstream, the water quality at station GBG-03 is generally a mix of characteristics from the MA-1 seep and GBG-02 upstream on Little Antelope Creek. Data from October 2009, when the seep was not contributing, are reasonably consistent between GBG-02 and GBG-03.

Between stations GBG-03 and GBG-04, drainage from the Newmont-reclaimed South WRSF enters Little Antelope Creek (see **Figure 3.6-2**). The adjoining tributary is monitored at stations B-1 and B-2. Water quality data are similar at the latter stations, and a longer period of record exists at B-1. The tributary contributes elevated levels of sulfate and total dissolved solids, which are somewhat attenuated as flows reach GBG-04 during the spring. By June, these constituents generally increase or remain at similar levels between GBG-03 and GBG-04 downstream. Based on available data, elevated specific conductance, sulfate, and total dissolved solids levels in late season flows at GBG-04 are largely reduced in flows at LAC near water well 5. From the available late-season data, most water quality constituents at LAC near water well 5 are within both Rock Creek standards and NDEP Profile 1 reference values. The one arsenic value at LAC near water well 5 (0.012 mg/L) is slightly elevated above the background levels downstream at the Rock Creek gage (USGS 10324500), which range from 0.005 to 0.010 mg/L (**Table 3.6-3**).

As indicated in **Table 3.6-4**, in the project area, dissolved arsenic concentrations in runoff range from 0.003 mg/L in the headwaters at GBG-01 to 0.031 mg/L from Seep MA-1. The higher concentrations from the seep are not reflected in downstream flows at GBG-03 or beyond, although there are some downstream exceedences of the NDEP Profile 1 reference values for arsenic. These values remain within Class C receiving water standards (0.050 mg/L), but commonly exceed drinking water standards. Far downstream at the Rock Creek Gage, NDEP data for arsenic (**Table 3.6-3**) are somewhat less than concentrations measured in Little Antelope Creek. Rock Creek Gage monitoring data show arsenic concentrations ranging from 0.005 mg/L to 0.010 mg/L. Project monitoring data show arsenic concentrations ranging from 0.003 to 0.031 mg/L (**Table 3.6-4**). Mercury and selenium concentrations are typically below detection limits in samples from Little Antelope Creek (Montgomery and Associates, Inc. 2010b). Dissolved oxygen concentrations typically satisfy the stream standard for waters without trout (5.0 mg/L), although exceptions occurred throughout the project area. As indicated in **Table 3.6-4**, dissolved oxygen concentrations below the stream standard occurred at least once at all monitoring locations except LAC, the station farthest downstream. That station is represented by one sample, which slightly exceeded the minimum standard. WAD cyanide concentrations were below detection limits for all surface water samples, except for a value of 0.13 mg/L at GBG-03 in October 2009. This result is not typical of the project area and is still less than the NDEP Profile 1 reference value.

Other water quality constituents in runoff, such as pH and TDS, vary from meeting to exceeding NDEP stream standards. This can be seen by comparing values in **Tables 3.6-3** and **3.6-4**. Several pH values are outside of the NDEP Profile 1 reference values; however, all but two pH values remain within the NDEP Class C standards for Rock Creek. TDS concentrations frequently exceeded the stream standard and reference value by June at GBG-02, and commonly exceeded it farther downstream on Little Antelope Creek. Sulfate concentrations typically exceed the stream standard and the Profile I reference value by June at GBG-02, and commonly exceeded them farther downstream. Other trace constituents, including mercury, selenium, and others, were well within reference values and stream standards. These constituents were commonly below laboratory detection limits.

The effects of the historic Newmont Ivanhoe Mine operations on surface water quality, and potential contributions of constituents to surface waters, are reflected in **Table 3.6-4**. In general, during wet years, the Newmont-reclaimed South WRSF contributed elevated sulfate concentrations to Little Antelope Creek. Seepage from the Newmont-reclaimed South WRSF has somewhat lower pH and elevated sulfates, and flows into a constructed wetland.

Water quality data also have been collected elsewhere in the Antelope Creek watershed as part of ongoing regional monitoring. Water quality data are available for the Antelope Creek stations sampled as part of the BVMP (Barrick 2010). Selected recent data from the program are indicated in **Table 3.6-5**. Mercury and selenium concentrations were consistently below laboratory detection limits. Other constituents indicated in **Table 3.6-5**, such as pH, arsenic, sulfate, and TDS also are well within stream standards.

Groundwater removed from the underground workings is pumped to the surface and conveyed by pipeline and re-infiltrated through a set of RIBs near the confluence of the Little Antelope and Antelope creeks. Discharged water is released and monitored in compliance with an NDEP-approved water pollution control permit (NEV2003114). Water quality is sampled quarterly for the NDEP Profile II suite of constituents, and the analytical results are reported to NDEP (RCG 2010d). Results from this program indicate that most water quality constituents in the discharges have been well within the NDEP Profile 1 reference values as well as the state water quality standards for Rock Creek. However, dissolved arsenic concentrations exceeded Profile 1 concentrations in 6 out of 10 quarterly samples, with a minimum of 0.026 mg/L, a median of 0.0585 mg/L, and a maximum of 0.3 mg/L.

Table 3.6-5 Recent Water Quality Data for Antelope Creek

Location	Date	Constituents[1,2]					
		pH	As	HCO_3	SO_4	TDS	SpC
ANT-1A	28-Apr-09	7.36	<0.003	71.3	43.2	153	205
ANT-1	28-Apr-09	7.76	<0.003	77.2	25.3	178	221
ANT-2	28-Apr-09	7.14	<0.003	89.3	27.4	193	276
ANT-3	28-Apr-09	8.09	0.00358	98	45.6	204	313

[1] As = arsenic, HCO_3 = hydrogen bicarbonate, SO_4 = sulfate, TDS = Total Dissolved Solids.

[2] Values are in mg/L (dissolved) except for pH in standard units; and Specific Conductance (SpC) in µS/cm.

Source: Barrick 2010.

These results generally are consistent with groundwater quality characteristics identified from some of the wells constructed (or partially constructed) in the Vinini Formation, as described in Section 3.5.1.3, Groundwater Quality. However, in the BH series wells located in the area of underground workings and gold-bearing zones of the Vinini Formation, water quality showed no exceedences of Nevada water quality standards.

Discharge values for pH exceeded Rock Creek Class C standards in 3 out of 10 samples; all of those instances were higher (more basic) than the compliance range, with a maximum value of 9.71 standard units. Occasional exceedences of iron, aluminum, and manganese also were recorded in pumping discharges, but these were infrequent.

No water quality data exist in the relatively undisturbed headwater location of the proposed Mud Springs WRSF Alternative. The water quality of surface runoff from snowmelt and rainfall is likely to resemble that at monitoring station GBG-01, the upstream site on Little Antelope Creek summarized in **Table 3.6-4**.

Affected Environment Watersheds

Watersheds

This watershed discussion examines runoff conditions over large drainage areas from a hydrologic perspective. The hydrographic basins, and the general setting of the study area and CESA, are described in the introductory text of this Section (3.6.1, Affected Environment). As described in Section 3.4, Geology and Minerals, the proposed project is located in the northern part of the Great Basin section of the Basin and Range Province. The CESA falls within two broad ecoregions, the Upper Humboldt Plains and the Semi-Arid Uplands (Bryce et al. 2003). The Upper Humboldt Plains ecoregion consists of rolling plains punctuated by occasional buttes and low mountains. It is wetter and cooler than other Nevada ecoregions in its elevation range, and is transitional to the hills, low mountains, and buttes of the Semi-Arid Uplands along the Tuscarora Mountains.

Most surface runoff results from snowmelt in the winter and spring, or later in the year from convective thunderstorms. Influences on runoff, erosion and sedimentation include snowmelt and rainfall, topography and soil characteristics, vegetation conditions, drainage controls and conservation practices. Overland flow originates on generally rocky hillslopes with non-existent or shallow soils, as well as on more gently sloping alluvial fans and valley floors. Infiltration and porosity typically are greater on the latter depositional features, and runoff is sometimes completely absorbed downslope. Sagebrush and grasses commonly intercept precipitation, utilize available soil moisture, and provide

additional surface protection and roughness. Lightning fires are common, and extensive cheatgrass stands tend to replace the native grasses and shrubs after fires (Bryce et al. 2003).

Grazing is the major land use. Some irrigated or sub-irrigated agriculture, mostly for hay, occurs along parts of the valley floors. Mineral exploration and mining are present. However, mining operations are typically permitted as zero-discharge facilities in terms of controlling process fluids, and release non-process discharges through relatively small-scale structures when compared to the land areas of local or regional watersheds. In the CESA, which is approximately 550,000 acres in size, mines currently disturb approximately 1,100 acres or approximately 0.2 percent of the land area. These sites include the existing Midas, Ivanhoe, Rossi, and Hollister operations, and portions of the Storm Underground and Dee mines. Additional disturbance from mineral exploration, roads, pipelines, and transmission lines currently exists within the CESA (shown on **Figure 3.2-2**). Given the proportion of mining disturbance (0.2 percent), it is estimated that up to 1 or 2 percent of the CESA is presently disturbed by mining, exploration, roads, pipelines, and utility corridors.

Disturbance from grazing, fire, and roads is a major influence on surface runoff conditions within the study area and CESA. The grazing and fire histories of the study area and CESA generally follow those of the larger northern Great Basin region. Grazing by cattle and sheep has occurred within the northern Great Basin since the middle 1800s (Northeastern Nevada Stewardship Group 2003). Within the CESA, rangeland fires are common. At least 70 percent of the surface water CESA, and most of the project study area, has been burned by wildfire since the year 2000 (see **Figure 3.2-3**). Parts of the CESA have burned more than once since 1985.

3.6.2 Environmental Consequences

Potential impacts to surface water resources include additional sediment loading and turbidity increases in streams from project surface disturbance, streamflow and geomorphic impacts along Little Antelope Creek and Antelope Creek from groundwater pumping discharges, surface water quality exceedences in Little Antelope and Antelope creeks, reduced water availability at seeps and springs from groundwater drawdown related to groundwater pumping, and cumulative impacts to streams, springs, and seeps within the CESA. In turn, these impacts may create associated adverse effects on riparian vegetation, wetlands, and aquatic habitats. While these resources (and potential impacts to them) are closely related to water resources, specific sections have been devoted to their assessment.

3.6.2.1 Proposed Action

<u>Potential Effects to Surface Water from Surface Disturbance</u>

As identified in Chapter 2.0, **Tables 2-5** and **2-6**, approximately 117 acres of disturbance would be associated with the Proposed Action and ongoing exploration, in addition to the 105 acres of existing authorized disturbance for a total of approximately 222 acres of disturbance for this project. A total of 34.7 acres would be associated with the proposed transmission line and associated components. Most of this Proposed Action disturbance acreage would be associated with additional laydown areas, the mine office complex, transmission lines, access road, pipeline, substation, and the Hatter production shaft, ramp, or raise site. Construction and operation of these facilities would generate local impacts to surface water resources, mainly in the form of additional turbidity and sediment loading from disturbed area runoff. The potential for these incremental impacts would be minimized by surface drainage controls best management practices (BMPs), detention in the storm water pond, and treatment as necessary in the existing East Pit treatment plant prior to release in accordance with an approved National Pollutant Discharge Elimination System (NPDES) permit or other approved permit.

As described in the Proposed Action, RCG maintains a Storm Water Pollution Prevention Plan (SWPPP), which fulfills NDEP requirements for the existing Hollister operations. Additional temporary

diversion channels may be constructed to control storm water runoff. Continued implementation and maintenance of measures from the SWPPP, Reclamation Plan, and Spill Prevention, Control, and Countermeasures Plan would reduce the potential for impacts to surface water from disturbed-area runoff.

No surface water impacts from drainage controls are anticipated. All constructed drainage features for the project would be designed and built in accordance with applicable NDEP regulatory provisions. Runoff controls would be monitored and maintained in compliance with an approved SWPPP and mining storm water permit issued under Nevada General Storm Water Permit NVR300000. Description of BMPs to be installed and implemented to protect water quality, and to prevent sedimentation, erosion, and scour in the receiving water would be part of an approved SWPPP under Sections I.C.3 and I.C.9 of the general storm water permit for mining activities.

RCG plans to build a diversion channel to route runoff along the main access road west to the secondary diversion channel originally constructed by Newmont (RCG 2009a). This additional diversion channel section would route storm water from previously disturbed areas away from the West Pit into a diversion channel around the west and south sides of the Newmont-reclaimed South WRSF. Runoff from approximately 28 acres would be diverted past the Newmont-reclaimed South WRSF into Little Antelope Creek. The new diversion channel would be approximately 1,200 feet long, within which the majority of the channel would follow a gentle gradient until joining an existing channel southeastward toward Little Antelope Creek. This downstream alignment to the creek follows a steep tributary draw.

Geomorphic impacts from the proposed constructed alignment could include additional erosion and sedimentation from increased runoff being routed down the diversion. Channel deepening and widening would occur as the drainage adjusts to increased flows. These impacts would be limited by the existence of coarse sands, gravels, and larger rock fragments along the existing alignment and in the natural channel setting. These coarser materials eventually would armor the diversion and limit the severity of drainage modifications. Providing for stable channel transitions through such slope changes into Little Antelope Creek, or for other runoff controls as needed, would be part of project design and maintenance activities. Stabilization practices, including velocity dissipation devices, would be installed as necessary to provide non-erosive flow velocities under part I.C.9 of the storm water general permit. For project runoff and drainage controls overall, the consideration and appropriate inclusion of BMPs for diversion and sediment controls, storm water control structures, preventative maintenance, and inspections is part of the NDEP permit application, review, and approval process and would be implemented. Compliance with approved permit provisions would reduce or eliminate impacts to surface water from project surface disturbance and drainage.

During the period when RCG discharges water from the mine into Little Antelope Creek, additional impacts to surface water quality may occur from occasional traffic along the Little Antelope Creek Road. These would involve sediment movement and turbidity impacts from traffic crossing the stream while it is flowing. Based on an aerial photo review, there are currently six road crossings at fords along Little Antelope Creek, and an additional forded crossing of Antelope Creek. The Little Antelope Creek Road is not proposed as a primary access route to the project area, so water quality impacts from stream crossings could result from occasional traffic. Sediment and muddy water from incidental traffic would settle out in other reaches of Little Antelope Creek or further downstream in Antelope Creek. Natural high-flow events, such as spring runoff and severe thunderstorms, are likely to make low-water road crossings on Little Antelope Creek and Antelope Creek impassable for parts of the year. Additional NPDES discharge into Little Antelope Creek may slightly increase the occurrence of impassable conditions at low-water crossings, depending on the nature of streambed and bank materials and the geometry at crossings. Most of the channel is armored by gravel and rock fragments, which would help to reduce the effects of traffic. However, some damages to channel and bank conditions are likely to result from crossings made while streams are flowing.

Monitoring and mitigation is described in Section 3.6.4, Potential Monitoring and Mitigation Measures.

Exploration surface drilling generally would disturb 30 to 40 surface drill sites per year through the projected 20 years of active underground mining. Thus, approximately 600 to 800 drill sites and their associated access roads would be disturbed over the project life. Each site would occupy approximately 0.1 acre. The total disturbance at any given time associated with exploration for the Proposed Action would be an additional 25 acres, for a total of up to 50 acres of surface disturbance due to exploration (**Table 2-6**). Potential impacts, in the form of reduced surface water quality, would result from increased erosion, sedimentation, and turbidity in runoff from drill sites and roads, and possibly from spills or leaks of drilling fluids, fuel, or other substances, equipment, or vehicles. These impacts would be largely avoided or mitigated by the ongoing implementation of BMPs and by agency review and approval of drilling sites and storage areas.

RCG already has approved exploration permits from the NDEP and BLM. NDEP permits for reclamation and storm water protection are required prior to construction of any exploration, mining or milling activity that proposes to create disturbance over 5 acres or remove in excess of 36,500 tons of material from the earth (NDEP-BMRR 2011). Storm water BMPs and reclamation practices would continue to be identified, implemented, and maintained as part of ongoing compliance with provisions of state and federal permits for controlling and reclaiming exploration disturbance. Concurrent reclamation would be part of the exploration program, and this also would help reduce sedimentation and turbidity impacts. Other preventative measures and response plans included in permit authorizations would further reduce impacts to surface water resources.

Potential Effects from Groundwater Pumping Discharges

Additional potential surface water impacts would involve effects on streamflow, channel seepage, and channel geomorphology from proposed mine groundwater pumping discharges to Little Antelope Creek. For the Proposed Action, discharges from mine groundwater pumping would be made year-round to Little Antelope Creek via an outfall. This outfall would be approved under the NPDES program administered by NDEP. RCG would continue to use the RIBs.

As described in Chapter 2.0, the proposed NPDES outfall is located somewhat south of the center of Section 4, T37N, R48E, near the causeway where the existing east-west road passes over Little Antelope Creek. The proposed outfall location is in a bedrock-controlled draw with steep rocky hillslopes on both sides of the channel. Natural rock materials already existing in the Little Antelope Creek channel bottom and sideslopes have size gradations ranging from approximately 6 inches to 48 inches, and would be adequate to ensure channel stability at the proposed NPDES outfall location at the maximum anticipated short-discharge rate of 1,100 gallons per minute (gpm) (RCG 2011b). This is equivalent to approximately 2.5 cubic feet per second (cfs). It is extremely unlikely that channel or bank instabilities would result from discharges at or near the outfall. Nonetheless, routine monitoring of the outfall in compliance with permit conditions would ensure continued stability. If monitoring identifies erosion concerns at or near the outfall location, additional durable, coarse gravel or boulders could be placed in the channel to provide greater energy dissipation. No waste rock would be used. No impacts to channel or bank stability are anticipated at or near the proposed NPDES outfall (Brown and Caldwell 2011b).

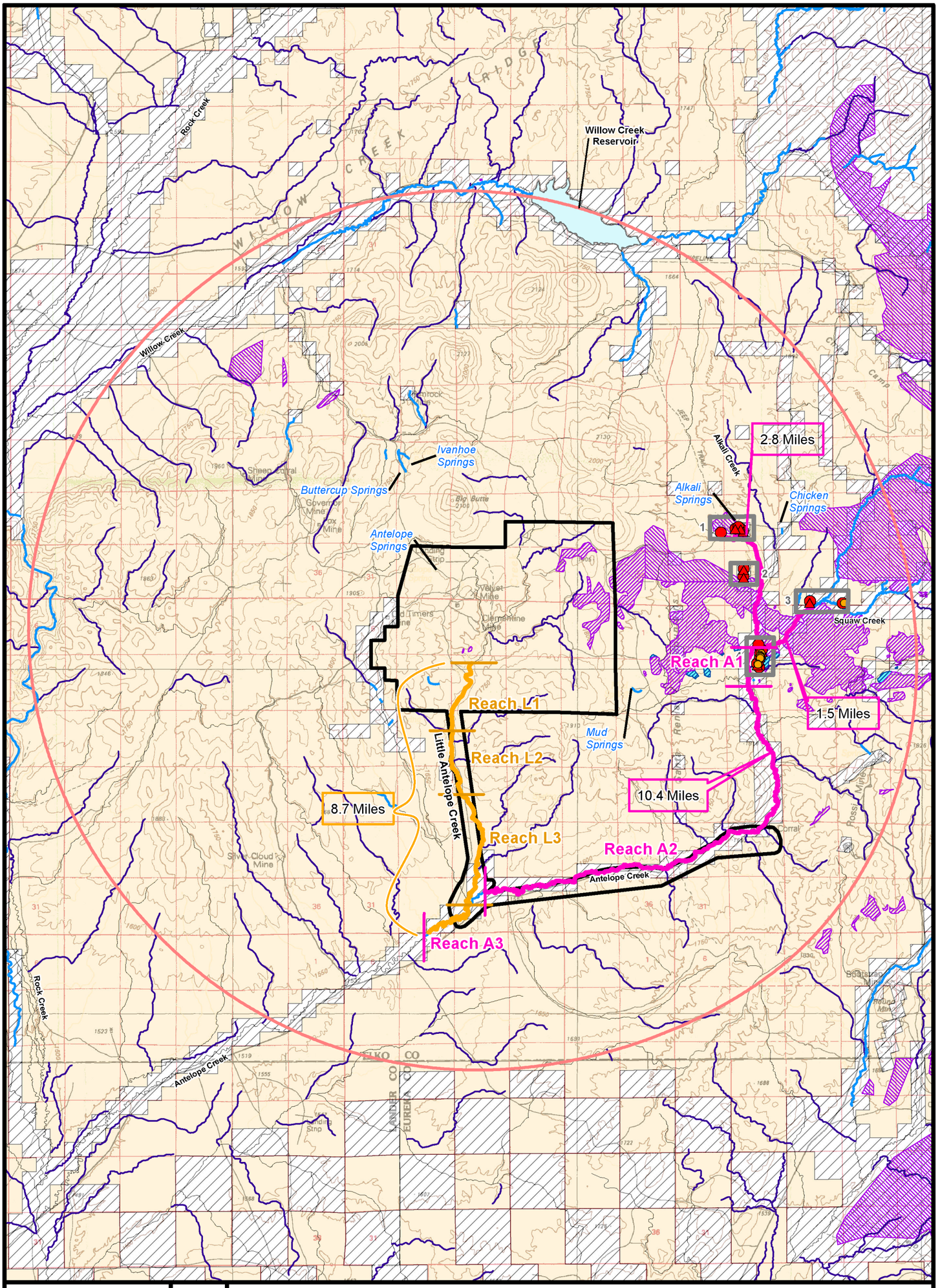
Under the Proposed Action, the average estimated groundwater pumping discharge is estimated to be 650 gpm (approximately 1.45 cfs). Short-term elevated rates are expected to be approximately 1,100 gpm (approximately 2.5 cfs). Discharges from mine pumping would increase flow durations in Little Antelope Creek downstream of the proposed NPDES outfall, and in part of Antelope Creek until the discharges seep into the porous channel bed. Anticipated flow conditions in Little Antelope Creek would be perennial or discontinuously flowing downstream and beyond the confluence with Antelope

Creek. Discontinuous flow stretches and/or pools would form where the channels alternately lose and gain water from the porous alluvium underlying the streambed. This happens as the irregular topography of the low-flow channel rises and falls, as the channel moves over shallower or deeper bedrock, or as the permeability of sediments changes.

A recent USGS study in the region quantified streambed infiltration rates in a setting generally similar to that of Little Antelope Creek (Prudic et al. 2007). Trout Creek, judged by the USGS to be a typical intermittent stream in the Middle Humboldt River Basin, was selected to develop methods of estimating and characterizing streambed infiltration and groundwater recharge in mountainous terrains (Prudic et al. 2007). Trout Creek drains the northwest flank of Battle Mountain near the Town of Valmy.

Infiltration of pumping discharges into the Little Antelope Creek streambed was estimated using the slower values of streambed-infiltration rates (approximately 0.2 cubic meter per square meter of flow area per day) from USGS measurements along Trout Creek. In addition, an assumed typical streambed width (4 feet) based on tabulated information from field surveys (JBR 2003a) and a 5-mile stream length were used. Based on available data and photographs, these dimensions are likely conservative for the purpose of assessing fairly small flow conditions in this variable channel. Based on these inputs and other hydraulic estimates, the original average groundwater pumping discharge of 1.45 cfs would be reduced by streamflow infiltration to a channel flow of approximately 0.65 cfs where Little Antelope Creek ends at its confluence with Antelope Creek. Additional flow reductions, which may be substantial, would occur from seasonally variable evaporation and vegetation uptake.

Based on these inputs, the length of flow that would continue down Antelope Creek from its confluence with Little Antelope Creek was estimated using a middle value of streambed infiltration (approximately 0.4 cubic meter per square meter of flow area per day), a flow width of 10 feet, and other hydraulic inputs. Based on these estimates, the remaining pumping discharges would move approximately 4,300 feet (0.8 mile) down Antelope Creek from the confluence before surface flow completely infiltrated into the streambed. The estimated area of streamflow impacts, which may be considered to be beneficial, is indicated in **Figure 3.6-4**. It should be noted that these values are rough estimates based on assumptions and regional data, and assume that no other flows have already wetted either stream. It is likely that with additional seasonal streamflows along Little Antelope or Antelope Creek, small remaining discharge volumes from pumping would mix with runoff from the watershed and move downstream during spring runoff. A similar condition would result if groundwater seepage contributed to flow or ponded conditions in lower Antelope Creek below its confluence with Little Antelope Creek. These would be beneficial impacts to streamflow during the project. These conditions would move groundwater pumping discharges farther downstream than was estimated for dry streambed conditions. The total length of additional flow, ponding, or available moisture in the alluvium is unknown; it would vary depending upon transient conditions. No water quality impacts would occur due to treatment of discharges before release to Little Antelope Creek, as needed, and anticipated compliance with NPDES permit provisions. Pumping discharges would flow along the streams to different extents depending on calculation inputs, existing channel flows, pumping discharge rates, channel characteristics, and seasonal conditions. In particular, sediment characteristics, evaporation, and plant uptake would have major influences on the downstream extent of a given discharge rate. Although the estimates are general in nature, these flow changes would increase the overall amount of water available for riparian vegetation and the uses of the streams during the life of the discharges.



Potentially Affected Stream Flow and Contributing Springs Potentially Affected

Figure 3.6-4

Hollister Underground Mine Project EIS

Legend

- Project Area Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Spring Complex
- Stream Length of Anticipated Increased Flow Presence
- Stream Length of Potentially Reduced Flow Presence
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Springs (Sada 2007)

- Springs Potentially Affected

Springs (BLM 2006)

- Spring Potentially Affected

Seeps/Springs (BLM 2000b)

- Seeps/Springs Potentially Affected

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Surface Ownership

- Bureau of Land Management
- Private

N

0 1 2 Miles

Sources: AECOM 2010a; BLM 2011b; JBR 2010; NBMG 2003; Sada 2007; USGS 2005.

3/23/2012

Floodplains along Antelope Creek and lower Little Antelope Creek would not be directly affected by proposed project disturbance. However, geomorphic impacts to stream channels and banks may occur within existing floodplains, as described below.

Potential changes to the existing channel and bank geomorphology could result from additional pumping discharges over time. The anticipated maximum short-term discharge is estimated to be approximately 2.5 cfs, with a smaller long-term average of approximately 1.5 cfs. As indicated in the Affected Environment section, these flows would pass through several different stream reaches, varying from stable well-vegetated, cobble- and boulder-reinforced perennial conditions near the project, to sandy and gravelly intermittent sections along lower Little Antelope Creek and Antelope Creek. In a number of places, floodplain and channel and bank conditions are improving from a past degraded state.

To investigate the potential for increased channel and bank instabilities, further hydrologic and channel stability assessments were conducted for the upper portions of Little Antelope Creek (Brown and Caldwell 2011b). Formal investigations included a site-visit to investigate channel, bank and floodplain conditions; derivation of peak runoff discharges for several recurrence intervals; and comparative calculations of flow hydraulics downstream from the project.

Based on site inspections, the Rosgen channel type classification was determined to be B3 in a short uppermost section, transitioning F2b and F3b types immediately downstream and through the lower sections. The Rosgen B3 type is a steep, relatively wide channel in comparison to its depth, with a cobbly susbtrate. The study reach resulted in an overall Rosgen F channel type, which exhibits past degradation through channel incision and widening. These channels exhibit incised or “confined” conditions, and the bank-full conditions are well below the top of the streambank. However, the width of the channel usually allows the stream to develop or initiate floodplain/bank-full benches, and to increase the meandering nature of the stream over time in the widened channel section (Brown and Caldwell 2011b).

In addition to map-derived subwatershed areas, detailed basin and channel inputs were developed from site-specific characterization (Brown and Caldwell 2011b). These were used as input to the hydrologic and hydraulic simulations. Such parameters included channel geometry and roughness coefficients, basin lag times, channel routing coefficients, and other inputs needed to model the runoff peak and volume characteristics of the sub-basins along Little Antelope Creek as an interconnected hydrologic/hydraulic system.

The comparative calculations of flow hydraulics used a detailed USDA-NRCS TR55 modeling approach (based on the USDA-NRCS curve-number method) in combination with published National Oceanographic and Atmospheric Administration (NOAA) precipitation depths for 2-year, 24-hour through 100-year, 24-hour storm events. This is standard accepted engineering practice. The NOAA values are based on collected data and interpretations by the agency. For modeling and design purposes, the published NOAA frequency-depth-duration precipitation values are typically used since they represent an intense, convective storm or other severe rainfall event.

These precipitation depths were used by Brown and Caldwell as inputs to storm runoff simulations using an appropriate rainfall distribution over time. Published USGS regional equations for the flow peaks at the same recurrence intervals and durations were used to cross-check the results of the USDA-NRCS modeling approach. Sensitivity analyses for varying curve-number values also were conducted.

The 2-year peak flow event is generally accepted as the discharge that creates bankfull conditions. It occurs or is exceeded on average in 50 percent of the years. Conceptually, this flow rate moves the

most sediment over time. Acceptable peak flow agreement for the 2-year, 24-hour runoff event was found between the regional equation and a selected curve number input.

The simulated 2-year, 24-hour peak discharge for the upstream end of the study reach was approximately 88 cfs for a basin area of approximately 14.5 square miles (Brown and Caldwell 2011b). At the lower end of the study reach, the cumulative basin area of 17.5 square miles produced a simulated 2-year, 24-hour peak discharge of 101 cfs. Assuming that the 2-year peak discharge represents bank-full conditions for Little Antelope Creek, the calculated average hydraulic depth, flow velocity, shear stress, and channel top width for the study reach are compared for background and proposed project conditions in **Table 3.6-6** (Brown and Caldwell 2011b). Proposed pumping discharges incorporated by Brown and Caldwell into the analysis were 1,500 gallons per minute (approximately 3.3 cfs), which is substantially higher than normal anticipated pumping discharges. This analysis is a conservative approach.

Table 3.6-6 Average Bank-full Hydraulic Conditions for the Little Antelope Creek Study Reach

Parameter	Existing Conditions	Proposed Conditions	Percent Increase
Hydraulic Depth, feet	0.76	0.78	1.7
Velocity, fee per /second	4.11	4.16	1.3
Shear Stress, pound per square foot	1.11	1.13	1.6
Top Width, feet	29.3	29.6	1.1

Source: Brown and Caldwell 2011b.

Based on this detailed investigation, it can be seen from **Table 3.6-6** that minimal changes to flow hydraulics would result from proposed groundwater pumping discharges to Little Antelope Creek. Although groundwater pumping discharges would occur year-round, these frequent peak conditions would govern the overall stream condition. The same would probably be true even if there were occasional freeze/thaw cycles and temporary ice formation in the creek. Since flows would infiltrate downstream, smaller downstream flow effects would be expected than those identified in **Table 3.6-6**. No impacts to the existing stability conditions of channels and banks are anticipated from the proposed project.

Potential Effects on Surface Water Quality

Existing water quality in Little Antelope Creek has been affected by previous open-pit mining activities in the project area, as described in Section 3.6.1, Affected Environment. These effects primarily include elevated concentrations of arsenic, sulfate, and total dissolved solids. Higher levels of specific conductance, an indicator of salinity, are present as well. Water drainage from the existing MA-1 seep and the existing Newmont-reclaimed South WRSF contribute to these conditions. Existing groundwater contributions along the creek also may reduce surface water quality. Section 3.5, Groundwater Resources and Geochemistry, describes groundwater conditions and potential impacts to that resource.

Potential impacts to surface water from adverse waste rock geochemistry would be avoided by the proposed selective placement of waste rock materials, and covering them with suitable material and growth media to control infiltration and seepage. Runoff and seepage from the existing lined and

engineered WRSF would be controlled by the existing sump and liner in accordance with the NDEP-approved Water Pollution Control Permit (# NEV2003107). Water would continue to be discharged into the existing RIBs and treated, if necessary, to meet NDEP permit requirements. As described in Chapter 2.0, the West Pit WRSF would be engineered, constructed, and reclaimed in the same manner as the existing RCG WRSF. Shallow water sometimes collects from November to July in the existing West Pit in wet years. The quality of water accumulated in the pit generally has elevated TDS concentrations and low (acidic) pH values (Brown and Caldwell 2010c). Drainage from the proposed West Pit WRSF would be managed by constructed storm water facilities and use of low permeability barriers. Given these approaches to managing surface drainage and containment, direct incremental impacts to surface water resources from materials deposited in the West Pit WRSF would be negligible.

As described in Section 3.5, Groundwater Resources and Geochemistry, backfilling the West Pit may create effects on groundwater flow directions in the adjacent perched aquifer. The West Pit acts as an evaporative sump when water is present during wet years and creates a zone of groundwater removal immediately adjacent to the pit. This zone is indicated in the groundwater monitoring levels as a groundwater divide near the West Pit. The groundwater assessment indicates that backfilling of the pit would end the evaporation from the pit and groundwater would be expected to flow past the pit and continue down gradient in a southeasterly direction. Based on groundwater analyses, backfilling of the West Pit may increase the flow rate at the MA-1 seep by up to 2 gpm and may affect the water quality at the seep. This potential impact is discussed further in Section 3.5, Groundwater Resources and Geochemistry and **Appendix B4**, Hollister Mine West Pit Shallow Groundwater Technical Memorandum.

Under the Proposed Action, the underground workings would be pumped as needed during the 20-year mine life, at rates up to 1,100 gpm (approximately 2.5 cfs). Of this amount, RCG would use between 100 and 150 gpm for mine operations, up to 300 gpm for RIBs discharge, and up to 650 gpm for discharge to Little Antelope Creek; however, RCG would maintain flexibility in their operations to discharge up to 700 gpm to the RIBs and 1,100 gpm to Little Antelope Creek. Water from mine pumping would be kept separate from surface water diversions. As described in Chapter 2.0, Description of Alternatives Including the Proposed Action, a dedicated system would isolate and route water pumped from the mine. Once pumped to the surface, the water would be piped to the existing East Pit water treatment and handling facilities, as needed. Data indicate that subsurface water quality is substantially different than surface water quality from snowmelt and rainfall runoff (Montgomery and Associates, Inc. 2010b).

As part of the Proposed Action, RCG would continue its current water management system of pumped water treatment prior to discharge into the RIBs (RCG 2009a). The current process involves pH adjustment, flocculant addition, thickening and clarification, solids management, and clean water discharge (RCG 2008b). To supplement the existing water management system for the Proposed Action, 8 to 12 underground wells may be installed within the underground mine workings as necessary to improve water handling. The groundwater pumping system (wells, pumps, pipelines, and tanks) would prevent groundwater from contact with the underground workings or from commingling with mine water that is handled by the existing water management system. Water produced from the underground wells would be routed to underground pumping stations through dedicated pipelines. Water then would be pumped from the mine to the surface. From this point, there would be two water streams denoted as “mine water” and “clean water.” The mine water would continue to be treated as described above and ultimately discharged to the RIBs. The “clean water” would remain separated from the mine water and would be treated, if necessary, prior to discharge into Little Antelope Creek in compliance with the NPDES discharge permit.

Depending on the water quality of groundwater pumping discharges as indicated in Section 3.5.1.3, Groundwater Quality, additional water treatment may be required by NDEP if necessary to reduce

arsenic, sulfate, and TDS concentrations to within NDEP Class C standards for Rock Creek and its tributaries, or to attain drinking water standards if underground Waters of the State could be affected. Without reductions in these constituent concentrations and attainment of other Nevada Class C standards, degradation of Waters of the State would occur if elevated levels of these or other constituents were present in groundwater pumping discharges. During the review of a discharge permit application, NDEP would review background and discharge water quality characteristics, as well as treatment approaches and monitoring. The Proposed Action would monitor and treat pumping discharges in compliance with permit provisions and authorizations.

Potential Effects from Groundwater Drawdown

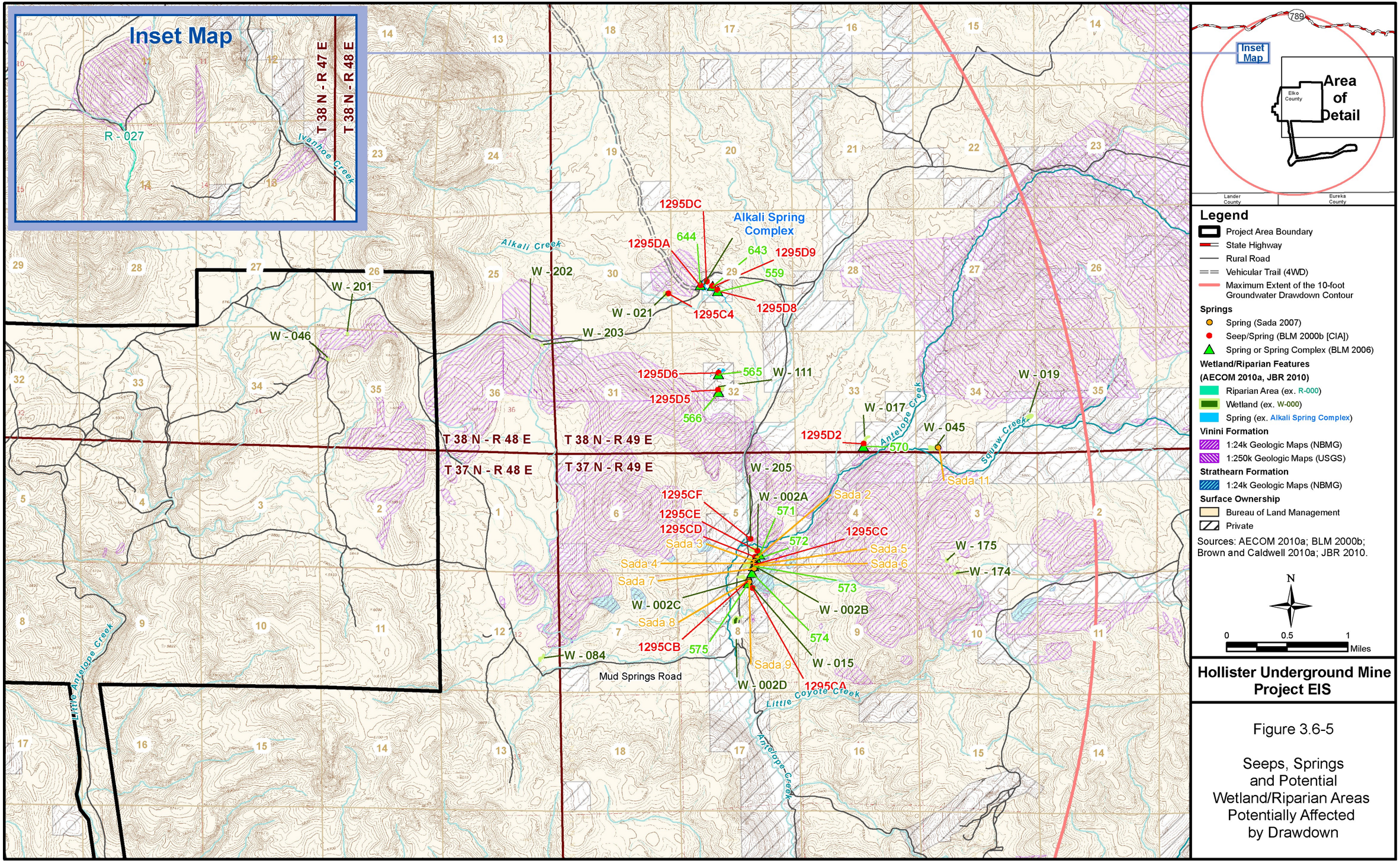
Drawdown from mine pumping is not expected to affect Antelope Spring, Ivanhoe Spring, or Buttercup Spring due to elevation differences between the aquifers that support these features and the zone that seeps into the underground workings. The geologic setting that supports these springs and isolates them from the effects of mine groundwater pumping is described in Section 3.5.1.2, Hydrogeology. In addition, as described by Brown and Caldwell and other investigators, differences in elevation and separation by geologic structures would eliminate the potential for impacts to these springs from the Proposed Action (JBR 2003b). Drawdown mainly would affect the deeper Vinini Formation, which is isolated from valley alluvium by the clayey, less permeable nature of overlying volcanic rock (see Section 3.5, Groundwater Resources and Geochemistry). Because of this isolation from the Vinini Formation, seepage losses through the channel beds of Little Antelope Creek, Antelope Creek, and Rock Creek are not expected to increase due to groundwater pumping.

Proposed groundwater pumping to drain the underground mine would create a zone of groundwater decline (drawdown). The zone bounded by the estimated maximum extent of 10 feet of groundwater drawdown has been used for purposes of assessing potential impacts to surface water. That area has been estimated by groundwater modeling for the proposed project, as described in Section 3.5, Groundwater Resources and Geochemistry. As indicated in **Appendix C, Figure C-1**, numerous springs, seeps, wetlands, and riparian areas occur within the zone bounded by the anticipated maximum extent of the 10-foot groundwater drawdown contour. Based on BLM geographic information system data, aerial photo interpretations, and other data sources, numerous springs or spring complexes, ponds or other open water features, wetland areas, and riparian zones occur within the maximum extent of the 10-foot groundwater drawdown contour. The estimated occurrence of wetland and riparian features is further described in Section 3.9, Riparian and Wetlands Areas.

Four spring complexes are potentially affected by the Proposed Action from groundwater drawdown in the Vinini Formation (**Figures 3.6-4**, **3.6-5**, and **Table 3.6-7**). All four complexes are located on private land. The criteria for determining which springs are potentially affected by groundwater drawdown are identified in Section 3.5, Groundwater Resources and Geochemistry. These features are depicted in **Table 3.6-7** and indicated in **Table 3.6-5** by type.

Table 3.6-7 was initially based on approximations from existing databases and geologic information, combined with modeling of the potential pumping effects on the Vinini Formation. The list was then revised following fieldwork by JBR in November 2010, to ground-truth the occurrence of the features for the project (JBR 2010). These results are informed interpretations of the surface features that are hydraulically connected to the Vinini Formation within the simulated maximum extent of the 10-foot groundwater drawdown contour, and therefore contain uncertainty.

The springs and seeps indicated in **Table 3.6-7** and on related figures are often closely associated with wetland and riparian features and habitats that support aquatic species. These features are indicated in **Figure 3.6-5** in an attempt to relate the different resource values. A number of data



Legend

- Project Area Boundary
- State Highway
- Rural Road
- Vehicular Trail (4WD)
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Springs

- Spring (Sada 2007)
- Seep/Spring (BLM 2000b [CIA])
- Spring or Spring Complex (BLM 2006)

Wetland/Riparian Features (AECOM 2010a, JBR 2010)

- Riparian Area (ex. R-000)
- Wetland (ex. W-000)
- Spring (ex. Alkali Spring Complex)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Surface Ownership

- Bureau of Land Management
- Private

Sources: AECOM 2010a; BLM 2000b; Brown and Caldwell 2010a; JBR 2010.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.6-5

Seeps, Springs and Potential Wetland/Riparian Areas Potentially Affected by Drawdown

3/23/2012

Table 3.6-7 Summary Table of Springs and Wetlands Potentially Impacted within the Hollister Maximum 10-foot Groundwater Drawdown Contour

Spring ID	Spring Complex (shown in Figures 3.6-4 and 3.6-5)	Source	Spring Distance to Vinini (feet)	Comment	Spring Elevation (feet)	Bedrock Groundwater Elevation (feet)	Groundwater Elevation- Spring Elevation[4] (feet)	Geologic Unit[3]	Comments	Potentially Affected by Vinini Formation Drawdown[5]
1295CA	NA	BLM 2000b	0-500	B[2]	5455	5486	31	Penn/Perm	Strathearn Fm spring	Low Potential
1295DA	1	BLM 2000b	0-500	A: 644	5600	5615	15	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
1295D9	1	BLM 2000b	500-800	A: 643	5601	5610	9	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
1295DC	1	BLM 2000b	0-500		5614	5610	-4	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
1295D8	1	BLM 2000b	500-800	A: 559	5588	5610	22	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
643	1	BLM 2006	500-800		5602	5610	8	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
644	1	BLM 2006	0-500		5600	5615	15	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
559	1	BLM 2006	500-800		5586	5610	24	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
1295C4	1	BLM 2000b	0-500		5620	5600	-20	Ov	Vinini Spring	High Potential
565	2	BLM 2006; JBR 2010	500-800		5601	5580	-21	Ov	Drainage associated with Vinini	High Potential
566	2	BLM 2006; JBR 2010	0-500		5597	5580	-17	Ov	Drainage associated with Vinini	High Potential
1295D6	2	BLM 2000b	500-800	A: 565	5601	5580	-21	Ov	Drainage associated with Vinini	High Potential
1295D5	2	BLM 2000b	0-500	A: 566	5603	5574	-29	Tcu	Spring along fault in Carlin Fm	Low Potential
570	3	BLM 2006; JBR 2010	0		5477	5600	123	Ov	Spring associated with Vinini	High Potential
1295D2	3	BLM 2000b	0-500	A[1]: 570	5580	5600	20	Ov	Vinini Spring	High Potential
1295CF	4	BLM 2000b	0-500		5438	5512	74	Ov	Vinini Spring	High Potential
571	4	BLM 2006	0-500	A: 1295CE	5477	5510	33	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
572	4	BLM 2006	500-800	A: Sada 2	5465	5510	45	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
573	4	BLM 2006	500-800	A: Sada 3-7	5460	5510	50	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
574	4	BLM 2006	500-800	A: Sada 3-7	5467	5510	43	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
575	4	BLM 2006	500-800	A: Sada 9	5459	5495	36	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CB	4	BLM 2000b	500-800	A: Sada 8	5457	5500	43	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CC	4	BLM 2000b	500-800	A: Sada 3-7	5460	5500	40	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CD	4	BLM 2000b	500-800	A: Sada 2	5456	5500	44	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CE	4	BLM 2000b; JBR 2010	0-500		5447	5510	63	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 8	4	Sada 2007	500-800		5460	5490	30	Penn/Perm	Strathearn Fm spring	Low Potential
Sada 9	4	Sada 2007	500-800		5460	5490	30	Penn/Perm	Strathearn Fm spring	Low Potential
Sada 2	4	Sada 2007; JBR 2010	500-800		5450	5510	60	Penn/Perm &Tcm	Strathearn Fm spring	Low Potential
Sada 3	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 4	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential

Table 3.6-7 Summary Table of Springs and Wetlands Potentially Impacted within the Hollister Maximum 10-foot Groundwater Drawdown Contour

Spring ID	Spring Complex (shown in Figures 3.6-4 and 3.6-5)	Source	Spring Distance to Vinini (feet)	Comment	Spring Elevation (feet)	Bedrock Groundwater Elevation (feet)	Groundwater Elevation- Spring Elevation[4] (feet)	Geologic Unit[3]	Comments	Potentially Affected by Vinini Formation Drawdown[5]
Sada 5	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 6	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 7	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 11	3	Sada 2007	0-500		5600	5610	10	Ov	Vinini Spring	High Potential

[1] A: Probable duplicate spring location.

[2] B: Potential outlier.

[3] Tert. = Tertiary,
Fm = Formation,
Alluv = Quaternary Alluvium,
Tcm or Tcu = Carlin Formation,
Penn/Perm = Strathearn Formation,
Ov = Vinini Formation,
Qtg = Quaternary gravel, and
Ta = Tertiary andesite.

[4] Springs sourced in the Vinini or Strathearn formations with a spring elevation within 50 feet of the groundwater elevation potentially would be impacted by groundwater drawdown. See Section 3.5.2.3 for a discussion of criteria for determining whether a spring would be impacted by groundwater drawdown in the Vinini Formation.

[5] High potential was assigned to springs located on Vinini Formation outcrops or within 500 feet of the Vinini Formation. Low potential was assigned to springs located 500 to 800 feet from the Vinini Formation or on Strathearn Formation. Springs associated with, or in close proximity to, the Strathearn Formation also could be potentially affected by groundwater drawdown in the Vinini Formation.

sources are presented, and those investigators conducted their inventories at different times, for different purposes. As a result, there is some duplication of points in **Table 3.6-7** and **Figure 3.6-5**, but it is felt that this approach best provides integrated resource coverage for the available data. Further discussion of potential impacts to wetlands and riparian areas is presented in Section 3.9, Riparian and Wetland Areas, and potential impacts to fisheries and aquatic resources are discussed in Section 3.13, Aquatic Biological Resources.

Groundwater drawdown of 10 feet or more potentially would reduce spring flows at locations indicated in **Figure 3.6-5**. In turn, these impacts potentially would reduce spring-derived streamflows on Antelope Creek downstream of the spring complexes. At present, the flow durations range from perennial to intermittent, with extensive portions of discontinuous perennial flow or ponded water along the low-flow channel. These current conditions extend from the vicinity of Spring Complex 1 at Alkali Springs (**Figure 3.6-4**) down to the confluence with Little Antelope Creek and beyond. A segment of Squaw Creek also potentially would be affected. The total length of streams that potentially would be affected includes approximately 2.8 miles of Alkali Creek, 1.5 miles of Squaw Creek, and up to 10.4 miles of Antelope Creek. The latter stream segment, shown as Reach A2 in **Figure 3.6-4**, would undergo variable flow reductions depending on the actual flow conditions at the springs and on runoff from contributing sub-watersheds. It is possible that flow reductions could occur downstream to the confluence with Little Antelope Creek, as indicated in **Figure 3.6-4** (a stream distance of 10.4 miles), or they could be much less extensive.

A total of 27 water rights within the maximum extent of the 10-foot groundwater drawdown contour are listed in **Appendix C, Table C-2**. Of these, six are owned by RCG and are located within the Hollister Project Area, as shown in **Figure 3.6-3**. A surface water right (VO6234) that is supplied by the Old Timers Channel west of the project would not be affected. A total of 17 underground rights and surface water at Willow Creek Reservoir would not be affected due to their geologic isolation from drawdown effects in the Vinini Formation. The 17 underground rights access water from springs or wells in the Carlin Formation and equivalent rocks. Willow Creek Reservoir is underlain by recent alluvium overlying volcanic tuffs. The Vinini Formation is far below the volcanic formations in the Willow Creek Reservoir area.

Based on drawdown predictions and the extent of the Vinini Formation in the area, pumping could adversely affect two remaining recorded rights within the maximum extent of the 10-foot groundwater drawdown contour. These are #27455 (at Alkali Springs) and VO6262 (26 Ranch Spring #25, spring location 1295D5 in **Figure 3.6-5**). Impacts to these water rights would include reduced spring flows from drawdown in the Vinini Formation.

Potential Effects from Access and Utility Corridors

Outlying components of the Proposed Action would include the access road and transmission lines. Minor impacts to creeks would result from road runoff and sedimentation due to increased use and grading of the existing Ivanhoe Road. These impacts would be minimized by road drainage features and ongoing maintenance. No water crossing impacts would occur at the Humboldt River, due to the substantial bridge on the highway. No water crossing impacts would be anticipated on Rock Creek due to its distance from project disturbance (see **Figure 3.6-4**). Potential impacts to Little Antelope Creek would be the same as those previously mentioned under Potential Effects to Surface Water from Surface Disturbance. The proposed transmission line alignments would cross both Little Antelope and Antelope creeks. Disturbance from transmission line construction would increase the potential for erosion and sedimentation, with associated reduction of runoff water quality. BMPs implemented as part of the construction storm water management program would reduce these impacts to minor levels. During operations, inspection and maintenance of BMPs would further reduce the potential for impacts to runoff and surface water quality.

Watersheds

As identified previously, the majority of the proposed disturbance would occur on hills in the Rock Creek Valley (Hydrographic Area 62), within the Humboldt River Basin. Two ephemeral drainages have been re-routed around the previously authorized disturbance areas. The proposed project configuration would require additional drainage modification; these considerations are assessed in the Potential Effects to Surface Water from Surface Disturbance section. Additional project-related exploration, mining, and transmission line construction disturbance would represent approximately 0.03 percent of disturbance within the hydrographic area. This would represent a small, probably negligible, incremental amount of disturbance to runoff and sedimentation conditions in the watershed.

Exploration disturbance could lead to increased compaction, runoff, and erosion, leading to sedimentation in depositional areas. In general, the disturbance associated with exploration would be surrounded by vegetated areas that would act as a buffer to nearby streams and drainages, capturing some of the sediment. Construction of the proposed transmission line and associated substation and storage area would cause compaction and disturbance of soil cover, which could lead to erosion and sedimentation to Little Antelope and Antelope creeks. Proposed revegetation and project controls on erosion and sedimentation would avoid or mitigate these impacts.

A small section of the Ivanhoe Road occurs within the Willow Creek drainage (Hydrographic Area 63). As described in Section 2.2.2, Access Roads, the Ivanhoe Road would be the primary access road to the site. Maintenance activities on the road would include grading, snow removal, and use of a dust suppressant such as magnesium chloride. Grading activities would result in loosening the surface soils, making them vulnerable to erosion. Application of magnesium chloride would result in the addition of salts to the surrounding soils, which may further degrade soil structure and protective vegetation, and increase erodibility. These factors may lead to increased sedimentation in Willow Creek and its tributaries, particularly where road drainage leads to stream crossings. Road inspections, and properly designed and maintained drainage and crossing features would help minimize this impact. This additional disturbance would represent less than 1 percent of the Willow Creek hydrographic basin, and would be similar in nature to existing public road maintenance activities in the area. It would generally represent a small incremental impact above existing conditions.

3.6.2.2 Mud Springs Road Transmission Line Alternative

Potential impacts from this alternative would be the same as described for the Proposed Action. However, stream crossings would be in more upgradient headwater locations. The proposed construction storm water management program would reduce or eliminate impacts to surface water.

3.6.2.3 Mud Springs Waste Rock Storage Facility Alternative

Potential impacts from this alternative would be generally similar to those discussed for the Proposed Action, with the exception of potential runoff and seepage from the alternative waste rock storage location. As described in Chapter 2.0, Description of Alternatives Including the Proposed Action, this alternative would employ storm water diversions, designed in compliance with agency requirements, to route runoff around the facility into existing drainages. The routed watershed area would be small, and existing conditions include steep ephemeral drainages with bedrock controls on the landscape. During operations, a wet-well or internal sump would collect any seepage through the waste rock materials. Downward seepage also would be controlled by placement of a synthetic liner beneath the storage facility. Suitable acid-neutralizing materials (such as dolomite) would be mixed into the waste rock during development of the facility to control acid rock drainage. Direct surface runoff from the facility would be controlled by its sideslope geometry and drainage features. Little or no impacts to the stability of the existing watershed are anticipated from runoff or storm water routing.

After operations, a 36-inch earth cover would be placed on this alternative facility, and other reclamation practices would be employed similar to those described for waste rock storage under the Proposed Action. However, the level of surface water containment provided by the West Pit under the Proposed Action would not be available at the Mud Springs WRSF Alternative. Long-term site stability and downgradient water quality conditions would depend on the continued integrity of storm water diversions, the success of dolomite rock in ameliorating the potential formation of acid seepage, the integrity of the underliner, and the long-term success of the earth cover to minimize infiltration into the facility.

3.6.2.4 Backfill Alternative

Under the Backfill Alternative, impacts to surface water resources would be the same as the Proposed Action. The monitoring/mitigation measures recommended for the Proposed Action also would apply to this alternative.

3.6.2.5 No Action Alternative

Under the No Action Alternative, there would be no incremental impacts to either surface water quantity or quality. The existing ephemeral and intermittent flows would continue in Little Antelope Creek and downstream in Antelope Creek. Water quality would vary according to the amount of snowmelt and rainfall runoff, as well as groundwater contributions later in the year.

3.6.3 Cumulative Impacts

The CESA for surface water resources is shown in **Figure 3.6-1**. Past, present, and RFFAs are summarized in Section 3.2. Cumulative impacts to surface water features such as streams, springs, and seeps would occur within the Rock Creek Valley and Willow Creek Valley hydrographic areas. These cumulative impacts would result from ongoing surface disturbance by mining and other land uses, and from mine dewatering and pumping discharges, including groundwater drawdown in the Carlin Trend.

The direct impacts as described previously from the Hollister Mine would add to the existing and ongoing surface water impacts within the CESA. Most of these cumulative impacts would result from mine water management effects in Rock Creek Valley, as well as from grazing, fire, roads, pipelines, and transmission lines.

Cumulative drawdown in the Carlin Trend region primarily results from the Gold Quarry and Leeville Projects operated by Newmont Mining Corporation, and the Betze/Post and Meikle mines operated by Barrick Goldstrike Mines Inc. Because groundwater drawdown from Hollister occurs in a separate and different aquifer than the other mines in the region, there would be no cumulative impacts to any specific aquifer resulting from the combination of such operations. However, the overall regional groundwater balance would experience cumulative decline. Such overall regional cumulative impacts may also result in adverse cumulative impacts to the number of springs, seeps, and groundwater contributions to streamflows that could experience reduced flows.

Numerical groundwater models that have been developed to estimate the maximum extent of cumulative drawdown to water-table aquifers are described in the Cumulative Impact Analysis report (BLM 2000b) and in other previous EIS assessments for Newmont and Barrick (BLM 2009a, 2002b,c, and others). The predicted cumulative drawdown from those projects is extensive through the Rock Creek Valley portion of the CESA, and extends 1 to 2 miles into the south-central part of Willow Creek Valley (BLM 2000b). In particular, **Figure 3.5-18** shows a small overlap between the Hollister maximum extent of the 10-foot groundwater drawdown contour and the Betze maximum extent of the 10-foot groundwater drawdown contour, although each drawdown occurs in a separate and unconnected aquifer. The proposed Hollister project's predicted impacts to seeps and springs would

add to the number of such features impacted from drawdown generated by Barrick or Newmont and thus would be an overall cumulative impact. Because each spring is assumed to be fed by a particular aquifer, cumulative impacts on any individual spring are not anticipated. The springs that would be impacted, and therefore add to the number of such features cumulatively impacted in the region, are depicted in **Figures 3.6-4** and **3.6-5**, and listed in **Table 3.6-7**.

Other potential sources of surface water impacts in the CESA include existing land uses such as grazing, wildland fires, and road construction and maintenance. All of these factors contribute to existing surface water flows and quality. As mentioned in the Affected Environment section, grazing has been the major historic land use in the CESA, and it is expected to be so in the future. Grazing impacts to the quantity and quality of surface water resources in the CESA are both beneficial and adverse. The contributions and impacts of grazing have been debated for years (e.g., Elko County Natural Resource Management Advisory Commission 2010; Northeastern Nevada Stewardship Group, Inc. 2003; Resource Concepts 2001; West 1983).

In summary, both beneficial and adverse effects from grazing are widespread in the CESA. Among others, these effects include additional herbaceous growth and diversity, livestock trampling in riparian areas, and reduced overall vegetative cover. Historical and ongoing range improvements include, among others, sagebrush reduction, pasture fencing, and crested wheatgrass seedings to increase forage production. Water developments at springs, water distribution systems, stockponds, and wells also have been built. Some of these range practices, such as water improvements and fences, had immediate benefits for wildlife. Others, such as crested wheatgrass seedings, were generally adverse for uses other than livestock grazing (Northeastern Nevada Stewardship Group, Inc. 2003). Management approaches to grazing have a major influence on its effects. In turn, the viewpoints of conflicting land use goals appear to be the major determining factors on whether impacts are interpreted as beneficial or adverse.

Fire extent in the CESA is depicted in **Figure 3.2-3**. Most of the CESA has been burned, sometimes repeatedly, since the year 2000. Extensive cheatgrass invasion is often responsible for the greater frequency and extent of range fires. However, vegetation burned in the Hot Lake Fire of 2001 consisted of sagebrush with a native grass understory and some patches of grasslands seeded with introduced grasses due to the 1964 wildland fires (BLM 2001). The Hot Lake Fire burned a total of 70,910 acres. Less than 5 percent of the burned area was dominated by non-native invasive grasses such as cheatgrass. In 2006, most of the Hot Lake Fire area was re-burned in the Sheep Fire.

From a watershed viewpoint, the most significant effect of these wildland fires is the loss of vegetation cover, which can lead to adverse changes in hillslope hydrologic function through decreased infiltration, increased runoff, and reduced soil quality (Pierson et al. 2011, 2003). These conditions then lead to increased flooding, accelerated erosion, increased turbidity and sedimentation and increased nutrient loading in surface water (National Wildfire Coordinating Group 2001). Other effects of fire, and the potential for fire in the watersheds, are discussed in the Vegetation Resources and Range Resources sections (Sections 3.8 and 3.11).

Other disturbances in the CESA include the roads, transmission lines, and pipelines. The Ruby Pipeline, a recently constructed natural gas pipeline, crosses about 28 miles of the Willow Creek Valley watershed. Assuming a disturbed width of 115 feet, approximately 390 acres were disturbed by the pipeline in the northern part of the CESA. Pipeline construction and maintenance are subject to National Environmental Policy Act analysis and environmental controls through regulatory permit reviews and approvals. BMPs for backfilling, topsoil handling, revegetation, and erosion control would avoid or reduce runoff and erosion impacts from the proposed pipeline in the CESA.

The road network is extensive in the CESA. Potential cumulative impacts to runoff, erosion, and sedimentation are similar to those described for direct impacts. These existing effects include

restricted drainage at road crossings of streams, channeling runoff and sediment along the road surface itself and in associated ditches and culverts, concentrated flow conditions that may accelerate erosion and sedimentation, additional disturbance from road maintenance that generates sedimentation, and additional water quality impacts from road surface treatment chemicals (e.g., magnesium chloride) carried in runoff to nearby streams or riparian areas.

3.6.4 Potential Monitoring and Mitigation Measures

SW-1

Issue: Site disturbance and outlying road improvements and maintenance would create adverse impacts from vegetation and soil removal, runoff concentration, and chemical treatments. Impacts would include accelerated erosion, sedimentation, and reduced runoff water quality, which could drain to nearby streams, springs, or ponds. Increased runoff or concentrated flows could reduce channel and bank stability, particularly on steep slopes near stream crossings.

Monitoring/Mitigation Measure: Annually, in early spring and after heavy precipitation events, low water crossings and direct disturbance areas around the mine site would be surveyed for erosion and sedimentation. Hay bales, silt fences, or other erosion control would be utilized until more permanent watershed stabilization methods could be installed.

If the surveys indicate project-related changes to existing landscape and stream geomorphic trends, RCG and BLM would identify and document probable causes and effects. If causes and effects are determined to be related to project activities, additional mitigation and stabilization practices would be implemented and maintained by RCG in coordination with BLM. These could take the form of compensatory watershed stabilization practices at locations determined by the BLM. RCG would submit documentation of these activities to BLM.

Effectiveness: The implementation of measure SW-1 would document the presence or absence of impacts caused by runoff, erosion, or sedimentation. These mitigation measures would improve the stability and surface water quality in the project area.

SW-2

Issue: RCG would continue to monitor water quality at the MA-1 seep and Little Antelope Creek to determine if backfilling the West Pit with waste rock would create changes to water quality and quantity at the MA-1 seep. This information would be utilized to refine the model and to determine whether or not the proposed Hollister Mine is affecting this seep.

Monitoring/Mitigation Measure: Monthly monitoring of flow rates and water quality (NDEP Profile 1) would be conducted by RCG during March through July at the MA-1 seep (because it is potentially flowing at this time) and sites GBG-02 and GBG-04 on Little Antelope Creek. Data and information would be submitted annually in writing to both BLM and NDEP. If consistent project-related water quality declines are confirmed, an artificial wetland between the MA-1 seep and Little Antelope Creek (or other remediation/mitigation alternative) would be developed by RCG in cooperation with NDEP and BLM, and implemented, operated, and maintained by RCG for a period to be determined through written communication between RCG, BLM, and NDEP.

Effectiveness: This measure would ensure early detection and remediation of potential project-related impacts to water quality in Little Antelope Creek. It would protect surface water quality in Little Antelope Creek and would prevent or reduce more widespread water quality impacts in the Rock Creek Valley. This information may be utilized to refine and validate the model regarding the West Pit WRSF finding of no impacts on MA-1 seep and Little Antelope Creek. This information also may be

used to determine whether or not the proposed project is contributing to the water quality issues at this site and Little Antelope Creek.

SW-3

Issue: Reduction in flow rates could occur at springs associated with the Vinini Formation and the Pennsylvanian/Permian Strathearn Formation that fall within the maximum extent of the 10-foot groundwater drawdown contour and meet the screening criteria for impacts. The drawdown associated with proposed mine groundwater pumping could reduce the availability of water from springs, seeps, or other water-related features for established beneficial uses.

Monitoring/Mitigation Measure: RCG, in consultation with the BLM, would develop and implement a monitoring system for the spring complexes that may be impacted by Hollister groundwater pumping in the Vinini Formation and the Pennsylvanian/Permian Strathearn Formation. Monitoring of seeps and springs on private lands requires permission from the land owner. The monitoring system would be designed to specifically address springs potentially impacted by groundwater pumping of the Vinini Formation attributable to the Hollister Project. Seeps and springs would be monitored in the fall. Data and results would be reported annually in writing to the BLM and NDWR. Interpretations and criteria for triggering additional sampling or mitigation activities would be developed for the monitoring program in writing with BLM. After 1 full year (12-month sampling round), the frequency of sampling could be reduced to quarterly, semi-annual (twice per year), or annual sampling for the duration of the project upon written agreement from BLM.

The locations and types of water supply mitigation would be determined cooperatively in writing between RCG, BLM, and any affected water right holders of record or private land owners. Other mitigation measures may include water augmentation of the springs, which could include drilling wells to feed the affected springs, piping water from wells through pipelines to the affected springs, or hauling water from other water sources to replenish the affected springs.

Effectiveness: This measure would identify project-related changes in water quantity and quality associated with existing springs within the maximum extent of the 10-foot groundwater drawdown contour. If needed, mitigation triggered by monitoring results and interpretive criteria would be implemented to ensure adequate continued water supplies for established beneficial uses.

SW-4

Issue: Implementation of the Proposed Action, and the potential expected reduced extent of flowing or ponded stream segments within the maximum extent of the 10-foot groundwater drawdown contour, could reduce the availability of surface water for livestock and wildlife use along streams such as Antelope Creek and Squaw Creek. Grazing and wildlife use could concentrate in the remaining areas containing remaining available water and riparian habitat, with consequent potential resource damage to those areas.

Monitoring/Mitigation Measure: If monitoring shows project-related impacts to surface water areas within the maximum extent of the 10-foot groundwater drawdown contour area that are utilized by livestock or wildlife, RCG would work with the BLM to identify appropriate areas to provide water for livestock on private or public lands. If site(s) are located on private land, the private landowner would have to participate in the discussions and would have to grant permission for the use of the land in order for the proposed activity to occur.

Effectiveness: Development of replacement water for livestock would protect and enhance water quantity and quality along streams, with resulting benefits to associated range and wildlife resources.

3.6.5 Residual Impacts

Residual impacts to surface water resources may include long-term flow reductions at seeps and springs, and along associated flow-dependent stream reaches, as a result of groundwater drawdown.

3.6 Surface Water Resources and Watersheds

3.6.1 Affected Environment

3.6.1.1 Surface Water

The surface water assessment includes two areas: the area of potential direct and indirect impacts (which is the same as the estimated maximum extent of the 10-foot groundwater drawdown contour described in Section 3.5, Groundwater Resources and Geochemistry), and the cumulative effects study area (CESA). These areas are depicted in **Figure 3.6-1**. The CESA includes designated groundwater basins, 62 (Rock Creek Valley), and 63 (Willow Creek Valley), as identified by the Office of the State Engineer, Nevada Division of Water Resources (NDWR) (NDWR 2005). The study area and CESA were determined on the basis of the Proposed Action's relationship to the watershed effects from grazing, fire, and mining, as well as potential cumulative impacts to Little Antelope Creek, Antelope Creek, and Rock Creek. Potential impacts at stream crossings and from road maintenance associated with ore transport alternatives are included in these study areas. Past, present, and reasonably foreseeable future actions (RFFAs) are described in Section 3.2.

Elevations within the CESA range from approximately 8,300 feet above mean sea level (amsl) in the Tuscarora Mountains, to approximately 4,700 feet amsl where Rock Creek flows from the Sheep Creek Range into Boulder Valley. Annual precipitation varies widely within the region, generally increasing with elevation. On average, total annual precipitation is 10 inches or less at lower elevations in Rock Creek Valley and is 16 to 24 inches at higher elevations in the Tuscarora Mountains (United States Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS] 1998). Most precipitation falls from early winter through late spring, typically as winter snow in the mountains or as rain in May or June (Rodeo Creek Gold Inc [RCG] 2008b). On average, the least amount of precipitation falls in July and August. Precipitation typically increases in September and October, transitioning to the higher monthly averages in winter and spring (Western Regional Climate Center 2010).

The most representative precipitation data for the project vicinity are from the nearby Carlin Mine, with 36 years of record at an elevation of 6,530 feet amsl, and from the Tuscarora Weather Station, with 53 years of record at an elevation of 6,170 feet amsl (Montgomery and Associates, Inc. 2010b). These data are summarized in **Table 3.6-1**, and represent elevations somewhat higher than the Little Antelope Creek drainage. For comparison, the average annual precipitation was approximately 8.3 inches at Battle Mountain (elevation 4,530 feet amsl) between 1960 and 2009 (Western Regional Climate Center 2010).

3.6.1.2 Watersheds

The watershed areas for Rock Creek Valley and Willow Creek Valley are approximately 447 and 412 square miles, respectively, for an overall land area within the CESA of 859 square miles. The watershed area for the Little Antelope Creek (LAC) tributary is 25.9 square miles, or 3 percent of the CESA, and the larger watershed area for Antelope Creek overall is 144.4 square miles, or approximately 17 percent of the CESA.

Table 3.6-1 Average Monthly and Annual Precipitation (inches)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Carlin Mine	1.13	0.95	1.23	1.09	1.26	1.10	0.41	0.46	0.96	0.94	1.13	1.43	12.09
Tuscarora	1.28	0.97	1.12	1.00	1.3	1.13	0.49	0.46	0.73	0.89	1.40	1.54	12.43

Source: Western Regional Climate Center 2010.

3.6.1.3 Surface Water Features

Surface water features in the study area and CESA include perennial to ephemeral stream segments, seeps and springs, small stockwater impoundments, and constructed drainage controls for existing mining disturbance. These features, plus irrigation ditches, Hot Lake, and Willow Creek Reservoir are included in the study area and the CESA in **Figure 3.6-1**.

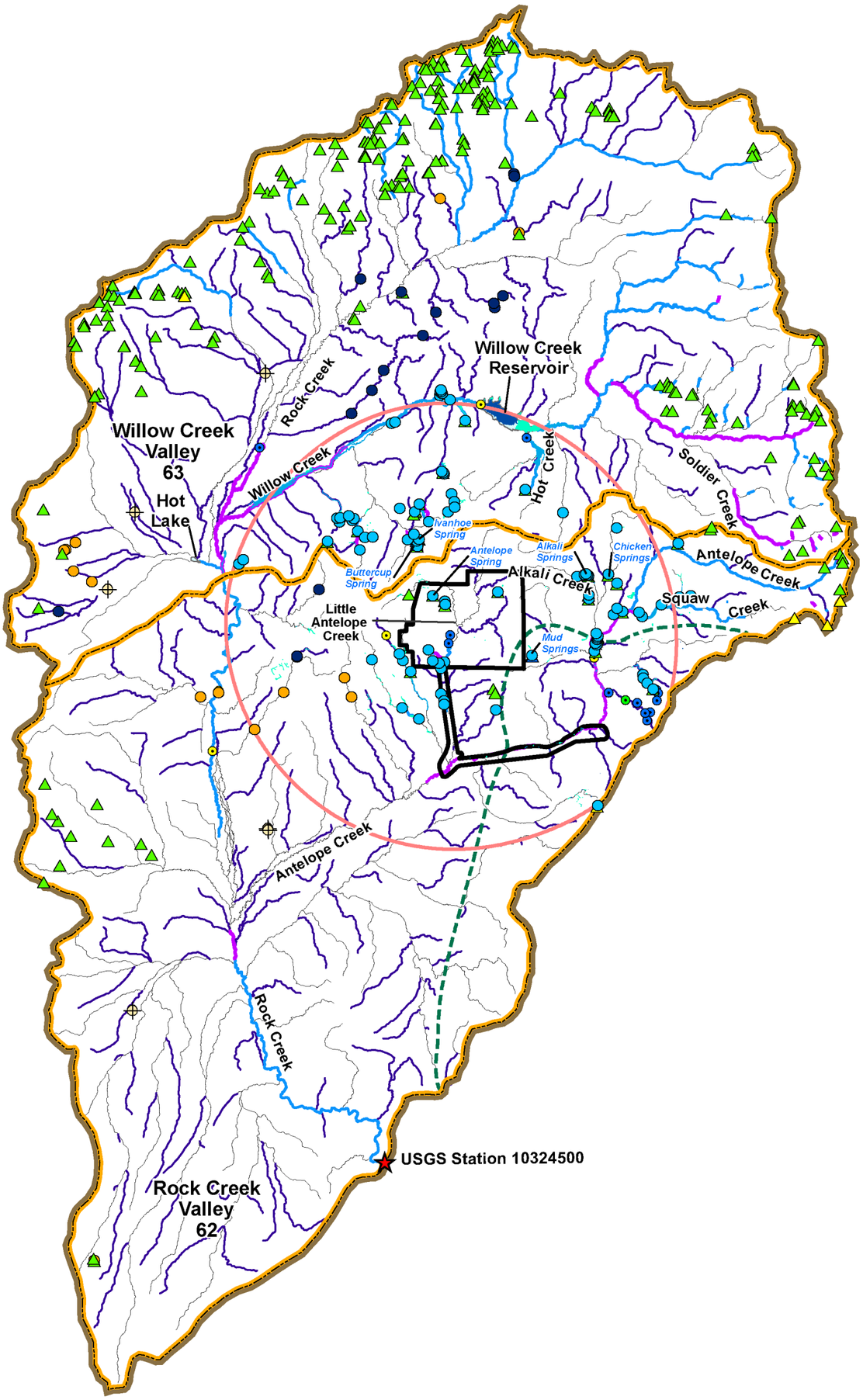
Most of the irrigated lands in the CESA are at or near the Squaw Valley Ranch, located along Willow Creek approximately 4 miles upstream of its confluence with Rock Creek. Additional irrigated areas occur farther downstream along Rock Creek, approximately 7 miles west-southwest of the project area. Within the study area, Little Antelope Creek, Antelope Creek, Willow Creek and their tributaries form the major naturally occurring flow channels. Little Antelope Creek is most closely associated with the proposed project area. The average width (at the Ordinary High Water Mark) of the Little Antelope Creek channel is simplistically stated to be approximately 5 feet (JBR Environmental Consultants, Inc. [JBR] 2003a). Tabulated widths range from 4 to 7 feet, and photos indicate the downstream reach may be up to 15 or 20 feet wide. The low flow channel dimensions would generally be smaller. The Little Antelope Creek watershed generally drains southward, joining Antelope Creek approximately 5 miles south of the project area. In addition to Little Antelope Creek, major headwaters tributaries in the project vicinity include Soldier Creek, Squaw Creek, and Alkali Creek. Both Antelope Creek and Willow Creek are major tributaries to Rock Creek, which drains to the Humboldt River.

Field surveys along Little Antelope Creek, Antelope Creek, and headwater streams have been conducted by JBR and the Bureau of Land Management (BLM) (BLM 2011b; JBR 2010, 2003a). In combination, these surveys identified wetlands and waters of the U.S., springs and seeps in the general Hollister project locale, stream channel conditions, flow conditions, and the types and extent of riparian vegetation.

The U.S. Army Corps of Engineers (USACE) formally determined that Little Antelope Creek and tributary features in the project area are jurisdictional waters of the U.S. (USACE 2004). That determination was valid through April 2009, and no modifications to that jurisdictional status have been made. According to earlier field surveys in the project area, approximately 2.43 acres of waters of the U.S. occur along Little Antelope Creek, and approximately 1.01 acres of wetlands occur along this creek (JBR 2003a). An additional 0.87 acre of hydrophytic vegetation occurred along this stream at the time of the 2003 survey. It is assumed that the USACE maintains jurisdiction over the previously delineated and confirmed waters of the U.S. and wetlands. Further information regarding wetland characteristics, riparian vegetation species, and waters of the U.S. is presented in Section 3.9, Riparian and Wetland Areas.

Flow and Channel Conditions

Flow and channel conditions identified along Little Antelope Creek by JBR in 2003 were recently verified by the BLM (BLM 2011b). The latter effort indicates that perennial flow duration and associated riparian conditions generally exist along the middle reaches of the stream, for approximately 1 mile within the southern part of the project study area to approximately 0.5 mile south of the study area (**Figure 3.6-2**). The setting along Little Antelope Creek can be summarized by describing typical conditions along three primary stream reaches (**Figure 3.6-2**). In the uppermost reach (Reach 1), stable channel conditions exist, and the corridor is well-vegetated with riparian species. In numerous sections, the channel is well armored with cobbles and boulders. Flows are somewhat ponded but generally perennial in the upper portion of Reach 1 and transition to intermittent conditions in the lower part. Reach 1 also includes a grazing exclosure that covers approximately 0.5 mile of stream channel as well as a spring on the western hillslope (BLM 2011b).



Legend

- Project Area Boundary
- Hydrographic Boundary
- Cumulative Effects Study Area
- Direct/Indirect Effects Study Area (Estimated Maximum Extent of the 10-foot Groundwater Drawdown Contour)
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinuous Flowing Stream Reach
- Maximum Extent of Cumulative 10-foot Drawdown Contour (Barrick 2007 Model)

Points of Diversion (Brown and Caldwell 2010)

- Active Surface Water Right
- Active Spring Water Right
- Active Underground Water Right

Note: Hydrographic Area boundary locations are approximate.
Source: Barrick 2010; BLM 2008b,2000b.

Wetland/Riparian Features (AECOM 2010; JBR 2010; BLM 2004)

- Open Water
- Riparian Area
- Wetland

Springs (BLM 2006)

- Ranch/Stock Ponds
- Pond
- Windmill
- Spring Complex
- Spring
- Spring/Seep

Seeps/Springs (BLM 2000)

- Seeps/Springs
- Surface Water Monitoring Station (USGS)

N

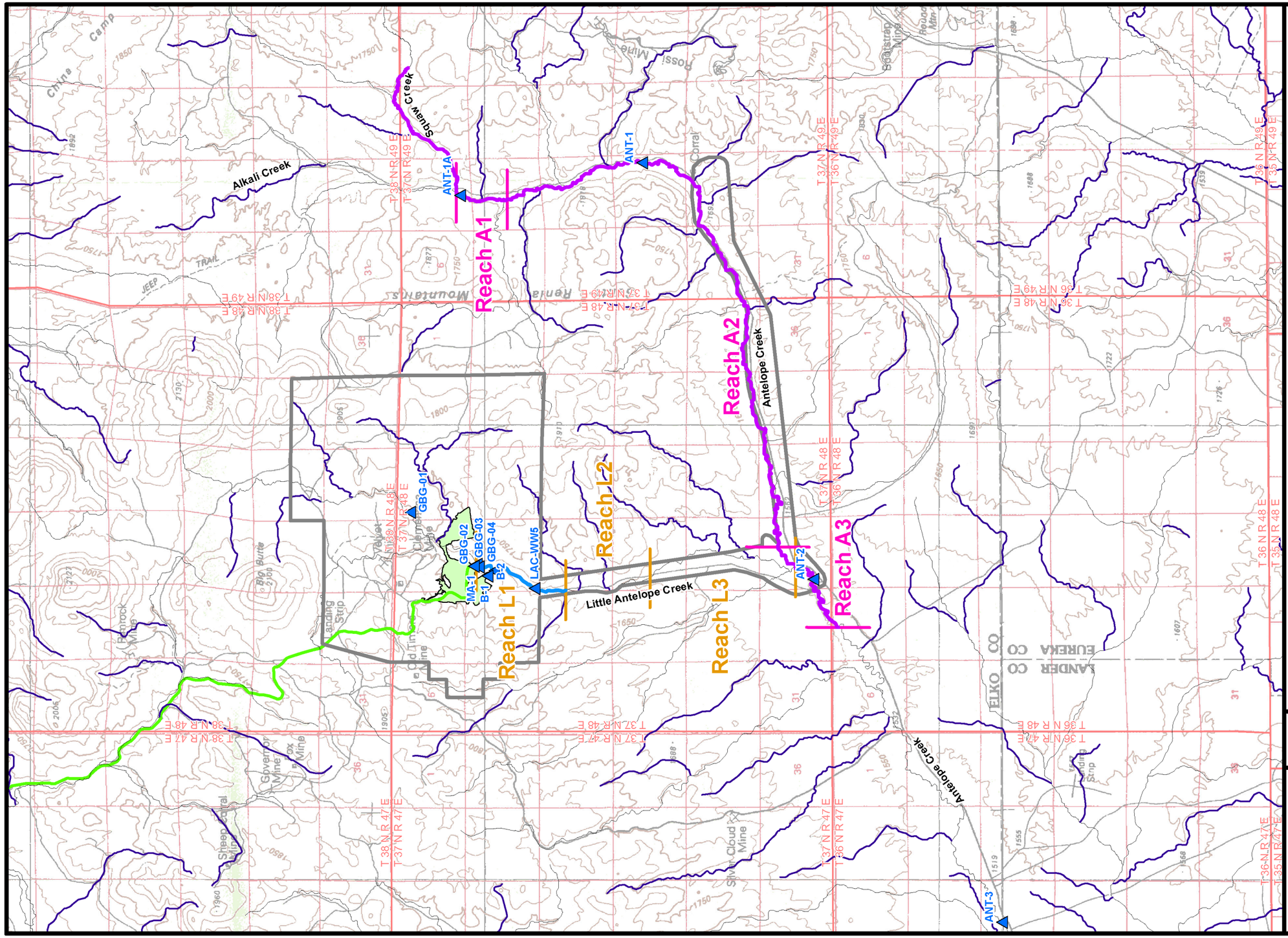
0 2 4 Miles

Figure 3.6-1

Surface Water Direct and Indirect Effects Study Area and Cumulative Effects Study Area

Hollister Underground Mine Project EIS

3/19/2012



Legend

- Existing Mining Disturbance
- Existing Surface Water Monitoring Locations
- Project Area Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach
- Discontinuously Flowing Perennial Reach
- Ivanhoe Road

Sources: Barrick 2010; BLM 2011b; Montgomery & Associates 2010a.

Hollister Underground Mine Project EIS

Figure 3.6-2

Existing Surface Water Monitoring Locations and Streamflow in the Antelope Creek Watershed

3/19/2012

Reach 2 (**Figure 3.6-2**) is mostly intermittent, but it is well-vegetated with riparian species. In addition to channel roughness from the vegetation, the channel surface contains large amounts of coarse alluvial rock. In combination with a relatively low gradient, this section dissipates commonly occurring flow energies well and also is naturally stabilized.

Reach 3 (**Figure 3.6-2**) is dominantly an intermittent section in the lower part of the Little Antelope Creek drainage (BLM 2011b). It is located primarily below the general bedrock-controlled hillslope portion of the watershed, on a broader, more porous, gently sloping surface that fans out into the valley. The channel is well-armored with rock; riparian vegetation is absent. This section of Little Antelope Creek also is a relatively low-gradient stream that is armored by a large proportion of coarse gravels and cobbles overlying porous alluvial deposits. It absorbs and dissipates flows from upstream.

Fieldwork conducted along Antelope Creek also distinguished three major zones on the basis of flow characteristics and riparian conditions (BLM 2011b). As headwater streams converge near the location of Site ANT-1A (**Figure 3.6-2**), a nearly 1-mile-long complex of springs and perennial flow conditions occur. This can be considered Reach A1 of Antelope Creek (BLM 2011b). The springs are grouped along a hillside adjacent to the confluence of Squaw and Antelope creeks. Fencing is in disrepair, allowing livestock to access the spring complex and adjacent stream banks, channel, and riparian zone.

Reach A2 of Antelope Creek consists of the main channel, banks, and floodplains between the upstream spring complex and the confluence with Little Antelope Creek (**Figure 3.6-2**). Flows are generally intermittent along the entire length of the channel, but shorter lengths of perennial pools or discontinuous perennial flow sections are common along this portion of Antelope Creek. This reach is approximately 8 to 8.5 miles long. Widespread evidence of past channel and bank instability can be seen along Antelope Creek in Reach A2 and other parts of Antelope Creek downstream from Reach A1. However, a new floodplain has been established between the historic cut-banks, and it is sufficiently wide to provide a base for growth and establishment of stabilizing riparian vegetation. Based on field observations, this new floodplain/riparian complex is re-stabilizing the stream reach and providing additional habitats.

Reach A3 of Antelope Creek extends downstream from the confluence with Little Antelope Creek. Flows are intermittent. Based on comparisons of aerial photos taken in different years, isolated perennial pools may be beginning to expand along this part of the stream. A well-developed riparian zone has established along the stream, which helps filter sediment loads from contributing tributaries such as Little Antelope Creek. Reach A3 extends between 1 to 2 miles downstream on Antelope Creek from the confluence with Little Antelope Creek.

There is evidence that the overall channel stability has been improving in recent years in the Little Antelope/Antelope creek segments near the project area. These changes are indicated by areas where riparian vegetation is being re-established or existing riparian conditions are improving (see Section 3.9, Riparian and Wetland Areas, for further information). These trends are related to, and closely interact with, improving floodplain stability within former zones of degraded cutbanks and active sediment transport. These upward trends within the stream corridors have several primary, interactive causes. Among these are the establishment of the grazing exclosure on Little Antelope Creek, improved seasonal grazing rotations, and the return of relatively normal precipitation from the dry conditions of the late 1990s/early 2000s.

Ranch/Stock Ponds and Springs

Numerous ranch/stock ponds and springs also occur within the CESA, as indicated in **Figure 3.6-1**. In addition, seeps and other zones of riparian vegetation and habitat are frequently associated with these water features. Seeps also are indicated in **Figure 3.6-1**. Seeps and other water-associated zones

and habitats are discussed in greater detail in Section 3.9, Riparian and Wetland Areas, and in Section 3.13, Aquatic Biological Resources.

In the direct/indirect study area, the major impoundment is Willow Creek Reservoir (**Figure 3.6-1**). Small impoundments in or near the project area include two stock ponds along the Silver Cloud Road southwest of the project boundary. Other small impoundments used for livestock watering are indicated within the CESA in **Figure 3.6-1**. Several named and unnamed springs (including Antelope Spring, Buttercup Spring, Ivanhoe Spring, Chicken Spring, Mud Spring, and others) also occur within the study area. Ivanhoe and Buttercup springs have flow sources likely associated with the Big Butte Rhyolite, whereas Antelope Spring is associated with an upper tuff unit in the Tertiary volcanic rock (volcanic rock) (Brown and Caldwell 2010a, 2003). Mud Spring and several other unnamed springs in the immediate project vicinity are associated with volcanic rock ash-flow tuff. The geologic settings of Antelope Creek, Antelope Spring, Ivanhoe Spring, and Buttercup Spring are discussed further in Section 3.5.1.2 (Hydrogeology). **Figure 3.5-7** depicts the three springs in a cross-sectional relation to their geologic setting.

A number of unnamed springs and seeps also occur along Antelope Creek and its major tributaries, Alkali Creek and Squaw Creek, in the project vicinity (see **Figure 3.6-1**). Several of these are supplied with groundwater discharge from the Vinini Formation or the volcanic rock. These groundwater sources are described by geologic investigations summarized in Section 3.5, Groundwater Resources and Geochemistry. Groundwater investigations (Section 3.5) indicate that other springs discharge from more limited, isolated zones in the near-surface volcanic rock and alluvium. Based on geology and groundwater studies of the area, a comprehensive list of springs and their geologic associations in the study area and within the maximum extent of the 10-foot groundwater drawdown contour is presented in **Table C-1**.These locations are indicated in **Figure C-1**. Although they have a geologic origin, springs and seeps are expressed as surface features that either provide flow (springs) or moisture (seeps) for beneficial uses in the watershed. Because of this, springs and seeps are discussed in this surface water section. Other sections of this environmental impact statement (EIS) also discuss springs and seeps with respect to their sources and uses.

Broad categories of surface management status (private, state, tribal, federal) also are depicted on **Figure C-1**. Within the maximum extent of the 10-foot groundwater drawdown contour, approximately 78 springs or seeps are identified on lands administered by the Bureau of Land Management. Most of these are not associated with the Vinini Formation. Approximately 48 springs or seeps occur on privately owned lands. No state or tribal lands occur within the maximum extent of the 10-foot groundwater drawdown contour. A few springs or seeps occur on private land southwest of the project area as indicated on **Figure C-1**. East of the project area, springs and seeps on private lands are more numerous. These include features in the Santa Renia Fields (along Antelope Creek due east of the project area), along Alkali Creek, and along Squaw Creek. In addition, most of the land is privately owned along Squaw Creek and Antelope Creek within the maximum extent of the 10-foot groundwater drawdown contour.

Disturbance Areas

Within the existing disturbance areas (**Figures 2-1** and **2-2**), overall infiltration and surface water flow conditions have been modified by contouring to improve runoff, containment of runoff in lined ponds, the development of mine pits and waste rock storage facilities (WRSFs), and the construction of diversion channels to control on-site water and prevent run-on from adjacent lands. These existing surface water management features are used to store or divert surface water. Diversion channels route runoff from undisturbed areas away from the project. Also within the project footprint, diversion channels convey runoff around the WRSF, to the storm water pond, or to the East and West pits (see **Figure 2-12**). Collected water is routed to one or two surge ponds (in the existing East Pit) for use in existing operations (RCG 2008b).

Under the Proposed Action, the electric power transmission line (transmission line) would parallel Little Antelope Creek along the existing road, and also cross and parallel Antelope Creek (**Figure 2-11**). Under the Mud Springs Road Transmission Line Alternative, the transmission line would cross a number of ephemeral drainages before crossing upper Antelope Creek along a perennial or discontinuously flowing reach. Little Coyote Creek, an ephemeral stream, would be crossed to reach the Coyote Creek Substation.

Floodplains occur in low-lying geomorphic positions along Little Antelope Creek and Antelope Creek, as well as at stream crossings of the Ivanhoe and Mud Springs roads. The Federal Emergency Management Agency (FEMA) has delineated flood hazard zones in unincorporated areas of Elko, Lander, and Eureka counties (FEMA 2010). However, current map sheets for the project area have not been compiled by FEMA, and historical map sheets are not presently available from the agency. In Lander County, an available historical map sheet (FEMA Panel 3200130050C) indicates the occurrence of Flood Hazard Zone A delineations along both Antelope Creek and Rock Creek (FEMA 2010). The Antelope Creek delineation is approximately 0.5 mile wide at the Elko/Lander county line. On available historical maps for Elko County, Rock Creek and Willow Creek have Flood Hazard Zone A delineations all along their stream courses. At its Ivanhoe Road crossing, the Willow Creek flood zone is approximately 0.25 mile wide. Based on these FEMA delineations, and the much narrower delineations that available FEMA mapping indicates along smaller nearby tributaries, it is likely that FEMA Zone A flood hazard positions would continue up Antelope Creek past the Mud Springs road crossing, and up Little Antelope Creek for approximately 1 mile from its confluence with Antelope Creek.

The Mud Springs WRSF Alternative would be located on a sloping bench intersected by ephemeral headwater streams. Based on an aerial photo review, the relatively narrow, steep-sided tributaries do not appear to support riparian zones, seeps, or springs. This review and its conclusions are further discussed in Section 3.8, Vegetation Resources, and Section 3.9, Riparian and Wetland Areas. Channels occurring within this alternative coalesce to drain generally west and northwest along an unnamed ephemeral tributary to Little Antelope Creek. The existing reclaimed heap leach pad and reclaimed pond resulting from historic operations are located along and adjacent to the unnamed tributary. Surface water drainage in other directions from the site would be restricted by higher topography to the south, east, and west.

Streamflows and Channel Conditions

Within the project vicinity, surface water primarily results from snowmelt and rainfall. Additional water is routed or stored as a result of existing mine operations. Flows in Little Antelope Creek and its tributaries depend mostly on the amount and distribution of precipitation within the watershed (Montgomery and Associates, Inc. 2010b). Typically, spring runoff creates temporary increases in streamflows. Flow durations largely depend on the amount of precipitation during preceding months, and may depend on conditions within the previous year or two. Considerable variation in seasonal and annual precipitation is normal in the project area and in the overall region. Under these conditions, streamflows and water levels in impoundments vary substantially.

Streamflow monitoring has been conducted in the project area since early 2007. Four stations are designated along Little Antelope Creek to monitor discharge and water quality conditions upstream, within, and downstream of the Hollister Site. These stations, from upstream to downstream, are numbered GBG-01 through GBG-04 (**Figure 3.5-12**). Locations GBG-02 and GBG-03 represent flow in Little Antelope Creek immediately upstream and downstream of an unnamed tributary. Discharge from Newmont's historic Ivanhoe Mine operations and the Newmont-reclaimed East WRSF potentially enters Little Antelope Creek below GBG-02 and above GBG-03. Additional recent surface water monitoring locations include Station MA-1, which is used to record conditions at a seep at the base of the Newmont-reclaimed East WRSF. Drainage in that locale proceeds down the unnamed tributary

and potentially enters Little Antelope Creek above GBG-03 (**Figure 3.6-2**). Other monitoring locations include Stations B-1 and B-2. Data from B-1 characterize flows from the base of the Newmont-reclaimed South WRSF, which drain down an unnamed wash to a constructed wetland. Location B-2 is about 500 feet downstream from B-1 and represents flow within the constructed wetland. The unnamed tributary drains to Little Antelope Creek above GB-04, which is the most downstream surface water monitoring station on the creek (**Figure 3.6-2**).

Recent monitoring interpretations have suggested that streamflows in upper Little Antelope Creek and its tributaries are ephemeral; however, several monitored years and seasons had below-average precipitation. Generally, the early part of the monitored period (from November 2006 through June 2008) received lower than average precipitation (Western Regional Climate Center 2010). Flows usually ceased by the end of June in the project area (Montgomery and Associates, Inc. 2010b). However, streamflows continued until November 2007 at Station GBG-04 in lower Little Antelope Creek. In 2009, flows resumed at most stations in late October, after abnormally high total precipitation since the previous May. These conditions imply that parts of Little Antelope Creek experience intermittent flows. Streamflows may result from groundwater baseflow in the lower reaches of Little Antelope Creek during part of the year.

Earlier survey work was conducted in the field by JBR (2003a). During the waters of the U.S. investigations for the Hollister Development Block project in early June 2003, JBR encountered discontinuous flows along Little Antelope Creek. In the narrower part of the canyon along the access road and pipeline corridor to the Rapid Infiltration Basin (RIBs), flows were 2 or 3 inches deep and ranged from 1 to 7 feet wide. No flows were observed at the northern or southern ends of the pipeline corridor. At the time of JBR's fieldwork in early June 2003, approximately 50 percent more precipitation than average had fallen in March, April, and May at Tuscarora, and approximately 40 percent more precipitation than average had fallen at Battle Mountain (Western Regional Climate Center 2010). For a comparative basis, the flows at the U.S. Geological Survey (USGS) gage on Rock Creek (Station 10324500 outside the study area) were well below average in early 2003.

Based on these data, it seems likely that parts of lower Little Antelope Creek gain groundwater baseflow contributions through the summer months during years of average or greater precipitation. A stable, well-vegetated, perennial reach emerges from a tributary in the northwest corner of Section 9 (Township 37 North [T37N], Range 48 East [R48E]), and extends downstream along Little Antelope Creek through a grazing exclosure to approximately the west quarter-corner of Section 16 (also T37N, R48E) (see **Figure 3.6-2**). The exclosure extends approximately 0.5 mile along the stream channel, and a spring occurs on the western hillside within it. In many locations, the channel is well armored with cobbles and boulders (BLM 2011b). Riparian plant species include Coyote willow, baltic rush and a number of species of riparian grasses and forbs. Flows are somewhat ponded but perennial in this portion of the drainage (BLM 2011b). Flow durations become intermittent downstream, but this lower portion of Little Antelope Creek also remains generally armored with cobbles and boulders as the channel passes below rocky hillslopes. Both upland and riparian herbaceous species occurs along intermittent channel portions, along with some willow stands (BLM 2011b). The channel then emerges from the steeper hills onto a broader, flatter surface comprised of colluvium and alluvial fan deposits. The stream becomes flatter, wider, and drier, and flows seep into the rocky, porous channel bed.

Antelope Creek ranges from perennial in its upper reaches and headwater tributaries, to intermittent in its lower reach near its confluence with Rock Creek. In the central part of the stream near the southern part of the project area, interrupted flow conditions occur (**Figure 3.6-2**). Discontinuous flowing sections or ponded channel portions occur along this reach, which extends for approximately 8 miles from a spring complex near Site ANT-1A in **Figure 3.6-2**, to the confluence with Little Antelope Creek near Site ANT-2 in **Figure 3.6-2**. A substantial riparian vegetation community now occurs along portions of Antelope Creek (BLM 2011b).

Within the larger CESA, flows in Willow Creek, Antelope Creek, and Rock Creek range from ephemeral to perennial in average years, depending on location (**Figure 3.6-1**). Most of the stream channel sections in the CESA have intermittent or ephemeral flow durations. Perennial reaches are most common in headwater locales, but also occur along most of lower Rock Creek. Discontinuous flowing reaches (**Figure 3.6-1**) consist of a series of generally short (tens to hundreds of feet long) perennial segments separated by intermittent segments. These areas are likely to have short stretches where water is stored beneath the surface in alluvial deposits, surfacing again at rock outcrops or other shallow, resistant zones. Again, flow durations vary widely with location, source, and weather conditions.

In the CESA near the project study area, flow monitoring has been conducted at four locations along Antelope Creek as part of the Boulder Valley Monitoring Plan (BVMP) conducted by Barrick Goldstrike Mines Inc. (Barrick 2010). These locations are indicated in **Figure 3.6-2**. Data are collected monthly, compiled quarterly, and submitted semi-annually to the BLM and Nevada State Engineer as a public record. The most upstream station, ANT-1A, is located just downstream of the confluence of Alkali Creek and upper Antelope Creek, Station ANT-1 is on Antelope Creek about 1.5 miles downstream of the confluence with Little Coyote Creek. Station ANT-2 is at the confluence with Little Antelope Creek, and the most downstream location, ANT-3, is just northeast of the Lander County line. Flow measurements at these locations indicate that Antelope Creek is ephemeral or intermittent throughout its monitored length from Alkali Creek to the Lander County line. After spring runoff, flows decline rapidly at all stations. Flow typically ceases in June at the upper stations (ANT-1A and ANT-1), and during April or May at Station ANT-2 downstream. These conditions likely result from the distribution and timing of snowmelt at the higher elevations, and losses to channel seepage in downstream alluvial settings. Small flow rates in November are frequently recorded at the upper two stations. These probably result from winter precipitation undergoing freeze-thaw cycles.

Many other streams occur in the CESA, as indicated in **Figure 3.6-1**. All are tributaries to Rock Creek or Willow Creek (**Figure 3.6-1**). Access routes within the CESA utilize stream crossings that would avoid or reduce traffic through streams. Improvements such as culverts are present on the existing Ivanhoe Road, which crosses several streams. Northeast of Golconda, State Route 789 crosses the Humboldt River on a substantial bridge in Emigrant Canyon. To the north and west, the existing Ivanhoe Road is an upgraded gravel road (Czarnowsky 2010b) that crosses Ivanhoe Creek and several small ephemeral tributaries. The Midas-Tuscarora Road crosses Willow Creek, Rock Creek, Frazer Creek, the Highline Canal, and Midas Creek. Ivanhoe Creek is intermittent. Willow Creek and Rock Creek at the road crossings are discontinuous flowing streams (BLM 2000b). All of the major creeks and the canal crossings along major routes used for equipment access or ore transport have existing improved crossing structures over the channels (Czarnowsky 2010b). Some channels that may be crossed less frequently by smaller-vehicle incidental traffic have fords or low water crossings through the streams (e.g., Rock Creek near its confluence with Antelope Creek).

Water Rights

Water rights in or near the study area that are on record with the NDWR are listed in **Table C-2** (**Appendix C**). Their locations are depicted in **Figure 3.6-3**. The area included in this summary consists of the estimated maximum extent of the 10-foot groundwater drawdown contour derived from project modeling. Listed water rights include six that support the Hollister project and approximately 21 others not associated with the project, as listed in **Table C-2**. Two certificated water wells and four permitted water rights for discharges support the present surface and underground exploration projects.

As can be seen in **Figure 3.6-3**, there are several surface water points-of-diversion along Rock Creek and Willow Creek, and a number of points-of-diversion associated with springs. Public Water Reserves No. 107 (PWR 107), an executive order issued by President Calvin Coolidge in 1926,

reserved certain water rights on public lands so as to provide water for animal and human consumption while simultaneously preventing the monopolization and control of large tracts of land. PWR 107 withdrew waters from "Every smallest legal subdivision of the public-land surveys which [was] vacant unappropriated unreserved public land and contain[ed] a spring or water hole, and all land within one quarter of a mine of every spring or water hole located on unsurveyed public land." In addition, PWR 107 applies only to those water resources that are considered "important" and have sufficient flow for consumption. No PWR 107 designations have been identified within the maximum extent of the 10-foot groundwater drawdown contour. Additionally, within the same area, no springs or water holes that could potentially meet PWR 107 criteria occur.

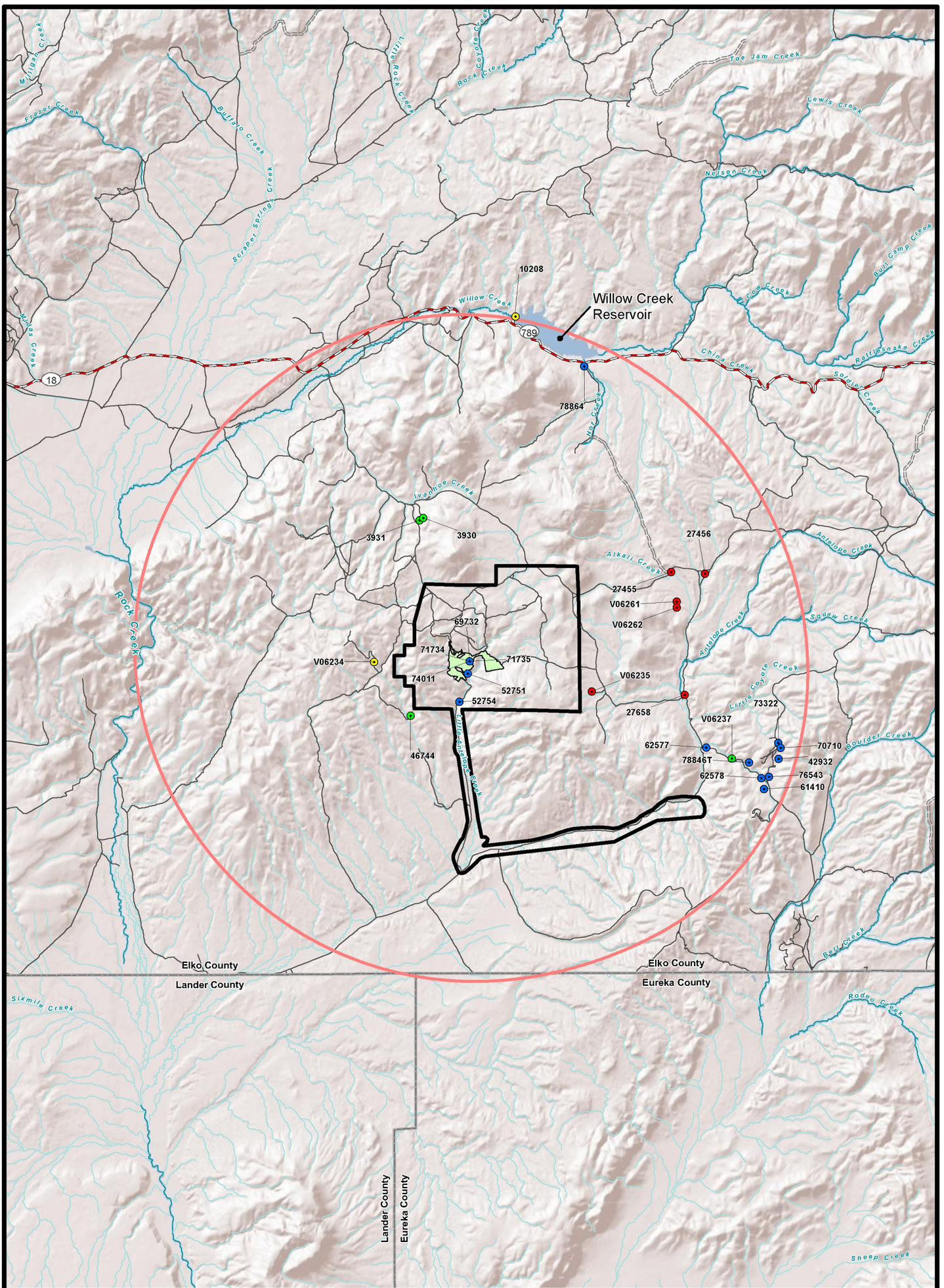
Surface Water Quality

Within the CESA, Rock Creek is categorized as a Class A water from its origin to the Squaw Valley Ranch north of Hot Lake (**Figure 3.6-1**) (Nevada Administrative Code [NAC] 2003). Class A waters, as defined in NAC 445A.124, are in areas with little human habitation, no industrial development or intensive agriculture, and where the watershed is relatively undisturbed by man. Beneficial uses of Class A waters include municipal or domestic supply or both (with treatment by disinfection only); aquatic life; wildlife uses; irrigation and livestock watering; and recreation that could include water contact.

Below the Squaw Valley Ranch, Rock Creek is a Class C water. Class C waters are in areas of moderate-to-urban human habitation, with moderate industrial development, intensive agriculture, and where the watershed has been considerably altered by man. Beneficial uses of Class C waters include municipal or domestic supply or both (following complete treatment); industrial supply; irrigation, and livestock watering; propagation of aquatic life; propagation of wildlife; and recreation that could involve water contact (NAC 445A.126). As tributaries to Rock Creek, Class C water quality standards currently apply to both Antelope Creek and Little Antelope Creek (Heggeness 2010). These class-specific surface water standards are indicated in **Table 3.6-2**.

A summary of Nevada water quality standards is presented in **Appendix B**, **Table B1-1**. Additional water quality parameters include drinking water standards used as "reference values" by Nevada Division of Environmental Protection (NDEP) in their Profile 1 constituent list for mines (Holmgren 2010; NDEP 2010a). These Profile 1 reference values are listed by bullets below. The values are not stream standards, but are used for comparisons between background water quality and discharges from mining sites (Holmgren 2010). The default water quality standards applicable to Rock Creek and its tributaries are presented in **Table 3.6-2**. For Profile 1 constituents not already identified in the Nevada Class C stream standards, the following additional permit conditions may be applied:

- Arsenic: 0.010 mg/L;
- Mercury: 0.002 mg/L;
- Selenium: 0.05 mg/L;
- Total Dissolved Solids (TDS): 1,000 mg/L;
- Magnesium: 150 mg/L;
- pH: 6.5 to 8.5 standard units;
- Sulfate: 500 mg/L; and
- Weak Acid Dissociable (WAD) Cyanide: 0.2 mg/L.



Legend

- Project Area Boundary
- Existing Mining Disturbance
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- State Highway
- Rural Road
- Vehicular Trail (4WD)

Points of Diversion (Brown and Caldwell 2010)

- Active Spring Water Right Potentially Affected
- Active Surface Water Right
- Active Spring Water Right
- Active Underground Water Right

N

0 1 2 Miles

Source: Brown and Caldwell 2010b.

Hollister Underground Mine Project EIS

Figure 3.6-3
Water Rights in the Study Area

3.6-11

3/19/2012

Table 3.6-2 Nevada Class C Water Quality Standards

Constituent	Standard
Floating solids, solids that will settle, or sludge deposits	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.
Sewage, industrial wastes, or other wastes	None, which are not effectively treated to the satisfaction of the department.
Toxic materials, oils, deleterious substances, colored or other wastes or heated or cooled liquids	Only such amounts as will not render the receiving waters injurious to fish and wildlife or impair the waters for any beneficial use established for this class.
pH	Range between 6.5 to 9.0 standard units.
Dissolved oxygen (DO)	For waters with trout, not less than 6.0 milligram per liter (mg/L); for waters without trout, not less than 5.0 mg/L.
Temperature	Must not exceed 20 degrees Celsius (°C) for waters with trout or 34°C for waters without trout. Allowable temperature increase above normal receiving water temperature: 3°C.
Fecal coliform	Most stringent of three specification alternatives.
Total phosphates	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).

Source: NAC 445A.126.

Surface water quality has been monitored by the USGS on Rock Creek at the mouth of the canyon where the stream flows out of the Sheep Creek Range (USGS station 10324500); **Figure 3.6-1**. These records are from the late 1970s to early 1990s. The NDEP Bureau of Water Quality Planning more recently sampled water quality on Rock Creek near that location (Station NV04-106-T-001), and analyzed a sample upstream of Antelope Creek (Station NV04-106-T-003). On Little Antelope Creek, both surface water and groundwater quality have been extensively sampled recently in the project vicinity (Montgomery and Associates, Inc. 2010b) (**Figure 3.6-2**).

Located at the CESA watershed outlet, USGS data at the Rock Creek gage (USGS 10324500) indicate that specific conductance ranges from 190 to 474 microSiemens per centimeter (µS/cm), with an average of 355. The range in pH was 8.2 to 9.5 standard units. The most complete USGS data represent two low-flow months: October 1990 and November 1991 (USGS- National Water Information System [NWIS] 2010). Common water quality constituent values recorded in USGS and NDEP data for Rock Creek at the gage are indicated in **Table 3.6-3**.

Surface water data from RCG are indicated in **Table 3.6-4**. These data represent flow conditions from upstream (GBG-01) to downstream (LAC near water well 5) monitoring locations along Little Antelope Creek. Available data for the MA-1 seep at the Newmont-reclaimed East WRSF and the B-1 location below the Newmont-reclaimed South WRSF also are indicated. Stations GBG-01 and -02 are on Little Antelope Creek upstream of the MA-1 seep and associated existing site disturbance, whereas

GBG-03, GBG-04, and LAC near water well 5 are downstream of tributaries that drain existing site disturbance (see **Figure 3.6-2**). The most downstream monitoring location, LAC near water well 5, is a site located approximately 1 mile downstream of all existing site disturbance.

Table 3.6-3 Surface Water Quality at the Rock Creek Gage (USGS 10324500)

Sampling Date	Constituents[1,2]									
	pH[2]	As	Ca	Mg	Hg	HCO_3	Se	SO_4	TDS	SpC[2]
Aug 1990 (a)	8.9	0.008	16	8.3	<0.0001	127	<0.0001	43	257	458
Nov 1991 (a)	8.4	0.006	34	7.5	<0.0001	166	<0.0001	31	293	427
Apr 1999 (b)	8.07	ND	ND	ND	ND	115	ND	23	187	290
Aug 1999 (b)	8.62	0.010	25	7	ND	115	0.003	34	233	408
Jun 2001 (b)	10.16	0.008	15	6	ND	44	ND	36	196	378
Sep 2001 (b)	8.77	ND	ND	ND	ND	151	ND	34	252	460
Apr 2002 (b)	8.41	ND	ND	ND	ND	132	ND	22	234	310
Sep 2002 (b)	8.73	0.005	27	8	ND	161	ND	34	300	440

[1] As = arsenic, Ca = calcium, Mg = magnesium, Hg = mercury, HCO_3 = hydrogen bicarbonate, Se = selenium, SO_4 = sulfate, TDS = Total Dissolved Solids.

[2] Values are in mg/L (dissolved) except for: pH in standard units and Specific Conductance (SpC) in µS/cm.

ND - no data.

Sources: (a) USGS-NWIS 2010; (b) USEPA STORET Database 2009.

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
GBG-01 (Upstream)	3-Apr-07	8.71	0.003	72	13	118	164	5.23
	4-May-07	***5.70***	0.004	102	10	136	162	6.92
	10-Apr-08	7.85	<0.0050	68	15	28	106	***2.16***
	7-May-08	7.92	0.0062	110	57	190	236	7.31
	30-Apr-09	7.63	<0.0050	82	14	150	244	10.46
GBG-02	3-Apr-07	8.73	0.006	79	31	156	215	6.72
	4-May-07	7.78	0.005	107	35	178	226	8.25
	8-Jun-07	7.79	0.008	332	***1,980***	***3,970***	4,130	8.79
	10-Apr-08	8.35	0.0053	63	19	130	135	***2.91***
	7-May-08	7.98	<0.025	100	110	310	342	5.38
	11-Jun-08	7.45	<0.025	340	***1,800***	***3,000***	3,980	5.27
	30-Apr-09	8.69	<0.0050	70	15	110	236	8.04

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
	28-Oct-09	6.76	<0.020	190	***1,100***	***2,100***	2,940	***3.87***
MA-1 Seep (On tributary)	2-Apr-07	7.75	0.026	217	***547***	***1,230***	1,760	***4.78***
	4-May-07	7.78	0.031	227	452	***1,110***	1,250	5.89
	8-Jun-07	7.70	0.028	239	***584***	***1,360***	1,580	5.82
	10-Apr-08	8.21	0.026	180	***530***	***1,100***	1,280	***3.45***
	7-May-08	7.76	<0.025	180	***540***	***1,100***	1,068	5.58
	30-Apr-09	7.71	0.033	160	***840***	***1,400***	399	***3.65***
GBG-03	3-Apr-07	7.98	0.014	142	***416***	***880***	1,228	9.10
	4-May-07	7.73	0.016	198	***502***	***1,120***	1,238	8.01
	8-Jun-07	7.81	0.018	244	***777***	***1,620***	1,830	7.77
	10-Apr-08	8.37	0.0072	68	***89***	250	91	***3.34***
	7-May-08	7.71	<0.025	170	***550***	***1,000***	1,258	6.64
	11-Jun-08	7.08	<0.010	210	***770***	***1,400***	2,080	6.78
	30-Apr-09	7.48	0.010	120	***540***	***900***	1,580	7.71
	28-Oct-09	7.20	0.013	200	***1,100***	***2,100***	3,010	6.45
B-1 (On Tributary)	2-Apr-07	6.95	0.004	171	***1,350***	***2,280***	2,610	***3.82***
	4-May-07	6.79	0.003	171	***1,280***	***2,220***	2,080	***4.72***
	8-Jun-07	6.92	0.003	171	***1,240***	***2,210***	2,210	***4.94***
	10-Apr-08	No data						
	7-May-08	6.55	<0.025	200	***940***	***1,700***	1,147	6.48
	11-Jun-08	***5.99***	<0.005	120	***1,300***	***1,900***	2,550	5.05
	30-Apr-09	6.57	0.0064	130	***1,200***	***1,700***	2,540	6.50
	27-Oct-09	6.82	<0.010	150	***1,000***	***1,700***	2,460	5.26
GBG-04 (Downstream)	3-Apr-07	7.71	0.009	183	***810***	***1,460***	1,900	6.38
	4-May-07	7.54	0.010	210	***926***	***1,770***	1,740	7.54
	8-Jun-07	7.31	0.013	239	***1,410***	***2,520***	2,500	6.04
	10-Apr-08	7.94	0.0071	88	130	310	230	***3.19***
	7-May-08	7.26	<0.010	180	***670***	***1,300***	964	6.12
	11-Jun-08	6.75	<0.0050	260	***950***	***1,800***	2,460	5.88

Table 3.6-4 Surface Water Data from Project Monitoring

Location	Date	pH	Constituents[1,2]					
			As	HCO_3	SO_4	TDS	SpC	DO
	30-Apr-09	7.60	<0.0050	140	***510***	***850***	1,520	6.55
	27-Oct-09	7.58	<0.0050	210	***1,100***	***2,000***	2,960	7.27
	16-Nov-09	7.07	<0.0050	230	***1,300***	***2,200***	3,200	5.67
LAC near water well 5	16-Nov-09	7.64	0.012	210	110	420	810	5.14

[1] As = arsenic, HCO_3 = hydrogen bicarbonate, SO_4 = sulfate, TDS = Total Dissolved Solids, DO = Dissolved Oxygen.

[2] Values are in mg/L (dissolved) except for pH in standard units; and Specific Conductance (SpC) in µS/cm.

Bold italicized values indicate exceedences of NDEP Class C stream standards.

Source: Montgomery and Associates, Inc. 2010b.

April and May data generally indicate water quality dominated by snowmelt or rainfall runoff. After runoff volumes decline in May, data indicate changes in water quality. Station GBG-01 represents an undisturbed headwater location approximately 1 mile northeast of site activities. Its data reflect undisturbed spring runoff; the creek typically goes dry at that location during May. Station GBG-02 is located downstream where the drainage passes alongside existing disturbance. April pH values at GBG-02 are consistently elevated. Although still upstream of tributaries leaving the Hollister Site, by June the water quality at GBG-02 shows a pronounced shift to greater concentrations of SO_4 and TDS, as well as greater salinity as indicated by specific conductance. This water quality shift also is apparent between the spring (April) runoff data and the October low-flow data for 2009 at GBG-02. It also occurs in seasonal data for other monitoring locations, as spring runoff declines. These surface water characteristics may be related to stronger aquifer influences later in the year, to lower flows exhibiting greater influence from bed and bank mineralogy, or to some other combination of factors.

Relatively consistent water quality occurs at the MA-1 seep (**Figure 3.6-2**). Data at that location indicate elevated concentrations of arsenic, sulfate, and TDS. Specific conductance at MA-1 is higher than those along the creek during spring runoff, as well. Downstream, the water quality at station GBG-03 is generally a mix of characteristics from the MA-1 seep and GBG-02 upstream on Little Antelope Creek. Data from October 2009, when the seep was not contributing, are reasonably consistent between GBG-02 and GBG-03.

Between stations GBG-03 and GBG-04, drainage from the Newmont-reclaimed South WRSF enters Little Antelope Creek (see **Figure 3.6-2**). The adjoining tributary is monitored at stations B-1 and B-2. Water quality data are similar at the latter stations, and a longer period of record exists at B-1. The tributary contributes elevated levels of sulfate and total dissolved solids, which are somewhat attenuated as flows reach GBG-04 during the spring. By June, these constituents generally increase or remain at similar levels between GBG-03 and GBG-04 downstream. Based on available data, elevated specific conductance, sulfate, and total dissolved solids levels in late season flows at GBG-04 are largely reduced in flows at LAC near water well 5. From the available late-season data, most water quality constituents at LAC near water well 5 are within both Rock Creek standards and NDEP Profile 1 reference values. The one arsenic value at LAC near water well 5 (0.012 mg/L) is slightly elevated above the background levels downstream at the Rock Creek gage (USGS 10324500), which range from 0.005 to 0.010 mg/L (**Table 3.6-3**).

As indicated in **Table 3.6-4**, in the project area, dissolved arsenic concentrations in runoff range from 0.003 mg/L in the headwaters at GBG-01 to 0.031 mg/L from Seep MA-1. The higher concentrations from the seep are not reflected in downstream flows at GBG-03 or beyond, although there are some downstream exceedences of the NDEP Profile 1 reference values for arsenic. These values remain within Class C receiving water standards (0.050 mg/L), but commonly exceed drinking water standards. Far downstream at the Rock Creek Gage, NDEP data for arsenic (**Table 3.6-3**) are somewhat less than concentrations measured in Little Antelope Creek. Rock Creek Gage monitoring data show arsenic concentrations ranging from 0.005 mg/L to 0.010 mg/L. Project monitoring data show arsenic concentrations ranging from 0.003 to 0.031 mg/L (**Table 3.6-4**). Mercury and selenium concentrations are typically below detection limits in samples from Little Antelope Creek (Montgomery and Associates, Inc. 2010b). Dissolved oxygen concentrations typically satisfy the stream standard for waters without trout (5.0 mg/L), although exceptions occurred throughout the project area. As indicated in **Table 3.6-4**, dissolved oxygen concentrations below the stream standard occurred at least once at all monitoring locations except LAC, the station farthest downstream. That station is represented by one sample, which slightly exceeded the minimum standard. WAD cyanide concentrations were below detection limits for all surface water samples, except for a value of 0.13 mg/L at GBG-03 in October 2009. This result is not typical of the project area and is still less than the NDEP Profile 1 reference value.

Other water quality constituents in runoff, such as pH and TDS, vary from meeting to exceeding NDEP stream standards. This can be seen by comparing values in **Tables 3.6-3** and **3.6-4**. Several pH values are outside of the NDEP Profile 1 reference values; however, all but two pH values remain within the NDEP Class C standards for Rock Creek. TDS concentrations frequently exceeded the stream standard and reference value by June at GBG-02, and commonly exceeded it farther downstream on Little Antelope Creek. Sulfate concentrations typically exceed the stream standard and the Profile I reference value by June at GBG-02, and commonly exceeded them farther downstream. Other trace constituents, including mercury, selenium, and others, were well within reference values and stream standards. These constituents were commonly below laboratory detection limits.

The effects of the historic Newmont Ivanhoe Mine operations on surface water quality, and potential contributions of constituents to surface waters, are reflected in **Table 3.6-4**. In general, during wet years, the Newmont-reclaimed South WRSF contributed elevated sulfate concentrations to Little Antelope Creek. Seepage from the Newmont-reclaimed South WRSF has somewhat lower pH and elevated sulfates, and flows into a constructed wetland.

Water quality data also have been collected elsewhere in the Antelope Creek watershed as part of ongoing regional monitoring. Water quality data are available for the Antelope Creek stations sampled as part of the BVMP (Barrick 2010). Selected recent data from the program are indicated in **Table 3.6-5**. Mercury and selenium concentrations were consistently below laboratory detection limits. Other constituents indicated in **Table 3.6-5**, such as pH, arsenic, sulfate, and TDS also are well within stream standards.

Groundwater removed from the underground workings is pumped to the surface and conveyed by pipeline and re-infiltrated through a set of RIBs near the confluence of the Little Antelope and Antelope creeks. Discharged water is released and monitored in compliance with an NDEP-approved water pollution control permit (NEV2003114). Water quality is sampled quarterly for the NDEP Profile II suite of constituents, and the analytical results are reported to NDEP (RCG 2010d). Results from this program indicate that most water quality constituents in the discharges have been well within the NDEP Profile 1 reference values as well as the state water quality standards for Rock Creek. However, dissolved arsenic concentrations exceeded Profile 1 concentrations in 6 out of 10 quarterly samples, with a minimum of 0.026 mg/L, a median of 0.0585 mg/L, and a maximum of 0.3 mg/L.

Table 3.6-5 Recent Water Quality Data for Antelope Creek

Location	Date	Constituents[1,2]					
		pH	As	HCO_3	SO_4	TDS	SpC
ANT-1A	28-Apr-09	7.36	<0.003	71.3	43.2	153	205
ANT-1	28-Apr-09	7.76	<0.003	77.2	25.3	178	221
ANT-2	28-Apr-09	7.14	<0.003	89.3	27.4	193	276
ANT-3	28-Apr-09	8.09	0.00358	98	45.6	204	313

[1] As = arsenic, HCO_3 = hydrogen bicarbonate, SO_4 = sulfate, TDS = Total Dissolved Solids.

[2] Values are in mg/L (dissolved) except for pH in standard units; and Specific Conductance (SpC) in µS/cm.

Source: Barrick 2010.

These results generally are consistent with groundwater quality characteristics identified from some of the wells constructed (or partially constructed) in the Vinini Formation, as described in Section 3.5.1.3, Groundwater Quality. However, in the BH series wells located in the area of underground workings and gold-bearing zones of the Vinini Formation, water quality showed no exceedences of Nevada water quality standards.

Discharge values for pH exceeded Rock Creek Class C standards in 3 out of 10 samples; all of those instances were higher (more basic) than the compliance range, with a maximum value of 9.71 standard units. Occasional exceedences of iron, aluminum, and manganese also were recorded in pumping discharges, but these were infrequent.

No water quality data exist in the relatively undisturbed headwater location of the proposed Mud Springs WRSF Alternative. The water quality of surface runoff from snowmelt and rainfall is likely to resemble that at monitoring station GBG-01, the upstream site on Little Antelope Creek summarized in **Table 3.6-4**.

Affected Environment Watersheds

Watersheds

This watershed discussion examines runoff conditions over large drainage areas from a hydrologic perspective. The hydrographic basins, and the general setting of the study area and CESA, are described in the introductory text of this Section (3.6.1, Affected Environment). As described in Section 3.4, Geology and Minerals, the proposed project is located in the northern part of the Great Basin section of the Basin and Range Province. The CESA falls within two broad ecoregions, the Upper Humboldt Plains and the Semi-Arid Uplands (Bryce et al. 2003). The Upper Humboldt Plains ecoregion consists of rolling plains punctuated by occasional buttes and low mountains. It is wetter and cooler than other Nevada ecoregions in its elevation range, and is transitional to the hills, low mountains, and buttes of the Semi-Arid Uplands along the Tuscarora Mountains.

Most surface runoff results from snowmelt in the winter and spring, or later in the year from convective thunderstorms. Influences on runoff, erosion and sedimentation include snowmelt and rainfall, topography and soil characteristics, vegetation conditions, drainage controls and conservation practices. Overland flow originates on generally rocky hillslopes with non-existent or shallow soils, as well as on more gently sloping alluvial fans and valley floors. Infiltration and porosity typically are greater on the latter depositional features, and runoff is sometimes completely absorbed downslope. Sagebrush and grasses commonly intercept precipitation, utilize available soil moisture, and provide

additional surface protection and roughness. Lightning fires are common, and extensive cheatgrass stands tend to replace the native grasses and shrubs after fires (Bryce et al. 2003).

Grazing is the major land use. Some irrigated or sub-irrigated agriculture, mostly for hay, occurs along parts of the valley floors. Mineral exploration and mining are present. However, mining operations are typically permitted as zero-discharge facilities in terms of controlling process fluids, and release non-process discharges through relatively small-scale structures when compared to the land areas of local or regional watersheds. In the CESA, which is approximately 550,000 acres in size, mines currently disturb approximately 1,100 acres or approximately 0.2 percent of the land area. These sites include the existing Midas, Ivanhoe, Rossi, and Hollister operations, and portions of the Storm Underground and Dee mines. Additional disturbance from mineral exploration, roads, pipelines, and transmission lines currently exists within the CESA (shown on **Figure 3.2-2**). Given the proportion of mining disturbance (0.2 percent), it is estimated that up to 1 or 2 percent of the CESA is presently disturbed by mining, exploration, roads, pipelines, and utility corridors.

Disturbance from grazing, fire, and roads is a major influence on surface runoff conditions within the study area and CESA. The grazing and fire histories of the study area and CESA generally follow those of the larger northern Great Basin region. Grazing by cattle and sheep has occurred within the northern Great Basin since the middle 1800s (Northeastern Nevada Stewardship Group 2003). Within the CESA, rangeland fires are common. At least 70 percent of the surface water CESA, and most of the project study area, has been burned by wildfire since the year 2000 (see **Figure 3.2-3**). Parts of the CESA have burned more than once since 1985.

3.6.2 Environmental Consequences

Potential impacts to surface water resources include additional sediment loading and turbidity increases in streams from project surface disturbance, streamflow and geomorphic impacts along Little Antelope Creek and Antelope Creek from groundwater pumping discharges, surface water quality exceedences in Little Antelope and Antelope creeks, reduced water availability at seeps and springs from groundwater drawdown related to groundwater pumping, and cumulative impacts to streams, springs, and seeps within the CESA. In turn, these impacts may create associated adverse effects on riparian vegetation, wetlands, and aquatic habitats. While these resources (and potential impacts to them) are closely related to water resources, specific sections have been devoted to their assessment.

3.6.2.1 Proposed Action

<u>Potential Effects to Surface Water from Surface Disturbance</u>

As identified in Chapter 2.0, **Tables 2-5** and **2-6**, approximately 117 acres of disturbance would be associated with the Proposed Action and ongoing exploration, in addition to the 105 acres of existing authorized disturbance for a total of approximately 222 acres of disturbance for this project. A total of 34.7 acres would be associated with the proposed transmission line and associated components. Most of this Proposed Action disturbance acreage would be associated with additional laydown areas, the mine office complex, transmission lines, access road, pipeline, substation, and the Hatter production shaft, ramp, or raise site. Construction and operation of these facilities would generate local impacts to surface water resources, mainly in the form of additional turbidity and sediment loading from disturbed area runoff. The potential for these incremental impacts would be minimized by surface drainage controls best management practices (BMPs), detention in the storm water pond, and treatment as necessary in the existing East Pit treatment plant prior to release in accordance with an approved National Pollutant Discharge Elimination System (NPDES) permit or other approved permit.

As described in the Proposed Action, RCG maintains a Storm Water Pollution Prevention Plan (SWPPP), which fulfills NDEP requirements for the existing Hollister operations. Additional temporary

diversion channels may be constructed to control storm water runoff. Continued implementation and maintenance of measures from the SWPPP, Reclamation Plan, and Spill Prevention, Control, and Countermeasures Plan would reduce the potential for impacts to surface water from disturbed-area runoff.

No surface water impacts from drainage controls are anticipated. All constructed drainage features for the project would be designed and built in accordance with applicable NDEP regulatory provisions. Runoff controls would be monitored and maintained in compliance with an approved SWPPP and mining storm water permit issued under Nevada General Storm Water Permit NVR300000. Description of BMPs to be installed and implemented to protect water quality, and to prevent sedimentation, erosion, and scour in the receiving water would be part of an approved SWPPP under Sections I.C.3 and I.C.9 of the general storm water permit for mining activities.

RCG plans to build a diversion channel to route runoff along the main access road west to the secondary diversion channel originally constructed by Newmont (RCG 2009a). This additional diversion channel section would route storm water from previously disturbed areas away from the West Pit into a diversion channel around the west and south sides of the Newmont-reclaimed South WRSF. Runoff from approximately 28 acres would be diverted past the Newmont-reclaimed South WRSF into Little Antelope Creek. The new diversion channel would be approximately 1,200 feet long, within which the majority of the channel would follow a gentle gradient until joining an existing channel southeastward toward Little Antelope Creek. This downstream alignment to the creek follows a steep tributary draw.

Geomorphic impacts from the proposed constructed alignment could include additional erosion and sedimentation from increased runoff being routed down the diversion. Channel deepening and widening would occur as the drainage adjusts to increased flows. These impacts would be limited by the existence of coarse sands, gravels, and larger rock fragments along the existing alignment and in the natural channel setting. These coarser materials eventually would armor the diversion and limit the severity of drainage modifications. Providing for stable channel transitions through such slope changes into Little Antelope Creek, or for other runoff controls as needed, would be part of project design and maintenance activities. Stabilization practices, including velocity dissipation devices, would be installed as necessary to provide non-erosive flow velocities under part I.C.9 of the storm water general permit. For project runoff and drainage controls overall, the consideration and appropriate inclusion of BMPs for diversion and sediment controls, storm water control structures, preventative maintenance, and inspections is part of the NDEP permit application, review, and approval process and would be implemented. Compliance with approved permit provisions would reduce or eliminate impacts to surface water from project surface disturbance and drainage.

During the period when RCG discharges water from the mine into Little Antelope Creek, additional impacts to surface water quality may occur from occasional traffic along the Little Antelope Creek Road. These would involve sediment movement and turbidity impacts from traffic crossing the stream while it is flowing. Based on an aerial photo review, there are currently six road crossings at fords along Little Antelope Creek, and an additional forded crossing of Antelope Creek. The Little Antelope Creek Road is not proposed as a primary access route to the project area, so water quality impacts from stream crossings could result from occasional traffic. Sediment and muddy water from incidental traffic would settle out in other reaches of Little Antelope Creek or further downstream in Antelope Creek. Natural high-flow events, such as spring runoff and severe thunderstorms, are likely to make low-water road crossings on Little Antelope Creek and Antelope Creek impassable for parts of the year. Additional NPDES discharge into Little Antelope Creek may slightly increase the occurrence of impassable conditions at low-water crossings, depending on the nature of streambed and bank materials and the geometry at crossings. Most of the channel is armored by gravel and rock fragments, which would help to reduce the effects of traffic. However, some damages to channel and bank conditions are likely to result from crossings made while streams are flowing.

Monitoring and mitigation is described in Section 3.6.4, Potential Monitoring and Mitigation Measures.

Exploration surface drilling generally would disturb 30 to 40 surface drill sites per year through the projected 20 years of active underground mining. Thus, approximately 600 to 800 drill sites and their associated access roads would be disturbed over the project life. Each site would occupy approximately 0.1 acre. The total disturbance at any given time associated with exploration for the Proposed Action would be an additional 25 acres, for a total of up to 50 acres of surface disturbance due to exploration (**Table 2-6**). Potential impacts, in the form of reduced surface water quality, would result from increased erosion, sedimentation, and turbidity in runoff from drill sites and roads, and possibly from spills or leaks of drilling fluids, fuel, or other substances, equipment, or vehicles. These impacts would be largely avoided or mitigated by the ongoing implementation of BMPs and by agency review and approval of drilling sites and storage areas.

RCG already has approved exploration permits from the NDEP and BLM. NDEP permits for reclamation and storm water protection are required prior to construction of any exploration, mining or milling activity that proposes to create disturbance over 5 acres or remove in excess of 36,500 tons of material from the earth (NDEP-BMRR 2011). Storm water BMPs and reclamation practices would continue to be identified, implemented, and maintained as part of ongoing compliance with provisions of state and federal permits for controlling and reclaiming exploration disturbance. Concurrent reclamation would be part of the exploration program, and this also would help reduce sedimentation and turbidity impacts. Other preventative measures and response plans included in permit authorizations would further reduce impacts to surface water resources.

Potential Effects from Groundwater Pumping Discharges

Additional potential surface water impacts would involve effects on streamflow, channel seepage, and channel geomorphology from proposed mine groundwater pumping discharges to Little Antelope Creek. For the Proposed Action, discharges from mine groundwater pumping would be made year-round to Little Antelope Creek via an outfall. This outfall would be approved under the NPDES program administered by NDEP. RCG would continue to use the RIBs.

As described in Chapter 2.0, the proposed NPDES outfall is located somewhat south of the center of Section 4, T37N, R48E, near the causeway where the existing east-west road passes over Little Antelope Creek. The proposed outfall location is in a bedrock-controlled draw with steep rocky hillslopes on both sides of the channel. Natural rock materials already existing in the Little Antelope Creek channel bottom and sideslopes have size gradations ranging from approximately 6 inches to 48 inches, and would be adequate to ensure channel stability at the proposed NPDES outfall location at the maximum anticipated short-discharge rate of 1,100 gallons per minute (gpm) (RCG 2011b). This is equivalent to approximately 2.5 cubic feet per second (cfs). It is extremely unlikely that channel or bank instabilities would result from discharges at or near the outfall. Nonetheless, routine monitoring of the outfall in compliance with permit conditions would ensure continued stability. If monitoring identifies erosion concerns at or near the outfall location, additional durable, coarse gravel or boulders could be placed in the channel to provide greater energy dissipation. No waste rock would be used. No impacts to channel or bank stability are anticipated at or near the proposed NPDES outfall (Brown and Caldwell 2011b).

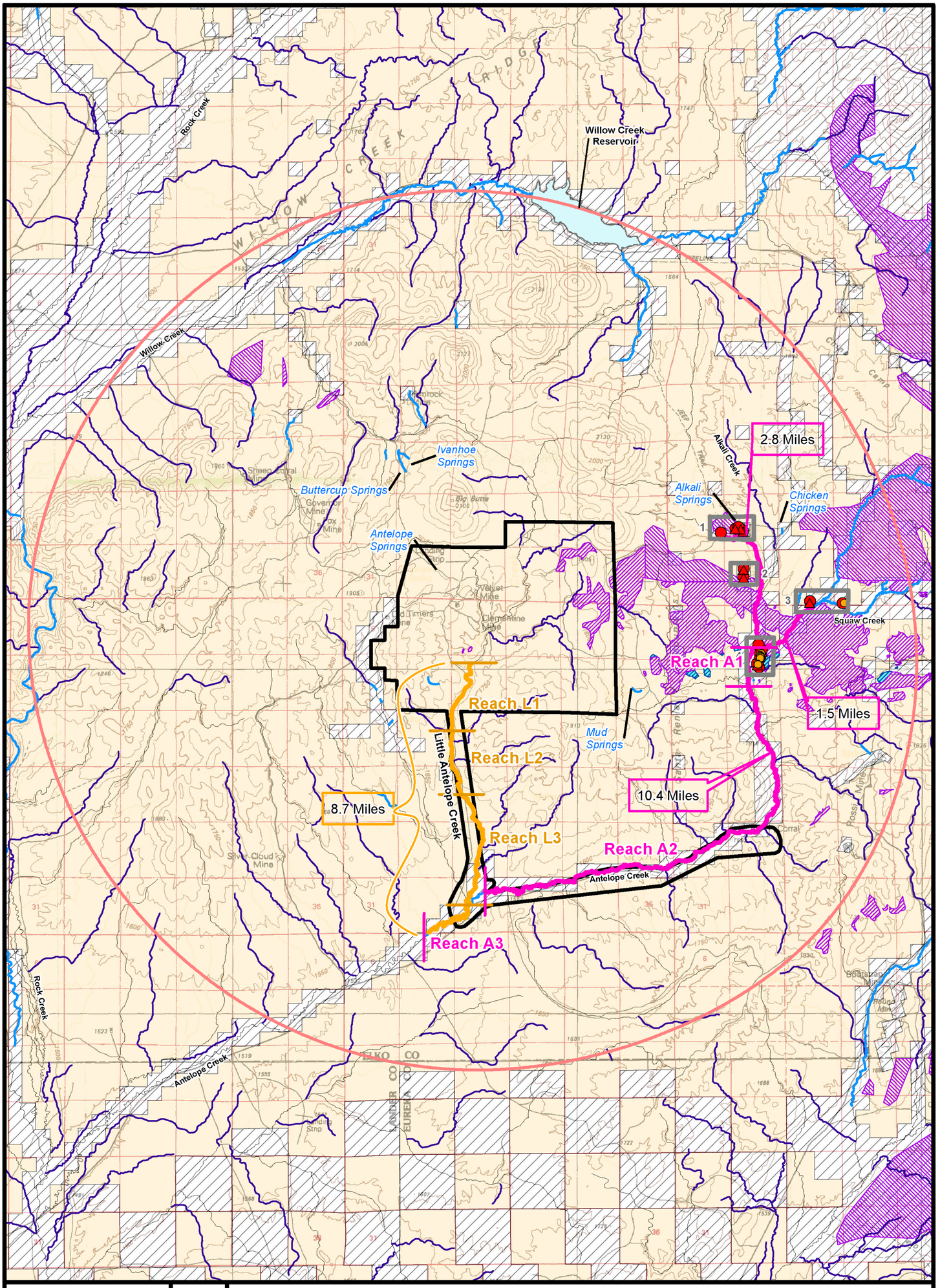
Under the Proposed Action, the average estimated groundwater pumping discharge is estimated to be 650 gpm (approximately 1.45 cfs). Short-term elevated rates are expected to be approximately 1,100 gpm (approximately 2.5 cfs). Discharges from mine pumping would increase flow durations in Little Antelope Creek downstream of the proposed NPDES outfall, and in part of Antelope Creek until the discharges seep into the porous channel bed. Anticipated flow conditions in Little Antelope Creek would be perennial or discontinuously flowing downstream and beyond the confluence with Antelope

Creek. Discontinuous flow stretches and/or pools would form where the channels alternately lose and gain water from the porous alluvium underlying the streambed. This happens as the irregular topography of the low-flow channel rises and falls, as the channel moves over shallower or deeper bedrock, or as the permeability of sediments changes.

A recent USGS study in the region quantified streambed infiltration rates in a setting generally similar to that of Little Antelope Creek (Prudic et al. 2007). Trout Creek, judged by the USGS to be a typical intermittent stream in the Middle Humboldt River Basin, was selected to develop methods of estimating and characterizing streambed infiltration and groundwater recharge in mountainous terrains (Prudic et al. 2007). Trout Creek drains the northwest flank of Battle Mountain near the Town of Valmy.

Infiltration of pumping discharges into the Little Antelope Creek streambed was estimated using the slower values of streambed-infiltration rates (approximately 0.2 cubic meter per square meter of flow area per day) from USGS measurements along Trout Creek. In addition, an assumed typical streambed width (4 feet) based on tabulated information from field surveys (JBR 2003a) and a 5-mile stream length were used. Based on available data and photographs, these dimensions are likely conservative for the purpose of assessing fairly small flow conditions in this variable channel. Based on these inputs and other hydraulic estimates, the original average groundwater pumping discharge of 1.45 cfs would be reduced by streamflow infiltration to a channel flow of approximately 0.65 cfs where Little Antelope Creek ends at its confluence with Antelope Creek. Additional flow reductions, which may be substantial, would occur from seasonally variable evaporation and vegetation uptake.

Based on these inputs, the length of flow that would continue down Antelope Creek from its confluence with Little Antelope Creek was estimated using a middle value of streambed infiltration (approximately 0.4 cubic meter per square meter of flow area per day), a flow width of 10 feet, and other hydraulic inputs. Based on these estimates, the remaining pumping discharges would move approximately 4,300 feet (0.8 mile) down Antelope Creek from the confluence before surface flow completely infiltrated into the streambed. The estimated area of streamflow impacts, which may be considered to be beneficial, is indicated in **Figure 3.6-4**. It should be noted that these values are rough estimates based on assumptions and regional data, and assume that no other flows have already wetted either stream. It is likely that with additional seasonal streamflows along Little Antelope or Antelope Creek, small remaining discharge volumes from pumping would mix with runoff from the watershed and move downstream during spring runoff. A similar condition would result if groundwater seepage contributed to flow or ponded conditions in lower Antelope Creek below its confluence with Little Antelope Creek. These would be beneficial impacts to streamflow during the project. These conditions would move groundwater pumping discharges farther downstream than was estimated for dry streambed conditions. The total length of additional flow, ponding, or available moisture in the alluvium is unknown; it would vary depending upon transient conditions. No water quality impacts would occur due to treatment of discharges before release to Little Antelope Creek, as needed, and anticipated compliance with NPDES permit provisions. Pumping discharges would flow along the streams to different extents depending on calculation inputs, existing channel flows, pumping discharge rates, channel characteristics, and seasonal conditions. In particular, sediment characteristics, evaporation, and plant uptake would have major influences on the downstream extent of a given discharge rate. Although the estimates are general in nature, these flow changes would increase the overall amount of water available for riparian vegetation and the uses of the streams during the life of the discharges.



Potentially Affected Stream Flow and Contributing Springs Potentially Affected

Figure 3.6-4

Hollister Underground Mine Project EIS

Legend

- Project Area Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Spring Complex
- Stream Length of Anticipated Increased Flow Presence
- Stream Length of Potentially Reduced Flow Presence
- Perennial Stream Reach
- Stream (Intermittent or Ephemeral)

Springs (Sada 2007)

- Springs Potentially Affected

Springs (BLM 2006)

- Spring Potentially Affected

Seeps/Springs (BLM 2000b)

- Seeps/Springs Potentially Affected

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Surface Ownership

- Bureau of Land Management
- Private

N

0 1 2 Miles

Sources: AECOM 2010a; BLM 2011b; JBR 2010; NBMG 2003; Sada 2007; USGS 2005.

3/23/2012

Floodplains along Antelope Creek and lower Little Antelope Creek would not be directly affected by proposed project disturbance. However, geomorphic impacts to stream channels and banks may occur within existing floodplains, as described below.

Potential changes to the existing channel and bank geomorphology could result from additional pumping discharges over time. The anticipated maximum short-term discharge is estimated to be approximately 2.5 cfs, with a smaller long-term average of approximately 1.5 cfs. As indicated in the Affected Environment section, these flows would pass through several different stream reaches, varying from stable well-vegetated, cobble- and boulder-reinforced perennial conditions near the project, to sandy and gravelly intermittent sections along lower Little Antelope Creek and Antelope Creek. In a number of places, floodplain and channel and bank conditions are improving from a past degraded state.

To investigate the potential for increased channel and bank instabilities, further hydrologic and channel stability assessments were conducted for the upper portions of Little Antelope Creek (Brown and Caldwell 2011b). Formal investigations included a site-visit to investigate channel, bank and floodplain conditions; derivation of peak runoff discharges for several recurrence intervals; and comparative calculations of flow hydraulics downstream from the project.

Based on site inspections, the Rosgen channel type classification was determined to be B3 in a short uppermost section, transitioning F2b and F3b types immediately downstream and through the lower sections. The Rosgen B3 type is a steep, relatively wide channel in comparison to its depth, with a cobbly susbtrate. The study reach resulted in an overall Rosgen F channel type, which exhibits past degradation through channel incision and widening. These channels exhibit incised or “confined” conditions, and the bank-full conditions are well below the top of the streambank. However, the width of the channel usually allows the stream to develop or initiate floodplain/bank-full benches, and to increase the meandering nature of the stream over time in the widened channel section (Brown and Caldwell 2011b).

In addition to map-derived subwatershed areas, detailed basin and channel inputs were developed from site-specific characterization (Brown and Caldwell 2011b). These were used as input to the hydrologic and hydraulic simulations. Such parameters included channel geometry and roughness coefficients, basin lag times, channel routing coefficients, and other inputs needed to model the runoff peak and volume characteristics of the sub-basins along Little Antelope Creek as an interconnected hydrologic/hydraulic system.

The comparative calculations of flow hydraulics used a detailed USDA-NRCS TR55 modeling approach (based on the USDA-NRCS curve-number method) in combination with published National Oceanographic and Atmospheric Administration (NOAA) precipitation depths for 2-year, 24-hour through 100-year, 24-hour storm events. This is standard accepted engineering practice. The NOAA values are based on collected data and interpretations by the agency. For modeling and design purposes, the published NOAA frequency-depth-duration precipitation values are typically used since they represent an intense, convective storm or other severe rainfall event.

These precipitation depths were used by Brown and Caldwell as inputs to storm runoff simulations using an appropriate rainfall distribution over time. Published USGS regional equations for the flow peaks at the same recurrence intervals and durations were used to cross-check the results of the USDA-NRCS modeling approach. Sensitivity analyses for varying curve-number values also were conducted.

The 2-year peak flow event is generally accepted as the discharge that creates bankfull conditions. It occurs or is exceeded on average in 50 percent of the years. Conceptually, this flow rate moves the

most sediment over time. Acceptable peak flow agreement for the 2-year, 24-hour runoff event was found between the regional equation and a selected curve number input.

The simulated 2-year, 24-hour peak discharge for the upstream end of the study reach was approximately 88 cfs for a basin area of approximately 14.5 square miles (Brown and Caldwell 2011b). At the lower end of the study reach, the cumulative basin area of 17.5 square miles produced a simulated 2-year, 24-hour peak discharge of 101 cfs. Assuming that the 2-year peak discharge represents bank-full conditions for Little Antelope Creek, the calculated average hydraulic depth, flow velocity, shear stress, and channel top width for the study reach are compared for background and proposed project conditions in **Table 3.6-6** (Brown and Caldwell 2011b). Proposed pumping discharges incorporated by Brown and Caldwell into the analysis were 1,500 gallons per minute (approximately 3.3 cfs), which is substantially higher than normal anticipated pumping discharges. This analysis is a conservative approach.

Table 3.6-6 Average Bank-full Hydraulic Conditions for the Little Antelope Creek Study Reach

Parameter	Existing Conditions	Proposed Conditions	Percent Increase
Hydraulic Depth, feet	0.76	0.78	1.7
Velocity, fee per /second	4.11	4.16	1.3
Shear Stress, pound per square foot	1.11	1.13	1.6
Top Width, feet	29.3	29.6	1.1

Source: Brown and Caldwell 2011b.

Based on this detailed investigation, it can be seen from **Table 3.6-6** that minimal changes to flow hydraulics would result from proposed groundwater pumping discharges to Little Antelope Creek. Although groundwater pumping discharges would occur year-round, these frequent peak conditions would govern the overall stream condition. The same would probably be true even if there were occasional freeze/thaw cycles and temporary ice formation in the creek. Since flows would infiltrate downstream, smaller downstream flow effects would be expected than those identified in **Table 3.6-6**. No impacts to the existing stability conditions of channels and banks are anticipated from the proposed project.

Potential Effects on Surface Water Quality

Existing water quality in Little Antelope Creek has been affected by previous open-pit mining activities in the project area, as described in Section 3.6.1, Affected Environment. These effects primarily include elevated concentrations of arsenic, sulfate, and total dissolved solids. Higher levels of specific conductance, an indicator of salinity, are present as well. Water drainage from the existing MA-1 seep and the existing Newmont-reclaimed South WRSF contribute to these conditions. Existing groundwater contributions along the creek also may reduce surface water quality. Section 3.5, Groundwater Resources and Geochemistry, describes groundwater conditions and potential impacts to that resource.

Potential impacts to surface water from adverse waste rock geochemistry would be avoided by the proposed selective placement of waste rock materials, and covering them with suitable material and growth media to control infiltration and seepage. Runoff and seepage from the existing lined and

engineered WRSF would be controlled by the existing sump and liner in accordance with the NDEP-approved Water Pollution Control Permit (# NEV2003107). Water would continue to be discharged into the existing RIBs and treated, if necessary, to meet NDEP permit requirements. As described in Chapter 2.0, the West Pit WRSF would be engineered, constructed, and reclaimed in the same manner as the existing RCG WRSF. Shallow water sometimes collects from November to July in the existing West Pit in wet years. The quality of water accumulated in the pit generally has elevated TDS concentrations and low (acidic) pH values (Brown and Caldwell 2010c). Drainage from the proposed West Pit WRSF would be managed by constructed storm water facilities and use of low permeability barriers. Given these approaches to managing surface drainage and containment, direct incremental impacts to surface water resources from materials deposited in the West Pit WRSF would be negligible.

As described in Section 3.5, Groundwater Resources and Geochemistry, backfilling the West Pit may create effects on groundwater flow directions in the adjacent perched aquifer. The West Pit acts as an evaporative sump when water is present during wet years and creates a zone of groundwater removal immediately adjacent to the pit. This zone is indicated in the groundwater monitoring levels as a groundwater divide near the West Pit. The groundwater assessment indicates that backfilling of the pit would end the evaporation from the pit and groundwater would be expected to flow past the pit and continue down gradient in a southeasterly direction. Based on groundwater analyses, backfilling of the West Pit may increase the flow rate at the MA-1 seep by up to 2 gpm and may affect the water quality at the seep. This potential impact is discussed further in Section 3.5, Groundwater Resources and Geochemistry and **Appendix B4**, Hollister Mine West Pit Shallow Groundwater Technical Memorandum.

Under the Proposed Action, the underground workings would be pumped as needed during the 20-year mine life, at rates up to 1,100 gpm (approximately 2.5 cfs). Of this amount, RCG would use between 100 and 150 gpm for mine operations, up to 300 gpm for RIBs discharge, and up to 650 gpm for discharge to Little Antelope Creek; however, RCG would maintain flexibility in their operations to discharge up to 700 gpm to the RIBs and 1,100 gpm to Little Antelope Creek. Water from mine pumping would be kept separate from surface water diversions. As described in Chapter 2.0, Description of Alternatives Including the Proposed Action, a dedicated system would isolate and route water pumped from the mine. Once pumped to the surface, the water would be piped to the existing East Pit water treatment and handling facilities, as needed. Data indicate that subsurface water quality is substantially different than surface water quality from snowmelt and rainfall runoff (Montgomery and Associates, Inc. 2010b).

As part of the Proposed Action, RCG would continue its current water management system of pumped water treatment prior to discharge into the RIBs (RCG 2009a). The current process involves pH adjustment, flocculant addition, thickening and clarification, solids management, and clean water discharge (RCG 2008b). To supplement the existing water management system for the Proposed Action, 8 to 12 underground wells may be installed within the underground mine workings as necessary to improve water handling. The groundwater pumping system (wells, pumps, pipelines, and tanks) would prevent groundwater from contact with the underground workings or from commingling with mine water that is handled by the existing water management system. Water produced from the underground wells would be routed to underground pumping stations through dedicated pipelines. Water then would be pumped from the mine to the surface. From this point, there would be two water streams denoted as “mine water” and “clean water.” The mine water would continue to be treated as described above and ultimately discharged to the RIBs. The “clean water” would remain separated from the mine water and would be treated, if necessary, prior to discharge into Little Antelope Creek in compliance with the NPDES discharge permit.

Depending on the water quality of groundwater pumping discharges as indicated in Section 3.5.1.3, Groundwater Quality, additional water treatment may be required by NDEP if necessary to reduce

arsenic, sulfate, and TDS concentrations to within NDEP Class C standards for Rock Creek and its tributaries, or to attain drinking water standards if underground Waters of the State could be affected. Without reductions in these constituent concentrations and attainment of other Nevada Class C standards, degradation of Waters of the State would occur if elevated levels of these or other constituents were present in groundwater pumping discharges. During the review of a discharge permit application, NDEP would review background and discharge water quality characteristics, as well as treatment approaches and monitoring. The Proposed Action would monitor and treat pumping discharges in compliance with permit provisions and authorizations.

Potential Effects from Groundwater Drawdown

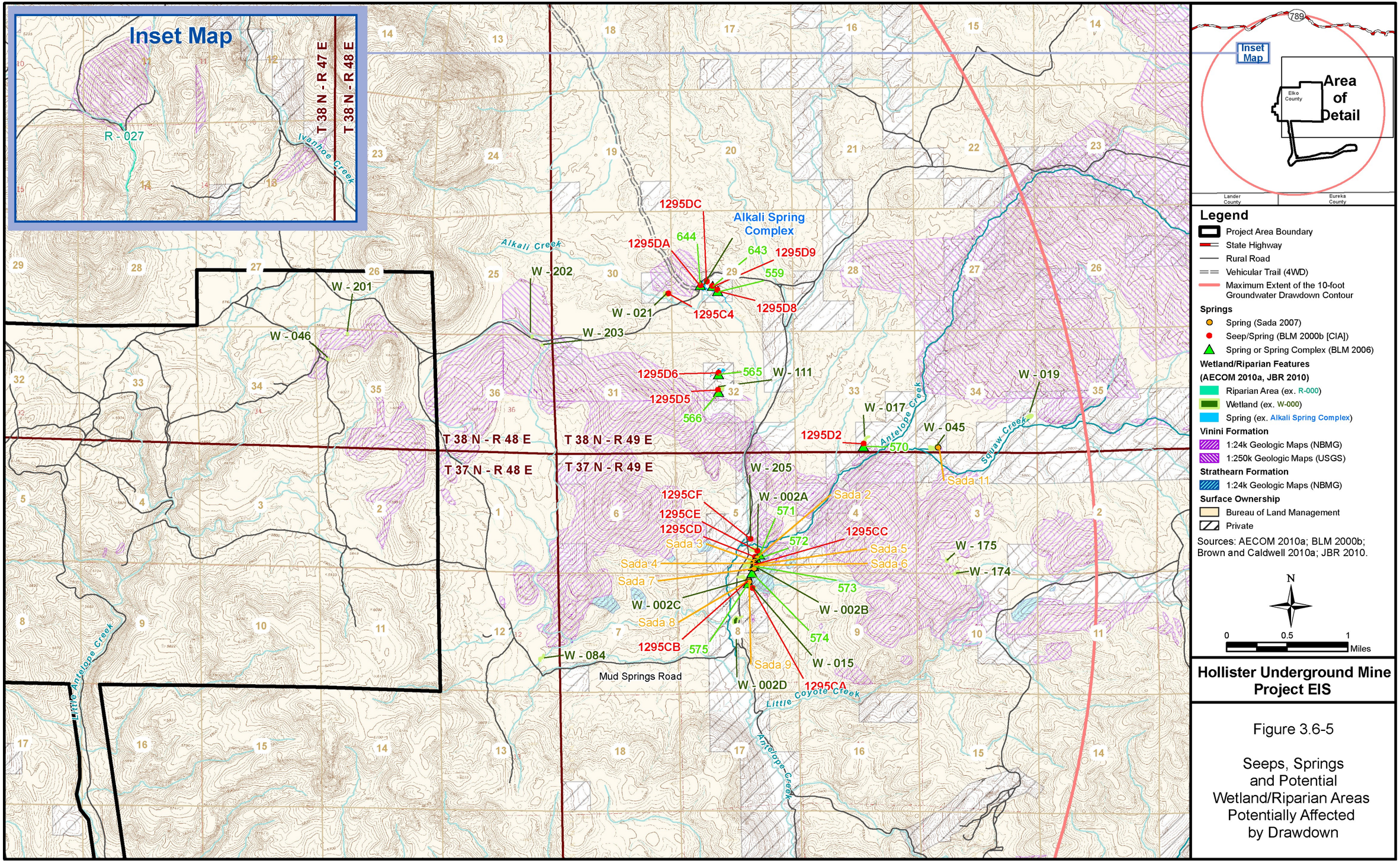
Drawdown from mine pumping is not expected to affect Antelope Spring, Ivanhoe Spring, or Buttercup Spring due to elevation differences between the aquifers that support these features and the zone that seeps into the underground workings. The geologic setting that supports these springs and isolates them from the effects of mine groundwater pumping is described in Section 3.5.1.2, Hydrogeology. In addition, as described by Brown and Caldwell and other investigators, differences in elevation and separation by geologic structures would eliminate the potential for impacts to these springs from the Proposed Action (JBR 2003b). Drawdown mainly would affect the deeper Vinini Formation, which is isolated from valley alluvium by the clayey, less permeable nature of overlying volcanic rock (see Section 3.5, Groundwater Resources and Geochemistry). Because of this isolation from the Vinini Formation, seepage losses through the channel beds of Little Antelope Creek, Antelope Creek, and Rock Creek are not expected to increase due to groundwater pumping.

Proposed groundwater pumping to drain the underground mine would create a zone of groundwater decline (drawdown). The zone bounded by the estimated maximum extent of 10 feet of groundwater drawdown has been used for purposes of assessing potential impacts to surface water. That area has been estimated by groundwater modeling for the proposed project, as described in Section 3.5, Groundwater Resources and Geochemistry. As indicated in **Appendix C, Figure C-1**, numerous springs, seeps, wetlands, and riparian areas occur within the zone bounded by the anticipated maximum extent of the 10-foot groundwater drawdown contour. Based on BLM geographic information system data, aerial photo interpretations, and other data sources, numerous springs or spring complexes, ponds or other open water features, wetland areas, and riparian zones occur within the maximum extent of the 10-foot groundwater drawdown contour. The estimated occurrence of wetland and riparian features is further described in Section 3.9, Riparian and Wetlands Areas.

Four spring complexes are potentially affected by the Proposed Action from groundwater drawdown in the Vinini Formation (**Figures 3.6-4**, **3.6-5**, and **Table 3.6-7**). All four complexes are located on private land. The criteria for determining which springs are potentially affected by groundwater drawdown are identified in Section 3.5, Groundwater Resources and Geochemistry. These features are depicted in **Table 3.6-7** and indicated in **Table 3.6-5** by type.

Table 3.6-7 was initially based on approximations from existing databases and geologic information, combined with modeling of the potential pumping effects on the Vinini Formation. The list was then revised following fieldwork by JBR in November 2010, to ground-truth the occurrence of the features for the project (JBR 2010). These results are informed interpretations of the surface features that are hydraulically connected to the Vinini Formation within the simulated maximum extent of the 10-foot groundwater drawdown contour, and therefore contain uncertainty.

The springs and seeps indicated in **Table 3.6-7** and on related figures are often closely associated with wetland and riparian features and habitats that support aquatic species. These features are indicated in **Figure 3.6-5** in an attempt to relate the different resource values. A number of data



Legend

- Project Area Boundary
- State Highway
- Rural Road
- Vehicular Trail (4WD)
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Springs

- Spring (Sada 2007)
- Seep/Spring (BLM 2000b [CIA])
- Spring or Spring Complex (BLM 2006)

Wetland/Riparian Features (AECOM 2010a, JBR 2010)

- Riparian Area (ex. R-000)
- Wetland (ex. W-000)
- Spring (ex. Alkali Spring Complex)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Surface Ownership

- Bureau of Land Management
- Private

Sources: AECOM 2010a; BLM 2000b; Brown and Caldwell 2010a; JBR 2010.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.6-5

Seeps, Springs and Potential Wetland/Riparian Areas Potentially Affected by Drawdown

3/23/2012

Table 3.6-7 Summary Table of Springs and Wetlands Potentially Impacted within the Hollister Maximum 10-foot Groundwater Drawdown Contour

Spring ID	Spring Complex (shown in Figures 3.6-4 and 3.6-5)	Source	Spring Distance to Vinini (feet)	Comment	Spring Elevation (feet)	Bedrock Groundwater Elevation (feet)	Groundwater Elevation- Spring Elevation[4] (feet)	Geologic Unit[3]	Comments	Potentially Affected by Vinini Formation Drawdown[5]
1295CA	NA	BLM 2000b	0-500	B[2]	5455	5486	31	Penn/Perm	Strathearn Fm spring	Low Potential
1295DA	1	BLM 2000b	0-500	A: 644	5600	5615	15	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
1295D9	1	BLM 2000b	500-800	A: 643	5601	5610	9	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
1295DC	1	BLM 2000b	0-500		5614	5610	-4	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
1295D8	1	BLM 2000b	500-800	A: 559	5588	5610	22	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
643	1	BLM 2006	500-800		5602	5610	8	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
644	1	BLM 2006	0-500		5600	5615	15	Tcu	Carlin Spring immediately downslope of Vinini Formation	High Potential
559	1	BLM 2006	500-800		5586	5610	24	Tc	Hill slope and drainage near Carlin Fm outcrop immediately downslope of Vinini Formation	High Potential
1295C4	1	BLM 2000b	0-500		5620	5600	-20	Ov	Vinini Spring	High Potential
565	2	BLM 2006; JBR 2010	500-800		5601	5580	-21	Ov	Drainage associated with Vinini	High Potential
566	2	BLM 2006; JBR 2010	0-500		5597	5580	-17	Ov	Drainage associated with Vinini	High Potential
1295D6	2	BLM 2000b	500-800	A: 565	5601	5580	-21	Ov	Drainage associated with Vinini	High Potential
1295D5	2	BLM 2000b	0-500	A: 566	5603	5574	-29	Tcu	Spring along fault in Carlin Fm	Low Potential
570	3	BLM 2006; JBR 2010	0		5477	5600	123	Ov	Spring associated with Vinini	High Potential
1295D2	3	BLM 2000b	0-500	A[1]: 570	5580	5600	20	Ov	Vinini Spring	High Potential
1295CF	4	BLM 2000b	0-500		5438	5512	74	Ov	Vinini Spring	High Potential
571	4	BLM 2006	0-500	A: 1295CE	5477	5510	33	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
572	4	BLM 2006	500-800	A: Sada 2	5465	5510	45	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
573	4	BLM 2006	500-800	A: Sada 3-7	5460	5510	50	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
574	4	BLM 2006	500-800	A: Sada 3-7	5467	5510	43	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
575	4	BLM 2006	500-800	A: Sada 9	5459	5495	36	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CB	4	BLM 2000b	500-800	A: Sada 8	5457	5500	43	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CC	4	BLM 2000b	500-800	A: Sada 3-7	5460	5500	40	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CD	4	BLM 2000b	500-800	A: Sada 2	5456	5500	44	Penn/Perm	Spring along hillslope in Strathearn Fm	Low Potential
1295CE	4	BLM 2000b; JBR 2010	0-500		5447	5510	63	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 8	4	Sada 2007	500-800		5460	5490	30	Penn/Perm	Strathearn Fm spring	Low Potential
Sada 9	4	Sada 2007	500-800		5460	5490	30	Penn/Perm	Strathearn Fm spring	Low Potential
Sada 2	4	Sada 2007; JBR 2010	500-800		5450	5510	60	Penn/Perm &Tcm	Strathearn Fm spring	Low Potential
Sada 3	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 4	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential

Table 3.6-7 Summary Table of Springs and Wetlands Potentially Impacted within the Hollister Maximum 10-foot Groundwater Drawdown Contour

Spring ID	Spring Complex (shown in Figures 3.6-4 and 3.6-5)	Source	Spring Distance to Vinini (feet)	Comment	Spring Elevation (feet)	Bedrock Groundwater Elevation (feet)	Groundwater Elevation- Spring Elevation[4] (feet)	Geologic Unit[3]	Comments	Potentially Affected by Vinini Formation Drawdown[5]
Sada 5	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 6	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 7	4	Sada 2007	500-800		5450	5505	55	Tcm	Spring in Carlin Fm at base of hill with Strathearn Fm	Low Potential
Sada 11	3	Sada 2007	0-500		5600	5610	10	Ov	Vinini Spring	High Potential

[1] A: Probable duplicate spring location.

[2] B: Potential outlier.

[3] Tert. = Tertiary,
Fm = Formation,
Alluv = Quaternary Alluvium,
Tcm or Tcu = Carlin Formation,
Penn/Perm = Strathearn Formation,
Ov = Vinini Formation,
Qtg = Quaternary gravel, and
Ta = Tertiary andesite.

[4] Springs sourced in the Vinini or Strathearn formations with a spring elevation within 50 feet of the groundwater elevation potentially would be impacted by groundwater drawdown. See Section 3.5.2.3 for a discussion of criteria for determining whether a spring would be impacted by groundwater drawdown in the Vinini Formation.

[5] High potential was assigned to springs located on Vinini Formation outcrops or within 500 feet of the Vinini Formation. Low potential was assigned to springs located 500 to 800 feet from the Vinini Formation or on Strathearn Formation. Springs associated with, or in close proximity to, the Strathearn Formation also could be potentially affected by groundwater drawdown in the Vinini Formation.

sources are presented, and those investigators conducted their inventories at different times, for different purposes. As a result, there is some duplication of points in **Table 3.6-7** and **Figure 3.6-5**, but it is felt that this approach best provides integrated resource coverage for the available data. Further discussion of potential impacts to wetlands and riparian areas is presented in Section 3.9, Riparian and Wetland Areas, and potential impacts to fisheries and aquatic resources are discussed in Section 3.13, Aquatic Biological Resources.

Groundwater drawdown of 10 feet or more potentially would reduce spring flows at locations indicated in **Figure 3.6-5**. In turn, these impacts potentially would reduce spring-derived streamflows on Antelope Creek downstream of the spring complexes. At present, the flow durations range from perennial to intermittent, with extensive portions of discontinuous perennial flow or ponded water along the low-flow channel. These current conditions extend from the vicinity of Spring Complex 1 at Alkali Springs (**Figure 3.6-4**) down to the confluence with Little Antelope Creek and beyond. A segment of Squaw Creek also potentially would be affected. The total length of streams that potentially would be affected includes approximately 2.8 miles of Alkali Creek, 1.5 miles of Squaw Creek, and up to 10.4 miles of Antelope Creek. The latter stream segment, shown as Reach A2 in **Figure 3.6-4**, would undergo variable flow reductions depending on the actual flow conditions at the springs and on runoff from contributing sub-watersheds. It is possible that flow reductions could occur downstream to the confluence with Little Antelope Creek, as indicated in **Figure 3.6-4** (a stream distance of 10.4 miles), or they could be much less extensive.

A total of 27 water rights within the maximum extent of the 10-foot groundwater drawdown contour are listed in **Appendix C, Table C-2**. Of these, six are owned by RCG and are located within the Hollister Project Area, as shown in **Figure 3.6-3**. A surface water right (VO6234) that is supplied by the Old Timers Channel west of the project would not be affected. A total of 17 underground rights and surface water at Willow Creek Reservoir would not be affected due to their geologic isolation from drawdown effects in the Vinini Formation. The 17 underground rights access water from springs or wells in the Carlin Formation and equivalent rocks. Willow Creek Reservoir is underlain by recent alluvium overlying volcanic tuffs. The Vinini Formation is far below the volcanic formations in the Willow Creek Reservoir area.

Based on drawdown predictions and the extent of the Vinini Formation in the area, pumping could adversely affect two remaining recorded rights within the maximum extent of the 10-foot groundwater drawdown contour. These are #27455 (at Alkali Springs) and VO6262 (26 Ranch Spring #25, spring location 1295D5 in **Figure 3.6-5**). Impacts to these water rights would include reduced spring flows from drawdown in the Vinini Formation.

Potential Effects from Access and Utility Corridors

Outlying components of the Proposed Action would include the access road and transmission lines. Minor impacts to creeks would result from road runoff and sedimentation due to increased use and grading of the existing Ivanhoe Road. These impacts would be minimized by road drainage features and ongoing maintenance. No water crossing impacts would occur at the Humboldt River, due to the substantial bridge on the highway. No water crossing impacts would be anticipated on Rock Creek due to its distance from project disturbance (see **Figure 3.6-4**). Potential impacts to Little Antelope Creek would be the same as those previously mentioned under Potential Effects to Surface Water from Surface Disturbance. The proposed transmission line alignments would cross both Little Antelope and Antelope creeks. Disturbance from transmission line construction would increase the potential for erosion and sedimentation, with associated reduction of runoff water quality. BMPs implemented as part of the construction storm water management program would reduce these impacts to minor levels. During operations, inspection and maintenance of BMPs would further reduce the potential for impacts to runoff and surface water quality.

Watersheds

As identified previously, the majority of the proposed disturbance would occur on hills in the Rock Creek Valley (Hydrographic Area 62), within the Humboldt River Basin. Two ephemeral drainages have been re-routed around the previously authorized disturbance areas. The proposed project configuration would require additional drainage modification; these considerations are assessed in the Potential Effects to Surface Water from Surface Disturbance section. Additional project-related exploration, mining, and transmission line construction disturbance would represent approximately 0.03 percent of disturbance within the hydrographic area. This would represent a small, probably negligible, incremental amount of disturbance to runoff and sedimentation conditions in the watershed.

Exploration disturbance could lead to increased compaction, runoff, and erosion, leading to sedimentation in depositional areas. In general, the disturbance associated with exploration would be surrounded by vegetated areas that would act as a buffer to nearby streams and drainages, capturing some of the sediment. Construction of the proposed transmission line and associated substation and storage area would cause compaction and disturbance of soil cover, which could lead to erosion and sedimentation to Little Antelope and Antelope creeks. Proposed revegetation and project controls on erosion and sedimentation would avoid or mitigate these impacts.

A small section of the Ivanhoe Road occurs within the Willow Creek drainage (Hydrographic Area 63). As described in Section 2.2.2, Access Roads, the Ivanhoe Road would be the primary access road to the site. Maintenance activities on the road would include grading, snow removal, and use of a dust suppressant such as magnesium chloride. Grading activities would result in loosening the surface soils, making them vulnerable to erosion. Application of magnesium chloride would result in the addition of salts to the surrounding soils, which may further degrade soil structure and protective vegetation, and increase erodibility. These factors may lead to increased sedimentation in Willow Creek and its tributaries, particularly where road drainage leads to stream crossings. Road inspections, and properly designed and maintained drainage and crossing features would help minimize this impact. This additional disturbance would represent less than 1 percent of the Willow Creek hydrographic basin, and would be similar in nature to existing public road maintenance activities in the area. It would generally represent a small incremental impact above existing conditions.

3.6.2.2 Mud Springs Road Transmission Line Alternative

Potential impacts from this alternative would be the same as described for the Proposed Action. However, stream crossings would be in more upgradient headwater locations. The proposed construction storm water management program would reduce or eliminate impacts to surface water.

3.6.2.3 Mud Springs Waste Rock Storage Facility Alternative

Potential impacts from this alternative would be generally similar to those discussed for the Proposed Action, with the exception of potential runoff and seepage from the alternative waste rock storage location. As described in Chapter 2.0, Description of Alternatives Including the Proposed Action, this alternative would employ storm water diversions, designed in compliance with agency requirements, to route runoff around the facility into existing drainages. The routed watershed area would be small, and existing conditions include steep ephemeral drainages with bedrock controls on the landscape. During operations, a wet-well or internal sump would collect any seepage through the waste rock materials. Downward seepage also would be controlled by placement of a synthetic liner beneath the storage facility. Suitable acid-neutralizing materials (such as dolomite) would be mixed into the waste rock during development of the facility to control acid rock drainage. Direct surface runoff from the facility would be controlled by its sideslope geometry and drainage features. Little or no impacts to the stability of the existing watershed are anticipated from runoff or storm water routing.

After operations, a 36-inch earth cover would be placed on this alternative facility, and other reclamation practices would be employed similar to those described for waste rock storage under the Proposed Action. However, the level of surface water containment provided by the West Pit under the Proposed Action would not be available at the Mud Springs WRSF Alternative. Long-term site stability and downgradient water quality conditions would depend on the continued integrity of storm water diversions, the success of dolomite rock in ameliorating the potential formation of acid seepage, the integrity of the underliner, and the long-term success of the earth cover to minimize infiltration into the facility.

3.6.2.4 Backfill Alternative

Under the Backfill Alternative, impacts to surface water resources would be the same as the Proposed Action. The monitoring/mitigation measures recommended for the Proposed Action also would apply to this alternative.

3.6.2.5 No Action Alternative

Under the No Action Alternative, there would be no incremental impacts to either surface water quantity or quality. The existing ephemeral and intermittent flows would continue in Little Antelope Creek and downstream in Antelope Creek. Water quality would vary according to the amount of snowmelt and rainfall runoff, as well as groundwater contributions later in the year.

3.6.3 Cumulative Impacts

The CESA for surface water resources is shown in **Figure 3.6-1**. Past, present, and RFFAs are summarized in Section 3.2. Cumulative impacts to surface water features such as streams, springs, and seeps would occur within the Rock Creek Valley and Willow Creek Valley hydrographic areas. These cumulative impacts would result from ongoing surface disturbance by mining and other land uses, and from mine dewatering and pumping discharges, including groundwater drawdown in the Carlin Trend.

The direct impacts as described previously from the Hollister Mine would add to the existing and ongoing surface water impacts within the CESA. Most of these cumulative impacts would result from mine water management effects in Rock Creek Valley, as well as from grazing, fire, roads, pipelines, and transmission lines.

Cumulative drawdown in the Carlin Trend region primarily results from the Gold Quarry and Leeville Projects operated by Newmont Mining Corporation, and the Betze/Post and Meikle mines operated by Barrick Goldstrike Mines Inc. Because groundwater drawdown from Hollister occurs in a separate and different aquifer than the other mines in the region, there would be no cumulative impacts to any specific aquifer resulting from the combination of such operations. However, the overall regional groundwater balance would experience cumulative decline. Such overall regional cumulative impacts may also result in adverse cumulative impacts to the number of springs, seeps, and groundwater contributions to streamflows that could experience reduced flows.

Numerical groundwater models that have been developed to estimate the maximum extent of cumulative drawdown to water-table aquifers are described in the Cumulative Impact Analysis report (BLM 2000b) and in other previous EIS assessments for Newmont and Barrick (BLM 2009a, 2002b,c, and others). The predicted cumulative drawdown from those projects is extensive through the Rock Creek Valley portion of the CESA, and extends 1 to 2 miles into the south-central part of Willow Creek Valley (BLM 2000b). In particular, **Figure 3.5-18** shows a small overlap between the Hollister maximum extent of the 10-foot groundwater drawdown contour and the Betze maximum extent of the 10-foot groundwater drawdown contour, although each drawdown occurs in a separate and unconnected aquifer. The proposed Hollister project's predicted impacts to seeps and springs would

add to the number of such features impacted from drawdown generated by Barrick or Newmont and thus would be an overall cumulative impact. Because each spring is assumed to be fed by a particular aquifer, cumulative impacts on any individual spring are not anticipated. The springs that would be impacted, and therefore add to the number of such features cumulatively impacted in the region, are depicted in **Figures 3.6-4** and **3.6-5**, and listed in **Table 3.6-7**.

Other potential sources of surface water impacts in the CESA include existing land uses such as grazing, wildland fires, and road construction and maintenance. All of these factors contribute to existing surface water flows and quality. As mentioned in the Affected Environment section, grazing has been the major historic land use in the CESA, and it is expected to be so in the future. Grazing impacts to the quantity and quality of surface water resources in the CESA are both beneficial and adverse. The contributions and impacts of grazing have been debated for years (e.g., Elko County Natural Resource Management Advisory Commission 2010; Northeastern Nevada Stewardship Group, Inc. 2003; Resource Concepts 2001; West 1983).

In summary, both beneficial and adverse effects from grazing are widespread in the CESA. Among others, these effects include additional herbaceous growth and diversity, livestock trampling in riparian areas, and reduced overall vegetative cover. Historical and ongoing range improvements include, among others, sagebrush reduction, pasture fencing, and crested wheatgrass seedings to increase forage production. Water developments at springs, water distribution systems, stockponds, and wells also have been built. Some of these range practices, such as water improvements and fences, had immediate benefits for wildlife. Others, such as crested wheatgrass seedings, were generally adverse for uses other than livestock grazing (Northeastern Nevada Stewardship Group, Inc. 2003). Management approaches to grazing have a major influence on its effects. In turn, the viewpoints of conflicting land use goals appear to be the major determining factors on whether impacts are interpreted as beneficial or adverse.

Fire extent in the CESA is depicted in **Figure 3.2-3**. Most of the CESA has been burned, sometimes repeatedly, since the year 2000. Extensive cheatgrass invasion is often responsible for the greater frequency and extent of range fires. However, vegetation burned in the Hot Lake Fire of 2001 consisted of sagebrush with a native grass understory and some patches of grasslands seeded with introduced grasses due to the 1964 wildland fires (BLM 2001). The Hot Lake Fire burned a total of 70,910 acres. Less than 5 percent of the burned area was dominated by non-native invasive grasses such as cheatgrass. In 2006, most of the Hot Lake Fire area was re-burned in the Sheep Fire.

From a watershed viewpoint, the most significant effect of these wildland fires is the loss of vegetation cover, which can lead to adverse changes in hillslope hydrologic function through decreased infiltration, increased runoff, and reduced soil quality (Pierson et al. 2011, 2003). These conditions then lead to increased flooding, accelerated erosion, increased turbidity and sedimentation and increased nutrient loading in surface water (National Wildfire Coordinating Group 2001). Other effects of fire, and the potential for fire in the watersheds, are discussed in the Vegetation Resources and Range Resources sections (Sections 3.8 and 3.11).

Other disturbances in the CESA include the roads, transmission lines, and pipelines. The Ruby Pipeline, a recently constructed natural gas pipeline, crosses about 28 miles of the Willow Creek Valley watershed. Assuming a disturbed width of 115 feet, approximately 390 acres were disturbed by the pipeline in the northern part of the CESA. Pipeline construction and maintenance are subject to National Environmental Policy Act analysis and environmental controls through regulatory permit reviews and approvals. BMPs for backfilling, topsoil handling, revegetation, and erosion control would avoid or reduce runoff and erosion impacts from the proposed pipeline in the CESA.

The road network is extensive in the CESA. Potential cumulative impacts to runoff, erosion, and sedimentation are similar to those described for direct impacts. These existing effects include

restricted drainage at road crossings of streams, channeling runoff and sediment along the road surface itself and in associated ditches and culverts, concentrated flow conditions that may accelerate erosion and sedimentation, additional disturbance from road maintenance that generates sedimentation, and additional water quality impacts from road surface treatment chemicals (e.g., magnesium chloride) carried in runoff to nearby streams or riparian areas.

3.6.4 Potential Monitoring and Mitigation Measures

SW-1

Issue: Site disturbance and outlying road improvements and maintenance would create adverse impacts from vegetation and soil removal, runoff concentration, and chemical treatments. Impacts would include accelerated erosion, sedimentation, and reduced runoff water quality, which could drain to nearby streams, springs, or ponds. Increased runoff or concentrated flows could reduce channel and bank stability, particularly on steep slopes near stream crossings.

Monitoring/Mitigation Measure: Annually, in early spring and after heavy precipitation events, low water crossings and direct disturbance areas around the mine site would be surveyed for erosion and sedimentation. Hay bales, silt fences, or other erosion control would be utilized until more permanent watershed stabilization methods could be installed.

If the surveys indicate project-related changes to existing landscape and stream geomorphic trends, RCG and BLM would identify and document probable causes and effects. If causes and effects are determined to be related to project activities, additional mitigation and stabilization practices would be implemented and maintained by RCG in coordination with BLM. These could take the form of compensatory watershed stabilization practices at locations determined by the BLM. RCG would submit documentation of these activities to BLM.

Effectiveness: The implementation of measure SW-1 would document the presence or absence of impacts caused by runoff, erosion, or sedimentation. These mitigation measures would improve the stability and surface water quality in the project area.

SW-2

Issue: RCG would continue to monitor water quality at the MA-1 seep and Little Antelope Creek to determine if backfilling the West Pit with waste rock would create changes to water quality and quantity at the MA-1 seep. This information would be utilized to refine the model and to determine whether or not the proposed Hollister Mine is affecting this seep.

Monitoring/Mitigation Measure: Monthly monitoring of flow rates and water quality (NDEP Profile 1) would be conducted by RCG during March through July at the MA-1 seep (because it is potentially flowing at this time) and sites GBG-02 and GBG-04 on Little Antelope Creek. Data and information would be submitted annually in writing to both BLM and NDEP. If consistent project-related water quality declines are confirmed, an artificial wetland between the MA-1 seep and Little Antelope Creek (or other remediation/mitigation alternative) would be developed by RCG in cooperation with NDEP and BLM, and implemented, operated, and maintained by RCG for a period to be determined through written communication between RCG, BLM, and NDEP.

Effectiveness: This measure would ensure early detection and remediation of potential project-related impacts to water quality in Little Antelope Creek. It would protect surface water quality in Little Antelope Creek and would prevent or reduce more widespread water quality impacts in the Rock Creek Valley. This information may be utilized to refine and validate the model regarding the West Pit WRSF finding of no impacts on MA-1 seep and Little Antelope Creek. This information also may be

used to determine whether or not the proposed project is contributing to the water quality issues at this site and Little Antelope Creek.

SW-3

Issue: Reduction in flow rates could occur at springs associated with the Vinini Formation and the Pennsylvanian/Permian Strathearn Formation that fall within the maximum extent of the 10-foot groundwater drawdown contour and meet the screening criteria for impacts. The drawdown associated with proposed mine groundwater pumping could reduce the availability of water from springs, seeps, or other water-related features for established beneficial uses.

Monitoring/Mitigation Measure: RCG, in consultation with the BLM, would develop and implement a monitoring system for the spring complexes that may be impacted by Hollister groundwater pumping in the Vinini Formation and the Pennsylvanian/Permian Strathearn Formation. Monitoring of seeps and springs on private lands requires permission from the land owner. The monitoring system would be designed to specifically address springs potentially impacted by groundwater pumping of the Vinini Formation attributable to the Hollister Project. Seeps and springs would be monitored in the fall. Data and results would be reported annually in writing to the BLM and NDWR. Interpretations and criteria for triggering additional sampling or mitigation activities would be developed for the monitoring program in writing with BLM. After 1 full year (12-month sampling round), the frequency of sampling could be reduced to quarterly, semi-annual (twice per year), or annual sampling for the duration of the project upon written agreement from BLM.

The locations and types of water supply mitigation would be determined cooperatively in writing between RCG, BLM, and any affected water right holders of record or private land owners. Other mitigation measures may include water augmentation of the springs, which could include drilling wells to feed the affected springs, piping water from wells through pipelines to the affected springs, or hauling water from other water sources to replenish the affected springs.

Effectiveness: This measure would identify project-related changes in water quantity and quality associated with existing springs within the maximum extent of the 10-foot groundwater drawdown contour. If needed, mitigation triggered by monitoring results and interpretive criteria would be implemented to ensure adequate continued water supplies for established beneficial uses.

SW-4

Issue: Implementation of the Proposed Action, and the potential expected reduced extent of flowing or ponded stream segments within the maximum extent of the 10-foot groundwater drawdown contour, could reduce the availability of surface water for livestock and wildlife use along streams such as Antelope Creek and Squaw Creek. Grazing and wildlife use could concentrate in the remaining areas containing remaining available water and riparian habitat, with consequent potential resource damage to those areas.

Monitoring/Mitigation Measure: If monitoring shows project-related impacts to surface water areas within the maximum extent of the 10-foot groundwater drawdown contour area that are utilized by livestock or wildlife, RCG would work with the BLM to identify appropriate areas to provide water for livestock on private or public lands. If site(s) are located on private land, the private landowner would have to participate in the discussions and would have to grant permission for the use of the land in order for the proposed activity to occur.

Effectiveness: Development of replacement water for livestock would protect and enhance water quantity and quality along streams, with resulting benefits to associated range and wildlife resources.

3.6.5 Residual Impacts

Residual impacts to surface water resources may include long-term flow reductions at seeps and springs, and along associated flow-dependent stream reaches, as a result of groundwater drawdown.

3.7 Soils and Reclamation

The study area for direct and indirect impacts for soils and reclamation encompasses the land within the project area (**Figure 3.7-1**), which includes undisturbed, disturbed, and reclaimed areas because disturbance to these resources would be limited to these areas. The cumulative effects study area (CESA) for soils encompasses the Rock Creek Valley Hydrographic Area (**Figure 3.7-2**) because the cumulative impacts to soils would be expected to be included in but limited to this basin. The CESA for reclamation is the Carlin Trend because the continuation of mine development and reclamation is in this mineralized area. For purpose of this document, the Carlin Trend is defined as the Gold Quarry Mine in the southeast to the Midas Mine in the northwest (**Figure 3.7-3**). Past, present, and reasonably foreseeable future actions (RFFAs), within the study area and CESA are described in Section 3.2.

3.7.1 Affected Environment

3.7.1.1 Soils and Reclamation

The project area lies within the Great Basin Section of the Basin and Range Province of the Intermountain Plateaus, Owyhee High Plateau Major Land Resource Region (U.S. Department of Agriculture-Natural Resources Conservation Service [USDA-NRCS] 2006). Soils within the study area are primarily derived from volcanic rock and have developed on lower mountain slopes and hills including alluvial fans, pediments, and terraces.

The soils information for the study area is based on Soil Survey Geographic database review and analyses (USDA-NRCS 2010). The occurrence of soils within the project area is illustrated in **Figure 3.7-1**.

The soils in the study area are characteristically shallow (i.e., less than 20 inches) to moderately deep (i.e., 20 to 40 inches); however, very deep soils (i.e., greater than 60 inches) generally occur on alluvial fans and floodplains. Soils along ridge tops and slopes tend to be shallow with gravel and cobble rock fragments. The alluvial fans along the valley bottom include deep, gravelly soils whereas floodplains include deep, finer textured soils, which formed in alluvium from mixed bedrock types. They are poorly drained soils with high water tables, and often are richer in organic matter. Most of the soils in the project area have clay subsoils, which are prone to water erosion and shrink-swell. The soils in the project area are slightly acid to strongly alkaline.

Appendix D, Table D-1 summarizes the physical and chemical characteristics and reclamation suitabilities of soil map units that occur where exploration and mining activities are proposed within the project area (as shown in **Figure 3.7-1**). The project area consists of undisturbed, disturbed, and previously reclaimed areas. Where previous mining disturbance and reclamation has occurred, the previously mapped soil characteristics have been altered or removed.

The study area is dominated by 10 soil associations. The Ninemile-Carstump association covers approximately 30 percent of the project area and occurs on hills. The soils are moderately deep to unweathered bedrock. They are gravelly to cobbly throughout the soil profile. The Ninemile soil should only be salvaged to a depth of 4 inches for use as growth media. The upper 14 inches of the Carstump soils are salvageable as growth media. The lower subsoil is high in clay and rock fragments. The Bregar-Ninemile-Pequop association covers approximately 24 percent of the project area and occurs on hills. The soils range from shallow to very deep. They are gravelly to cobbly throughout the soil profiles. The Bregar soil is not recommended for use as growth media due to the high percentage of rock fragments and clay. The upper 14 inches of the Ninemile and the upper 12 inches of the Pequop soils are suitable for use as growth media. The lower subsoils are not recommended for use due to the high rock fragment and clay content. The Quarz-Alyan-Ninemile association covers approximately 17 percent of the project area and occurs on hills. The soils are moderately deep to unweathered bedrock. None of these soils are recommended for use as reclamation material due to the high percentage of rock

fragments and clay. The Akler-Susie Creek association covers approximately 13 percent of the project area and occurs on hills. The soils are moderately deep to very deep. The upper 4 inches of the Akler and the upper 10 inches of the Susie Creek soils are suitable for use as growth media. The Susie Creek subsoil ranges from a clay loam to clay texture.

If the subsoil is clay, it may be salvaged for use in the evapotranspiration (ET) cover for the waste rock storage facilities (WRSFs). The clay loam may be salvaged as suitable growth media. This would need to be determined in the field due to the variable nature of the subsoil. The remaining soils in the project area are of lesser extents. Refer to **Appendix D, Table D-1** for a summary and description of soils.

In general, the study area soils are high in rock fragments with clay subsoils. Growth media and ET cover materials may be limited due to rock fragment content. Sorting rock fragments from the soil materials may provide additional growth media and cover material, if needed, for reclamation purposes.

Table 3.7-1 summarizes the physical and chemical characteristics (in acres) of soil map units that occur within the proposed electric power transmission line (transmission line) corridor. The soil characteristics described are related to potential impacts associated with construction of the transmission line and overland travel by equipment. No severely wind erodible soils or prime farmland soils occur within the transmission line corridor. A soil map unit can be made up of more than one soil, typically called an association or complex. Each soil is given a percentage of the map unit, and soil characteristics are calculated based on that percentage. For instance, although 563 acres of the Shabliss-Skull Creek-Puett association occur within the corridor, only 338 acres are erodible.

The Shabliss-Skull Creek-Puett association formed in alluvium derived from mixed rocks and volcanic ash on fan pediments. The soils range from shallow to very deep. They are gravelly and some of the soil components have a low reclamation potential. The Skull Creek-Shabliss-Puett association is very similar to the previously mentioned soil. The Orovada-Humdun association occurs on inset fans and mountains. The soils are very deep and highly erodible by water. The Orovada soils can be slightly to moderately saline, affecting reclamation potential of these soils. The Bregar-Ninemile-Pequop association formed in residuum and colluvium derived from volcanic rocks on hills. The soils range in depth from shallow to very deep and are gravelly. The remaining soils are of lesser extents. Refer to the **Table 3.7-1** for a description of these soils.

3.7.2 Environmental Consequences

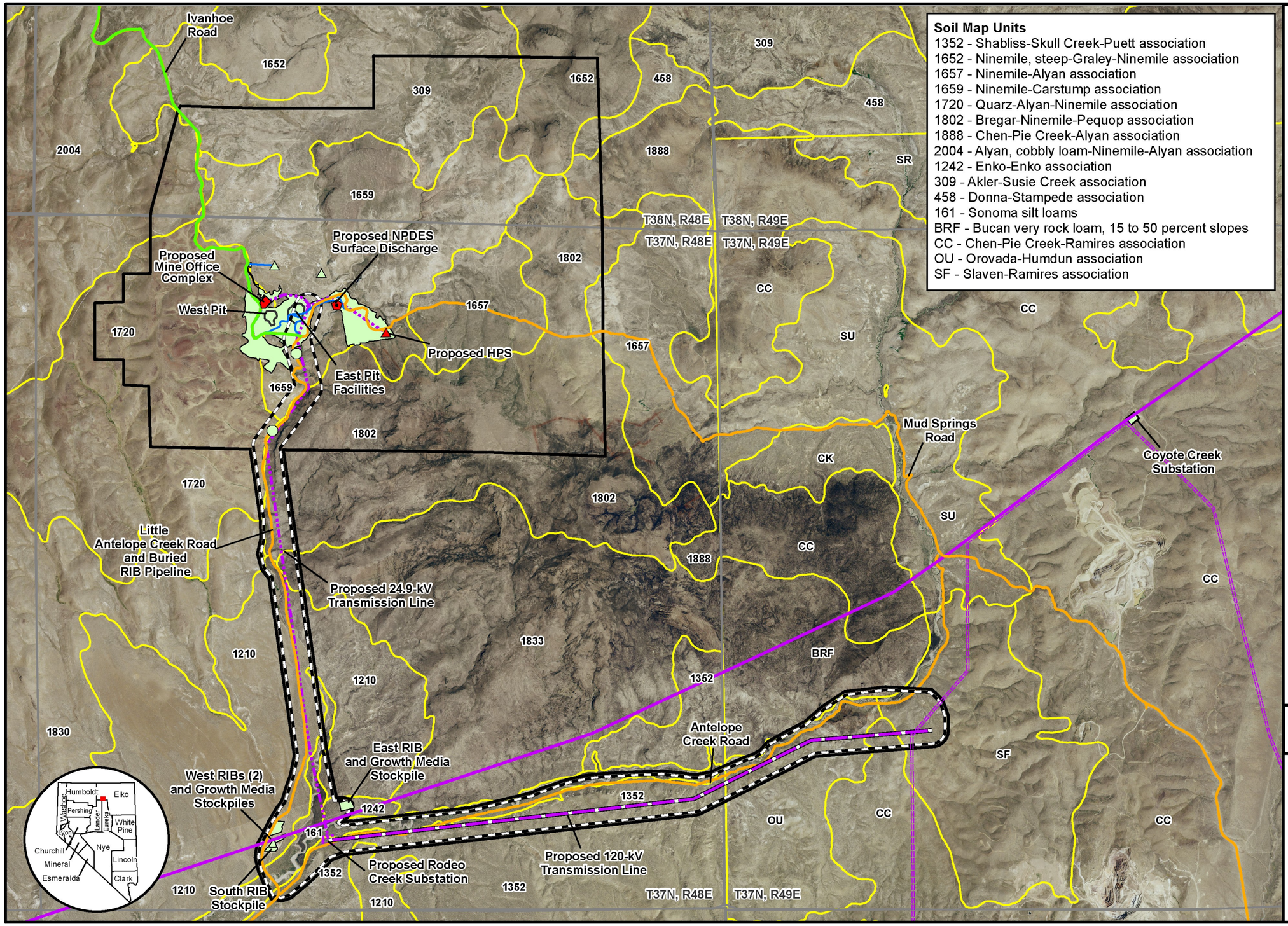
Mining, surface exploration, construction of a transmission line, and road maintenance activities could impact the soil resource when soils are disturbed. Impacts also may occur post-mining when the final growth media is redistributed during reclamation activities. Issues related to soils and reclamation during the proposed project include the following:

- Potential erosion impacts;
- Availability of suitable soils and growth media for revegetation; and
- Potential for successfully reclaiming surface disturbances.

3.7.2.1 Proposed Action

<u>Soils</u>

The proposed project would result in approximately 117 total acres of disturbance to soils, of which an additional 25 acres would be disturbed as a result of exploration activities (for a total of up to 50 acres of surface exploration disturbance). This disturbance would be in addition to the previously authorized 80 acres for a total of approximately 222 acres of disturbance. A total of 51.5 acres would be new disturbance, 8.1 acres would be previously disturbed, and 32.4 acres would be previously disturbed



Soil Map Units
1352 - Shabliss-Skull Creek-Puett association
1652 - Ninemile, steep-Graley-Ninemile association
1657 - Ninemile-Alyan association
1659 - Ninemile-Carstump association
1720 - Quarz-Alyan-Ninemile association
1802 - Bregar-Ninemile-Pequop association
1888 - Chen-Pie Creek-Alyan association
2004 - Alyan, cobbly loam-Ninemile-Alyan association
1242 - Enko-Enko association
309 - Akler-Susie Creek association
458 - Donna-Stampede association
161 - Sonoma silt loams
BRF - Bucan very rock loam, 15 to 50 percent slopes
CC - Chen-Pie Creek-Ramires association
OU - Orovada-Humdun association
SF - Slaven-Ramires association

Legend

Existing/Authorized Surface Disturbance or Facilities
- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities
- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline

Source: USDA-NRCS 2010.

N

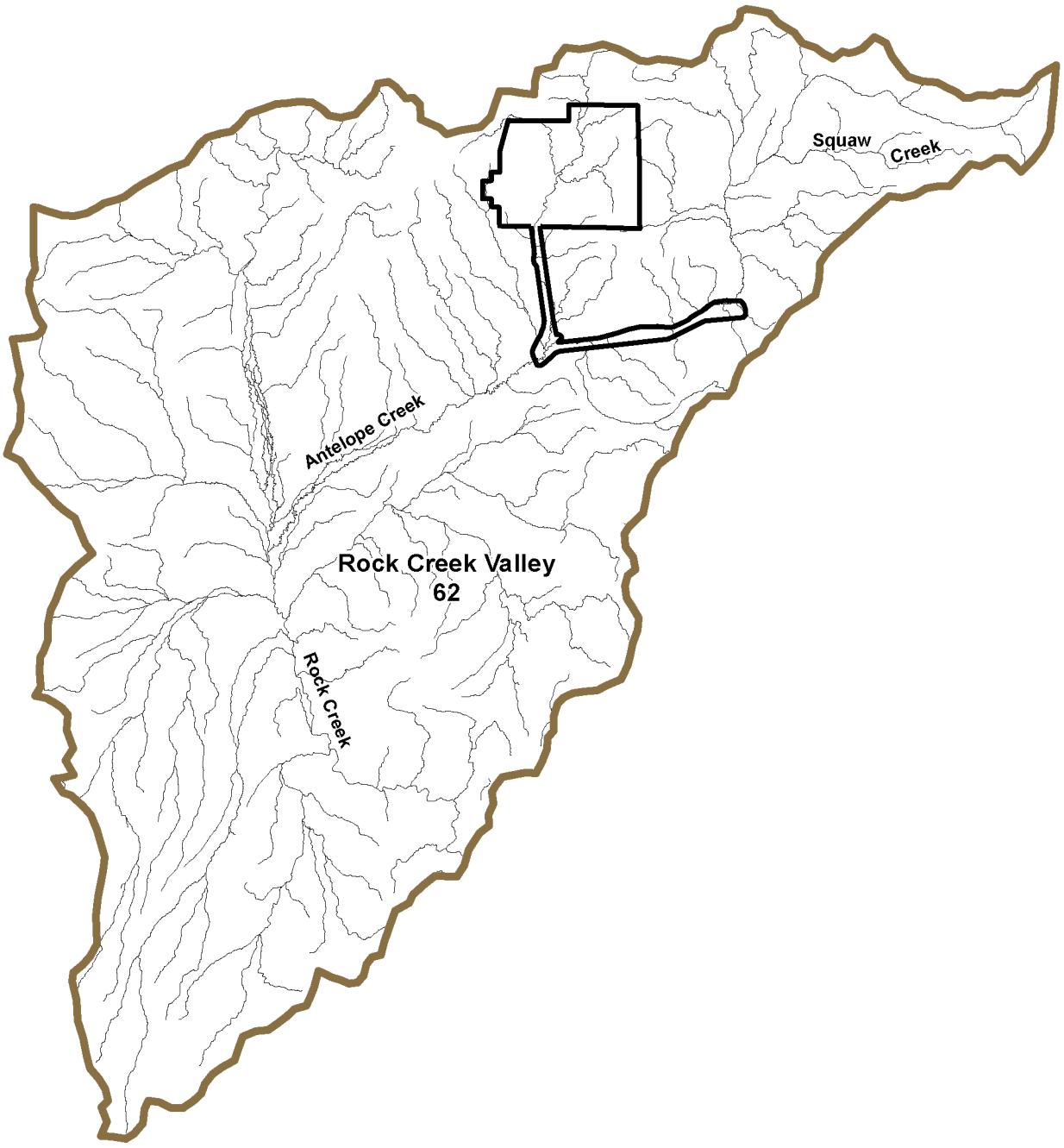
0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.7-1

Soils in the Study Area

3/23/2012



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Stream (Intermittent or Ephemeral)

N

0 2 4 Miles

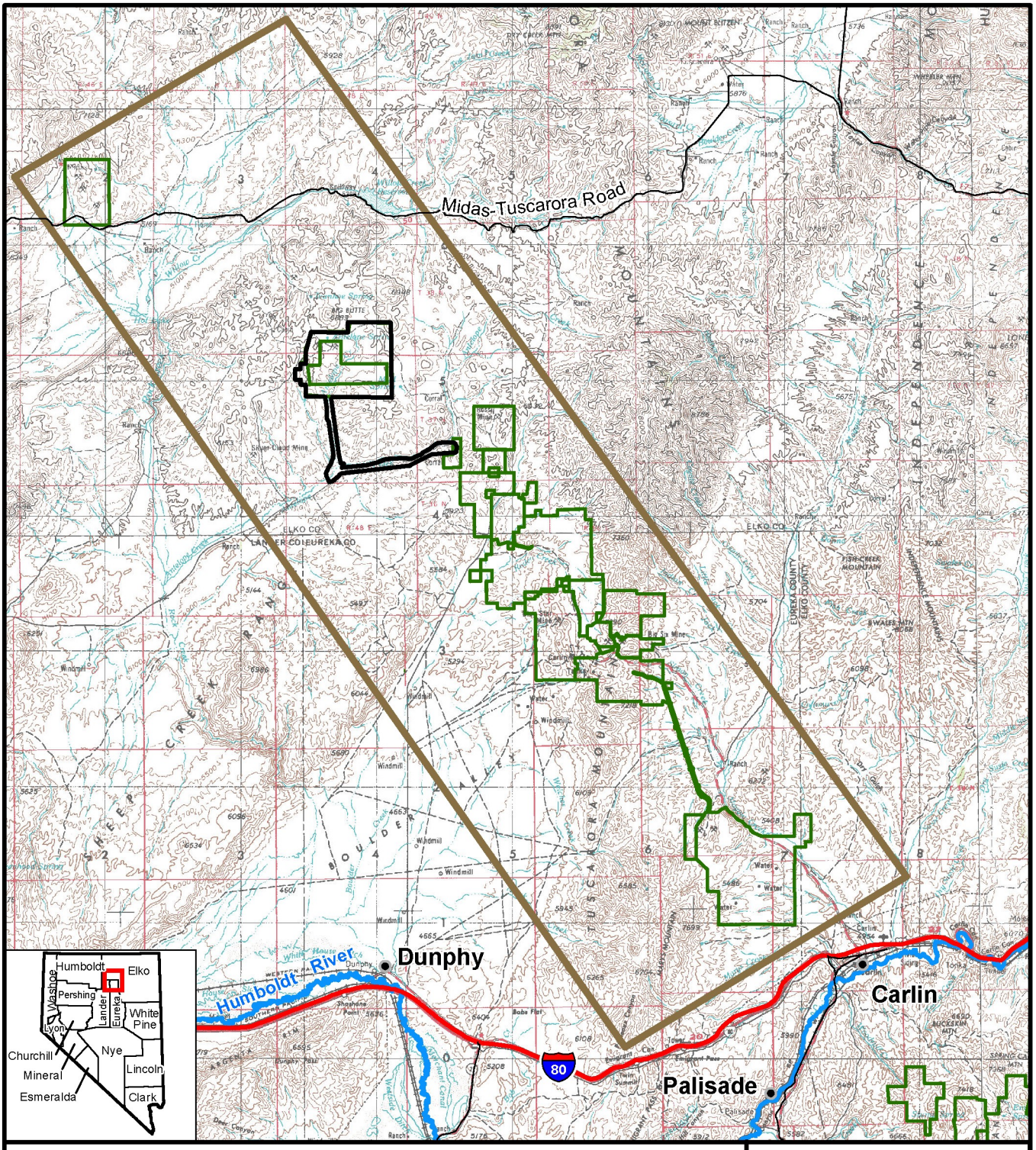
Note: Hydrographic Area boundary locations are approximate.
Source: BLM 2009b.

Hollister Underground Mine Project EIS

Figure 3.7-2

Soils
Cumulative Effects
Study Area

3/19/2012



Legend

- Project Area Boundary (Study Area)
- Cumulative Effects Study Area
- Other Mine Plan Boundaries
- River

N

0 5 10 Miles

Source: BLM 2009b.

Hollister Underground Mine Project EIS

Figure 3.7-3

Reclamation Cumulative Effects Study Area

09/07/2011

Table 3.7-1 Transmission Line Corridor – Soil Characteristics (acres)

Map Unit Symbol	Map Unit Name	Acres	Water Erodible[1]	LRP[2]	Hydric	Compaction Prone[3]	Shallow Bedrock[4]	Stony-Rocky[5]	Droughty[6]
1720	Quarz-Alyan-Ninemile association	24	22.8	0.0	0.0	14.4	22.8	22.8	0.0
1802	Bregar-Ninemile-Pequop association	124.8	18.7	0.0	0.0	87.4	87.4	106.1	0.0
1210	Skull Creek-Shabliss-Puett association	395.0	59.3	276.5	0.0	0.0	59.3	276.5	98.8
1242	Enko-Enko, strongly sloping association	25.5	5.1	21.6	0.0	0.0	0.0	0.0	0.0
1352	Shabliss-Skull Creek-Puett association	563.3	338.0	394.3	0.0	0.0	112.7	507.0	225.3
161	Sonoma silt loam, drained, 0 to 2 percent slopes	334.2	0.0	284.2	0.0	0.0	0.0	0.0	0.0
1830	Vanwyper, steep-Alyan-Vanwyper association	6.3	4.4	0.0	0.0	0.0	5.7	5.7	0.0
1833	Vanwyper-Rock outcrop-Trunk association	30.5	10.7	0.0	0.0	6.1	16.8	16.8	0.0
BRF	Bucan very rocky loam, 15 to 50 percent slopes	27.0	27.0	0.0	0.0	27.0	27.0	27.0	0.0
CC	Chen-Pie Creek-Ramires association	40.1	32.0	8.0	2.0	24.0	32.0	32.0	0.0
OU	Orovada-Humdun association	275.6	234.3	192.9	0.0	0.0	41.3	0.0	0.0
SF	Slaven-Ramires association	142.7	128.4	64.2	0.0	128.4	128.4	128.4	0.0
Total		**1,989.0**	**880.7**	**1,241.7**	**2.0**	**287.3**	**533.4**	**1,122.3**	**324.1**

[1] Water erosion hazard class determined from Soil Erodibility Factor (Kw) for surface horizons and slope.

[2] Low Reclamation Potential (LRP) = soils with high strong acidity, strong alkalinity, salinity, or sodic properties.

[3] Compaction Prone = surface horizons are a sandy clay loam or finer.

[4] Shallow Bedrock = soils with lithic (hard) bedrock at 60 inches or less.

[5] Stony-Rocky = soil profile has large stones or rocks that may pose reclamation or excavation challenges.

[6] Droughty = soils with a surface texture of sandy loam or coarser that are moderately well to excessively drained.

Note: No wind erodible soils are within the transmission line corridor. Acreage only accounts for soils outside of the proposed exploration area but within the transmission line corridor, to avoid double counting soils in the project area shown in **Table D-1**.

Source: USDA-NRCS 2010.

but reclaimed areas. Soil units that are located in proposed disturbance areas are shown in **Figure 3.7-1**. New disturbance is mostly related to the construction of the proposed transmission lines, substation, and exploration activities. **Tables 2-5** and **2-6** describe the acres of disturbance associated with the Proposed Action, and total acreages associated with mining facilities, transmission line construction, water management facilities, roads, ancillary facilities, and surface exploration.

The impacts associated with construction of the transmission line would be temporary and a result of construction traffic along the corridor, temporary staging areas, and work areas around each structure. Short-term impacts to soils would include compaction from construction vehicles and possible erosion due to soil and vegetation disturbance. If construction occurs when the soils are wet, rutting and soil mixing could occur. Long-term impacts would include the loss of soil productivity associated with spur roads to the transmission line and within the pole locations. Construction of the substation would result in the site-specific permanent or long-term removal of approximately 2 acres of soil resources at the substation location. Where substation structures are located, the soils would be taken out of production and the area around the substation graveled. A long-term loss in soil productivity and quality would be expected in these locations.

As stated in Section 2.2.3, surface exploration activities consist of surface geologic or geophysical surveys, access road construction or maintenance, drill site preparation and drilling, and exploration or condemnation hole drilling programs. At this time, it is uncertain exactly where these activities would occur under the Proposed Action; they can take place anywhere in the project area. Existing two track roads would be utilized where possible, but overland travel on undisturbed, vegetated soils may occur. Road maintenance would consist of blading, gravelling, snow removal, and watering for dust suppression. Culverts or gravel may be placed in drainages to create a low water crossing, which may result in sedimentation downstream in the drainages. In general, impacts related to exploration activities would include compaction and rutting related to overland travel and drill site preparation and use. Drill site preparation may result in some mixing of the topsoil with lower productivity subsoil. Soil cover, such as vegetation and vegetative litter, would be disturbed by overland travel or drill site preparation, leaving the soils exposed to wind and water erosion.

Grading and leveling would be required to prepare drill sites with the greatest level of effort required on more steeply sloping areas. During preparation, mixing the soil profiles would result in a corresponding loss of soil structure. Soils would be compacted as a result of the preparation of drill sites and associated facilities. The potential for erosion would increase through the loss of vegetation cover and soil structure as compared to an undisturbed state. Soil productivity would decrease, in like manner, primarily as a result of profile mixing and compaction along with the loss in vegetative cover.

Soils with high silt content at the surface have the potential to “powder,” a condition where the soil particles lose their cohesiveness. This condition would occur where dry silty soils are heavily driven and become pulverized by repeated travel from vehicles and equipment. This condition would remain until such time as the soils receive enough moisture to regain their cohesiveness, typically over the winter months. Fine textured soils are susceptible to compaction and rutting under dry conditions. Ruts deepen with continued use. Roads often become braided as vehicles avoid ruts causing a wider disturbance footprint. Impacts to soils as a result of maintenance activities would include compaction, soil mixing, and erosion.

Much of the disturbance from the proposed project related to mining activities would occur in previously disturbed areas. The mine office complex, West Pit backfill area, existing Rodeo Creek Gold Inc (RCG) WRSF, and Hatter production shaft, ramp, or raise would occur within previously disturbed areas, some of which have been reclaimed. The Proposed Action includes disposal of waste rock at the permitted existing RCG WRSF and a new WRSF in the West Pit. All of the disturbance would occur within previously disturbed areas that have already had reduced soil quality and productivity.

Erosion hazard of the native soils across the project area are shown in **Appendix D**, **Table D-1**. Soils would be subject to wind and water erosion as they are disturbed by mining activities. Although accelerated erosion due to soil disturbance could occur at any stage of the proposed project, the maximum potential for erosion within the study area would be expected while soils are loose, with no established cover. Erosion also would be of concern after reclamation work has occurred but before a vegetative cover has been reestablished. If the ground surface is left smooth and barren during this period, winds could dislodge soil particles and rainfall intercepting barren surfaces could result in increased erosion. Revegetation of disturbed areas would be conducted as soon as practicable to reduce the potential for wind and water erosion.

Soil compaction occurs when soil particles are pressed together by an applied load and the pore spaces between them are reduced while bulk density is increased. Moist fine textured soils are most susceptible to severe compaction by equipment and haul trucks. However, compaction also may occur on loamy to coarse textured soils and under drier conditions due to multiple passes by heavy equipment. Compaction damages soil structure and reduces pore space, which impedes the movement of air and water to plant roots and can result in lower growth rates and hinder revegetation. Compaction reduces infiltration and results in excessive surface runoff, erosion, nutrient loss, and potential water quality problems.

Rutting affects the surface hydrology of a site as well as the rooting environment. The process of rutting physically severs roots and reduces the aeration and infiltration of the soil, thereby degrading the rooting environment. Rutting also disrupts natural surface water hydrology by damming surface water flows, creating increased soil saturation upgradient from ruts, or by diverting and concentrating water flows creating accelerated erosion. Rutting is most likely to occur on moist or wet fine-textured soils but also may occur on dry sandy soils due to their low soil strength.

Soil compaction and rutting could result from the movement of heavy mining vehicles and constant repeated light vehicle traffic. The degree of compaction would depend on the moisture content and texture of the soil at the time of impact. Compaction would be most severe where heavy equipment operates on moist to wet soils with high clay contents. Reclamation of disturbed sites would include ripping or scarifying compacted surfaces to loosen the soil.

Soil contamination could result from material spills during mining activities. If large spills occur, contamination could result in the removal and disposal of large amounts of soil. Saturated soils have the potential to diffuse contaminants. As described in the Plan of Operations, implementation and maintenance of measures from the Reclamation Plan and Spill Prevention, Control, and Countermeasures Plan would reduce the potential for impacts to soils from spills. If spills occur, they would be cleaned up in accordance with local, state, and federal regulations.

Overall site productivity is primarily a matter of revegetation success. Productivity varies with vegetation community, but more importantly, with land management objectives as they relate to the establishment of desirable or productive vegetation types. In contrast, soil quality is an inherent soil resource characteristic involving aeration, permeability, texture, salinity, alkalinity, microbial populations, fertility, and other physical and chemical characteristics that are accepted as beneficial to overall plant growth and establishment. Based on this concept, there would be impacts to the existing quality of native soils from project-related disturbance.

Replacement of growth media is proposed for major disturbances associated with the proposed project. The recommended salvage depth for native soil material is identified in **Appendix D**, **Table D-1**. RCG also would test and evaluate the existing waste rock material in the existing Newmont waste rock facilities for use as growth medium in the reclamation process for the Hollister Underground Mine site. If the material is non-potentially acid generating and suitable as a growth medium, this material may be utilized in the reclamation and closure activities for the Hollister Underground Mine site. RCG would submit a reclamation plan amendment to the Bureau of Land

Management (BLM) and Nevada Division of Environmental Protection describing how and where the growth media would be used and describing the reclamation of the material removal site.

If adequate suitable growth media is not available on-site, suitable growth media would be imported to the mine site for reclamation. The impacts associated with importing growth media to the site include introduction of noxious weeds and non-native invasive plant species, soil textural changes, or inhibitive soil chemical characteristics. In addition, there is potential for soil color differences that may not blend with native soils in the landscape.

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

RCG performed agronomic soils tests on their existing growth media stockpiles in July of 2010. Three of the four existing stockpiles exhibited acceptable physical and chemical characteristics for plant growth. The south Rapid Infiltration Basin stockpile (see **Figure 3.7-1**) exhibited elevated salts and sodium but had acceptable textures. Seed mixtures for revegetation may need to be modified to salt and sodium tolerant species where this growth media is used for reclamation.

Growth media excavation, transport, storage, and redistribution would modify existing soil structure, generating residual impacts relative to aeration and permeability. It is likely that some mixing of textural zones would occur, as well as mixing of saline and/or alkaline materials with relatively salt-free materials. This mixing may create adverse chemical impacts to soil quality for seedbeds. Currently existing microbial populations would likely decrease during growth media stockpiling and storage. Due to these probable effects, the initial soil quality of reconstructed seedbeds and root zones would be less than that of the existing soil resources. In addition, compaction from vehicular traffic would occur during construction of the proposed transmission line and operation activities, decreasing soil quality in those areas temporarily.

These impacts would be reduced based on RCG's commitment to reclaim project components and successfully restore productive post-mining land uses. These objectives would be attained through the use of best management practices, such as installation of storm water diversions to route water around disturbance areas and project facilities and the placement of erosion control devices (e.g., silt fences, staked weed-free straw bales, riprap, sediment traps, etc.). Revegetation of disturbance areas would be conducted as soon as practical to reduce the potential for wind and water erosion, minimize impacts to soils and vegetation, help prevent the spread of noxious weeds and non-native invasive plant species in disturbance areas, and facilitate post-mining land uses. Following construction activities, areas such as cut-and-fill embankments and growth media stockpiles, would be seeded. Concurrent reclamation would be conducted to the extent practical to accelerate revegetation of disturbance areas. Surface exploration activities would be reclaimed as described in Section 2.2.10.1, Drill Hole and Water Well Abandonment. The transmission line and associated facilities would be reclaimed as described in Section 2.4.10.6, Hollister Mine Facility Reclamation. In addition, state and federal reclamation requirements require revegetation monitoring in comparison with established quantitative standards for the locale. A period of overall reclamation monitoring (and maintenance as necessary) also is required prior to agency approval of reclamation bond release. Based on these requirements, it is likely that short- to long-term (e.g., up to 10 years or more) decreases in soil quality would not limit the attainment of overall post-mining land use objectives. Over time, soil quality on reclaimed and revegetated sites would resemble pre-mining conditions. Major effects on the desired post-mining, exploration, and transmission line site productivity from soil quality impacts are not anticipated.

Reclamation

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

Reclamation plans address concurrent reclamation and stabilization practices that are implemented as a project proceeds, as well as post-mining practices that are implemented during the final stages of project completion. Concurrent reclamation typically consists of revegetation, erosion controls, and associated drainage practices that minimize the impacts of clearing and accelerated erosion during project activities. Final reclamation is conducted following completion of exploration and mining activities.

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

Controlling accelerated erosion and sedimentation, storm water drainage and discharges, and associated water quality minimizes potential impacts to soil resources, and promotes overall site stabilization as a project proceeds.

After proposed mining and exploration operations cease, reclamation and closure plans would be implemented in accordance with permit requirements. Reclamation of the project area is extensively discussed in Section 2.4.10, Reclamation and Site Closure. All components of the Proposed Action would be reclaimed, except for roads that are part of BLM's Transportation Plan. Impacts to soils would be temporary until successful revegetation is achieved.

3.7.2.2 Mud Springs Road Transmission Line Alternative

The impacts associated with this alternative would be similar to the Proposed Action except soil disturbance would be reduced by approximately 9.5 acres and 15.2 acres for North and South options, respectively. The proposed route would parallel a portion of the Mud Springs Road. This alternative is located within the Rock Creek Valley Hydrographic Area 62. Implementation of this alternative would have potential to cause sedimentation to occur to Antelope Creek in the vicinity of the Mud Springs Road crossing and the tributary drainages to Antelope Creek that the transmission line would cross. A temporary construction laydown area would be established, adjacent to the proposed new substation to facilitate temporary storage of pole structures, line spools, and miscellaneous transmission line supplies. Impacts to the laydown area would include compaction and a possible reduction in soil cover leading to accelerated runoff and erosion, until successful reclamation have been achieved. This temporary laydown area would be reclaimed upon completion of transmission line construction.

3.7.2.3 Mud Springs Waste Rock Storage Facility

The Mud Springs WRSF would be constructed on an upland area adjacent to a tributary of Little Antelope Creek as opposed to backfilling the West Pit, as described for the Proposed Action. The impacts associated with this alternative would be similar to what is described for the Proposed Action except it would result in increased new surface disturbance to soils and an increased potential for erosion and sedimentation to the tributary of Little Antelope Creek. The construction of the Mud Springs WRSF and ancillary facilities would disturb 21 acres, 90 percent of which would be new surface disturbance to soils. Growth media would be salvaged from the site and stockpiled for use in final reclamation. Because the Mud Springs WRSF would require a substantial amount of cover material (approximately 55,000 cubic yards more than the West Pit WRSF) for reclamation, and because of the lack of suitable quantities in the project area, it is likely that additional cover material would need to be imported to the site. Diversion channels would divert storm water runoff from the

Mud Springs WRSF; however, surface runoff from the facility itself would be diverted directly to the diversion channel that flows into Little Antelope Creek. Erosion of growth media down slopes would occur after placement and would continue until the WRSF and associated disturbances are effectively revegetated after final reclamation and mine closure.

3.7.2.4 Backfill Alternative

This alternative would result in similar impacts to soils as the Proposed Action with the following exceptions. This alternative would result in 10.6 acres of additional surface disturbance to soil resources to accommodate access road upgrades to the East and West raises, and to accommodate the stockpiling of waste rock material and maneuvering of haul trucks around each raise site. The resulting impacts would include an increase in compaction, increased runoff, and erosion around the raise sites. Impacts to soils would last until successful revegetation has occurred.

3.7.2.5 No Action Alternative

The proposed project would not occur under the No Action Alternative, and associated impacts to soils would not occur. Under this alternative, RCG would continue surface exploration and bulk sampling activities as currently authorized.

3.7.3 Cumulative Impacts

3.7.3.1 Soils

The soils CESA encompasses the Rock Creek Valley Hydrographic Area (**Figure 3.7-2**), which encompasses approximately 284,160 acres. Cumulative impacts to soils result from surface disturbance related to mining and exploration, wildfire, grazing, dispersed recreation, roads, and other natural and human induced activities within the analysis area. The past, present, and RFFAs that could occur are described in Section 3.2.

In addition to mine and mineral exploration activities in the CESA, numerous major wildfires have occurred in the soils CESA, creating additional regional impacts to soils. **Figure 3.2-3** illustrates the locations of the wildfires within the CESA. High severity wildfires result in increased water repellency in soil, which limits infiltration, volatilization, increased mobility of some soil nutrients, mortality of some soil organisms, combustion of surface soil organic matter and loss of effective ground cover that leaves the soil susceptible to erosion and could contribute to noxious weeds and/or non-native invasive plant species infestations (Korb et al. 2004). Detrimental and severe soil effects can occur down to 10 cm below the surface (Massman et al. 2003). Areas with detrimental soil conditions can persist for decades. Wildfires also can change the soil chemistry by infusing nitrogen into naturally nitrogen-deficient soils. High amounts of nitrogen in the soil provides a boost for plants such as cheatgrass to establish and thrive.

Two grazing allotments occur on public lands within the CESA. Where public and private lands are grazed, soils may see an increase in compaction which may result in accelerated runoff and erosion and a reduction in soil quality. Impacts to riparian and wetland soils include compaction, reduced infiltration, and elimination of ground cover due to grazing.

Past, present, and RFFAs within the soils CESA (283,001 acres in total) include the Hollister and Rossi mines, and Rodeo Creek Exploration project, which have resulted, or would result, in approximately 2,130 acres of soil disturbance from mining, mineral exploration, and pipeline construction activities. The proposed project incrementally would increase disturbance to soils by an additional 117 acres (approximately 0.04 percent of the CESA), resulting in a total cumulative disturbance of approximately 2,247 acres (approximately 0.8 percent of the CESA). It is assumed that portions of past mine and mineral exploration disturbances in the CESA have been reclaimed, and ongoing reclamation at existing operations would continue to reduce the impacts to soils. Pending

completion of successful reclamation, the incremental additional impacts to soils as a result of the proposed project would be temporary in nature, lasting until successful reclamation is achieved.

Further descriptions of cumulative impacts to soil resources are presented in other National Environmental Policy Act assessments conducted by the BLM. These include the Betze Pit Expansion Project Supplemental Environmental Impact Statement (SEIS) (BLM 2008b), the Leeville Project Cumulative Effects SEIS (BLM 2010d), and the South Operations Area Project Amendment Cumulative Effects SEIS (BLM 2010e).

The North and South options for the Mud Springs Road Transmission Line Alternative would result in fewer acres of disturbance within the CESA and, as a result, fewer acres of surface disturbance to soil resources. The Mud Springs WRSF and Backfill alternatives would result in additional acres of disturbance within the CESA and additional acres of surface disturbance to soils. All alternative disturbance would be completely reclaimed. Impacts to soils as a result of this alternative would last until successful revegetation is achieved.

3.7.3.2 Reclamation

The CESA for reclamation is the Carlin Trend. It contains 455,584 acres and is shown on **Figure 3.7-3**. The proposed project is located within the Ivanhoe Mining District on the northern end of the Carlin Trend in northeastern Nevada. Past, present, and RFFAs within the Carlin Trend are illustrated in Section 3.2.

Past, present, and RFFAs within the reclamation CESA have resulted, or would result, in 8.7 percent (39,860 acres) of disturbance due to mining, mineral exploration, and pipeline construction activities. The proposed project incrementally would increase disturbance by an additional 0.03 percent (117 acres) of the CESA resulting in a total cumulative disturbance of approximately 9.63 percent (39,977 acres) of the CESA. Portions of past mine, mineral exploration, and pipeline construction disturbances in the CESA have been and would continue to be reclaimed by re-contouring, re-spreading of growth media, and revegetating disturbed sites. In addition, partial or complete backfilling of the pit is proposed for the Betze and Genesis mines and would reduce the overall impacts within the Carlin Trend over time. Pending completion of successful reclamation, the incremental additional impacts as a result of the proposed project would be temporary in nature and minor within the CESA.

3.7.4 Potential Monitoring and Mitigation Measures

SL-1

Issue: The existing growth media stockpile, south Rapid Infiltration Basin stockpile, exhibited elevated salts and sodium, which can prohibit plant growth.

Monitoring/Mitigation Measure: A salt and sodium tolerant seed mixture would be developed for areas where the south Rapid Infiltration Basin stockpile is used. Adding other amendments (such as organic matter or elemental sulfur) would be considered to establish vegetation.

Effectiveness: In general, excess salts and sodium prohibit plant growth. Certain vegetation types are adapted to these types of conditions. This measure would initiate development of a seed mixture with species that can generally tolerate the salt and sodium content of the growth media in the south Rapid Infiltration Basin stockpile.

3.7.5 Residual Impacts

Residual impacts to soils or reclamation are not anticipated from the implementation of the proposed project and recommended mitigation measures because impacts to soils would be temporary and lasting until reclamation is complete and successful revegetation is achieved.

3.8 Vegetation Resources

The vegetation resources study area for direct and indirect impacts is the project area because impacts to upland vegetation would be limited to surface disturbance areas associated with the Proposed Action and alternatives (**Figure 3.8-1**). The cumulative effects study area (CESA) was chosen to encompass the relevant grazing allotments (Squaw Valley, Tuscarora, and Twenty-Five) because impacts to upland vegetation from the Proposed Action and past, present, and reasonably foreseeable future actions (RFFAs) would affect vegetation (i.e., forage) available for livestock grazing in these allotments (**Figure 3.8-2**). The past, present, and RFFAs are summarized in Section 3.2.

3.8.1 Affected Environment

The study area is located entirely within the Rock Creek Valley Watershed and is typical of the Great Basin in northern Nevada. The Ivanhoe Road extends north out of the study area and is partially within the Willow Creek Valley Watershed. Upland vegetation within the study area consists of sagebrush and grassland vegetation types. **Table 3.8-1** summarizes the general upland vegetation types, specific vegetation types, ecological sites, and dominant species that occur in the study area. An ecological site is a landform with specific physical characteristics, which differs from other landforms in its ability to produce distinctive kinds and amounts of vegetation and in its response to management. General vegetation types are comprised of multiple ecological sites. In addition to upland vegetation types, wetland areas and disturbed/sparsely vegetated areas also occur in the study area. Wetland areas are described in Section 3.9, Riparian and Wetland Areas. Disturbed/sparsely vegetated land (i.e., mined or quarried lands) also occurs in the existing project area.

Distribution of vegetation types in these areas is strongly influenced by variations in landscape position, soil type, moisture, elevation, and aspect. Species composition, species abundance, and vegetative structure within these vegetation types have been affected by fires that occurred in the study area in 2001, 2005, and 2006 (**Figures 3.2-3** and **3.8-3**). Descriptions of these vegetation types are provided in the following sections. **Figure 3.8-1** illustrates the vegetation types present within the study area.

3.8.1.1 Sagebrush Shrubland

Sagebrush shrubland is characterized as a lower elevational type of the Great Basin and Inter-Mountain Basin ecoregions (**Figures 3.8-1** and **3.8-4**). This vegetation type consists of four specific sagebrush types (i.e., big sagebrush, basin big sagebrush, Wyoming big sagebrush, and low sagebrush). Soils associated with this vegetation type are typically deep, well-drained, and non-saline. These shrublands are dominated by a variety of shrubs and herbaceous species that are presented in **Table 3.8-1**.

The sagebrush habitat identified within the Project Area in **Figure 3.8-4** was derived from detailed field-verified surveys (AECOM 2010b) and does not precisely match the big sagebrush shrubland vegetation type identified in **Figures 3.8-1** and **3.8-2** that were derived from the United States Department of Agriculture, Natural Resources Conservation Service [USDA-NRCS] 2011 imagery mapped at a much smaller scale (less detail).

3.8.1.2 Grassland

This vegetation type occurs in lowland and upland areas and may occupy swales, playas, mesatops, plateau parks, alluvial flats, and plains. Sites are typically xeric (dry). Substrates are often well drained sandy or loamy-textured soils derived from sedimentary parent materials but are quite variable and may include fine-textured soils derived from igneous and metamorphic rocks. Dominant perennial bunchgrasses and shrubs within this vegetation type are all very drought-resistant species. Grassland is dominated by a variety of grasses and other herbaceous species that are presented in **Table 3.8-1**.

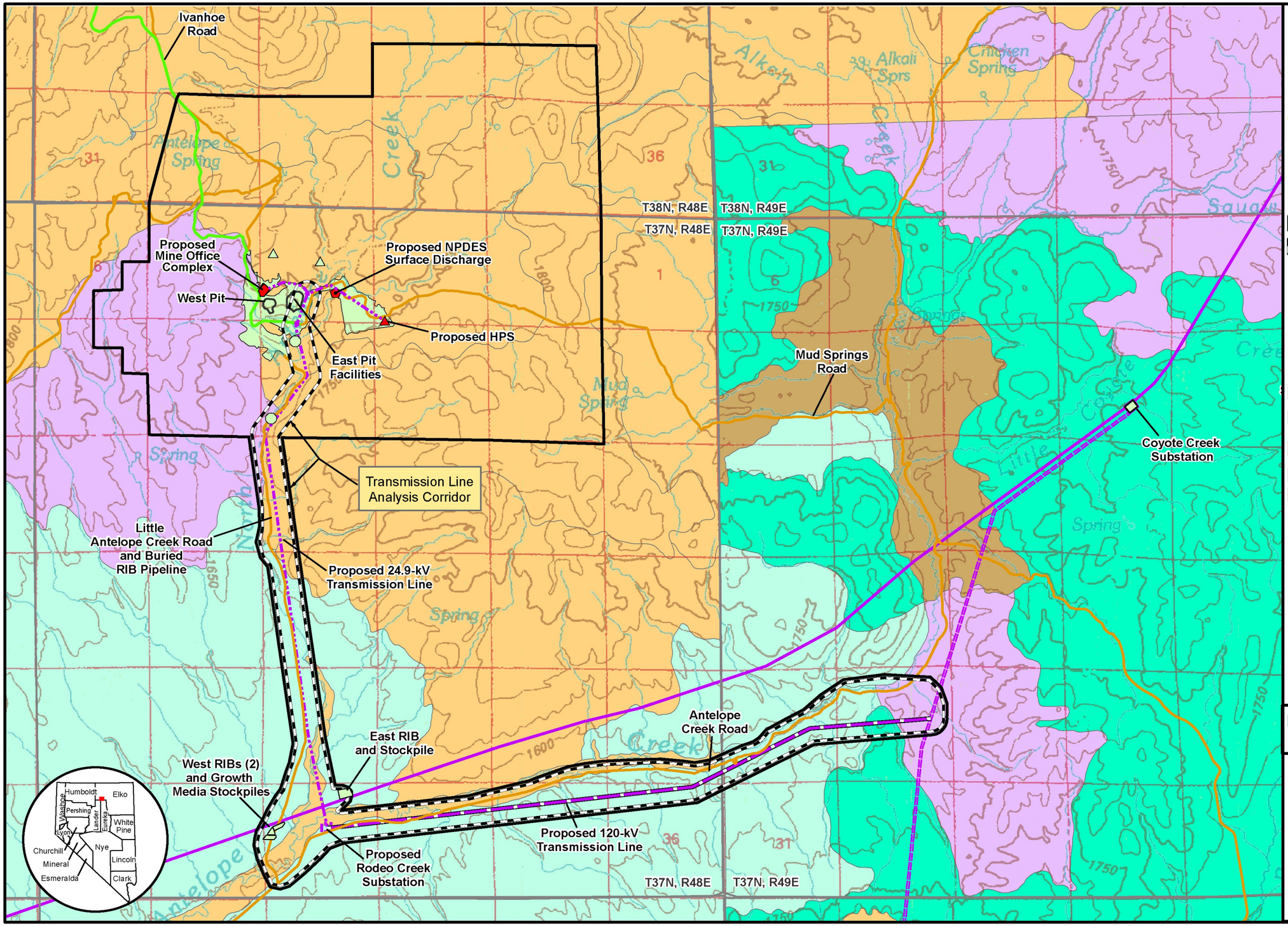
Table 3.8-1 General Vegetation Types, Specific Vegetation Types, and Ecological Sites Within the Study Area

General Vegetation Type	Specific Vegetation Type	Ecological Site Code	Ecological Site Name	Potential Native Vegetation (Dominant Species)
Sagebrush Shrubland	Basin big sagebrush shrubland	025XY013NV	Churning Clay 8-12" P.Z.[1]	Basin wildrye (*Leymus cinereus*) and basin big sagebrush (*Artemisia tridentata* ssp *tridentata*)
	Big sagebrush shrubland	025XY009NV	South Slope 12-14" P.Z.	Bluebunch wheatgrass (*Pseudoroegneria spicata*), big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), and basin wildrye
		025XY014NV	Loamy 10-12" P.Z.	Bluebunch wheatgrass, Thurber's needlegrass (*Achnatherum thurberianum*), and big sagebrush
	Wyoming big sagebrush shrubland	024XY005NV	Loamy 8-10" P.Z.	Thurber's needlegrass and Wyoming big sagebrush (*Artemisia tridentata* spp. w*yomingensis)*
		025XY019NV	Loamy 8-10" P.Z.	Thurber's needlegrass and Wyoming big sagebrush
	Low sagebrush shrubland	025XY022NV	Cobbly Claypan 8-12" P.Z.	Bluebunch wheatgrass, Thurber's needlegrass and low sagebrush (*Artemisia arbuscula*)
Grassland	NA[2]	025XY003NV	Loamy Bottom 8-14" P.Z.	Basin wildrye
		025XY012NV	Loamy Slope 12-16" P.Z.	Idaho fescue (*Festura idahoensis*), bluebunch wheatgrass, mountain big sagebrush (*Artemisia tridentata* spp. v*aseyana*), and antelope bitterbrush
		025XY015NV	South Slope 8-12" P.Z.	Bluebunch wheatgrass
		025XY017NV	Claypan 12-16" P.Z.	Idaho fescue, bluebunch wheatgrass, and low sagebrush
		025XY018NV	Claypan 10-12" P.Z.	Bluebunch wheatgrass, Thurber's needlegrass and low sagebrush
		025XY051NV	Eroded Claypan 12-16" P.Z.	Idaho fescue, bluebunch wheatgrass, low sagebrush, antelope bitterbrush, Thurber's needlegrass and Sandberg's bluegrass (*Poa secunda*)
Disturbed Land	NA[2]	NA[2]	NA[2]	NA[2]

[1] P.Z. – Precipitation Zone.

[2] Not applicable.

Source: USDA-NRCS 2011.



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Vegetation Types

- Big Sagebrush Shrubland
- Basin Big Sagebrush Shrubland
- Wyoming Big Sagebrush Shrubland
- Low Sagebrush Shrubland
- Grassland

Source: USDA-NRCS 2011.

N

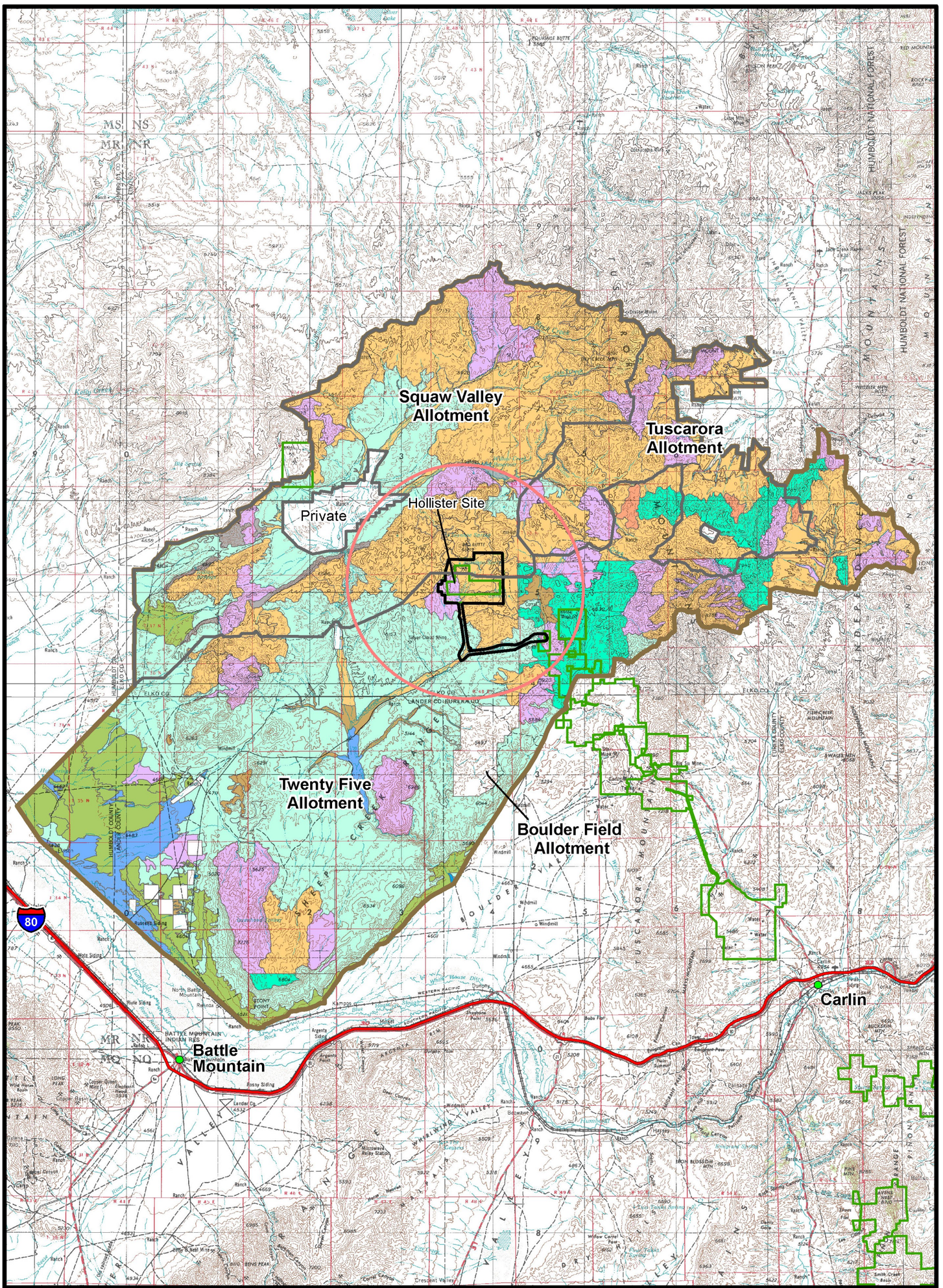
0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.8-1

Vegetation Types in the Study Area

3/23/2012



Hollister Underground Mine Project EIS

Figure 3.8-2

Vegetation and Range Resources Cumulative Effects Study Area

3.8-4

3/23/2012

Ivanhoe Road
Proposed Mine Office Complex
West Pit
Proposed NPDES Surface Discharge
Proposed HPS
East Pit Facilities
Mud Springs Road
Coyote Creek Substation
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
East RIB
West RIBs (2) and Growth Media Stockpiles
Antelope Creek Road
Proposed 120-kV Transmission Line
Proposed Rodeo Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
Antelope Spring
Alkali Spring
Chicken Spring
Mud Spring
Little Coyote Creek
Squaw Creek
Spring Creek
Humboldt
Elko
Washoe
Pershing
Lander
Eureka
White Pine
Lyon
Churchill
Nye
Mineral
Lincoln
Esmeralda
Clark

Legend

Existing/Authorized Surface Disturbance or Facilities
- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities
- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline

Year of Fire
- 1980-1984
- 1985-1989
- 1990-1994
- 1995-1999
- 2000-2004
- 2005-2009

Source: BLM 2010f.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.8-3

Fire History within the Project Vicinity

3/1/2012

Ivanhoe Road
Proposed NPDES Surface Discharge
Proposed Mine Office Complex
Proposed HPS
West Pit
East Pit Facilities
Mud Springs Road
Coyote Creek Substation
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
East RIB
West RIBs (2)
Antelope Creek Road
Proposed 120-kV Transmission Line
Proposed Rodeo Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
T37N, R48E
T37N, R49E
Alkali Creek
Alkali Sprs
Chicken Spring
Mud Spring
Little Coyote Creek
Spring
Springs
Creek
Antelope Creek
North Fork
1750
1800
1650
1600
36
31
6
1

Humboldt
Elko
Washoe
Pershing
Lander
Eureka
White Pine
Lyon
Churchill
Nye
Mineral
Lincoln
Esmeralda
Clark

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Habitat

- Big Sagebrush Habitat

Source: AECOM 2010b.

N

0 0.5 1 Miles

Hollister Underground Mine Project EIS

Figure 3.8-4

Field-verified Sagebrush Habitat within the Project Area

3/1/2012

3.8.1.3 Riparian and Wetland Areas

Riparian and wetland resources are described in Section 3.9, Riparian and Wetland Areas.

3.8.1.4 Disturbed Land

This type includes previously disturbed or sparsely vegetated areas that have been mined, of which some areas have been reclaimed. Plant densities and vegetative cover provided by these areas are much lower due to the physical disturbance of the surface soils.

Extensive reclamation activities have occurred at the Hollister Site between 1993 and 1998. A total of 268 acres of previously disturbed land have been reclaimed with a seed mix consisting of native grasses, forbs and shrubs (JBR Environmental Consultants, Inc. [JBR] 2004a). Reclamation of disturbed lands at the Ivanhoe open pit operation was completed in 1997 and 1998. Facilities that were reclaimed included process/administration facilities, Newmont Waste Rock Storage Facilities (WRSFs), ore stockpile, growth media stockpiles, heap leach pad, diversion channel, overflow pond, and roads. Reclamation monitoring was completed at the site in 2002 to evaluate reclamation success (Cedar Creek and Associates 2003; JBR 2004a). Perennial ground cover values were approximately 50 and 40 percent for the reclaimed disturbance areas, respectively, as compared to adjacent and undisturbed reference areas, which had a perennial ground cover value of approximately 29 percent. Based on these values, the reclamation was deemed successful. In addition to exceeding the vegetative cover criterion, plant diversity within reclaimed areas was high based on the 66 plant taxa that were observed during reclamation monitoring activities (Cedar Creek and Associates 2003).

Vegetation is re-established in stages in reclaimed areas. Early serial is the first stage. In this stage grasses and forbes are usually the dominant plant species. Plants go through growth stages finally reaching late serial, which usually consist of mature plants including grasses, forbs, and shrubs. Shrubs may be the dominant plant species. It takes years for plants to go through the different vegetation stages.

3.8.2 Environmental Consequences

Primary issues related to vegetation resources include direct and/or indirect impacts to upland vegetation.

3.8.2.1 Proposed Action

Surface Disturbance

Under the Proposed Action, mine development and exploration activities would disturb approximately 117 acres. The existing disturbance consists of approximately 105 acres for a total of approximately 222 acres. A total of 43.8 acres of sagebrush shrubland and 65.1 acres of grassland vegetation would be disturbed or removed; approximately 8.1 acres of disturbed/sparsely vegetated land would be re-disturbed (**Table 3.8-2**). Project-related activities in sagebrush shrubland areas would result in the conversion of a shrub-dominated vegetation cover type to a grass/forb-dominated vegetation cover type in the short term. Over the long-term, shrubs would become re-established and increase in abundance within the majority of disturbed areas as a result of reclamation and natural re-colonization. The loss of 43.8 acres of shrub-dominated vegetation would represent a long-term impact as it could take up to 25 years following reclamation for mature shrub species to re-establish (Bureau of Land Management [BLM] 2011c).

Surface exploration activities would directly impact up to an additional 25 acres of predominantly grassland and some sagebrush shrubland vegetation from construction of drill sites and access roads. This disturbance would be in addition to the previously authorized 25 acres of surface exploration disturbance. Although the surface disturbance would be reclaimed as soon as possible after exploration activities are completed in the localized area, and the re-establishment of an initial

grass/forb dominated vegetative cover would minimize impacts from erosion; impacts may be long-term due to the estimated 25 years required to re-establish a mature shrub species community in the sagebrush shrubland areas (BLM 2011c).

Table 3.8-2 Vegetation Types Disturbed or Removed by the Proposed Action

Project Component	Sagebrush Shrubland	Grassland	Disturbed/Sparsely Vegetated Land	Total Acres
Mining Facilities				
West Pit WRSF	--	--	8.0	8.0
Hatter Production Shaft, Ramp, or Raise (HPS)	--	5.0	--	5.0
Laydown Areas	--	10.0	--	10.0
Electric Power Transmission Line (Transmission Line) and Associated Components				
Rodeo Creek Substation	2.0	--	--	2.0
East Pit Switchgear Facility	--	--	0.1	0.1
Pads for 24.9-kilovolt (kV) Transmission Line	0.1	0.1	--	0.2
Pads for 120-kV Transmission Line	0.2	--	--	0.2
Temporary Access Roads for 24.9-kV Transmission Line	7.6	7.6	--	15.2
Temporary Access Roads for 120-kV Transmission Line	15.0	--	--	15.0
Laydown Areas for 24.9-kV Transmission Line	1.0	--	--	1.0
Laydown Areas for 120-kV Transmission Line	1.0	--	--	1.0
Water Management Facilities				
New Water Tanks	--	0.3	--	0.3
Proposed Buried Pipelines	15.9	4.5	--	20.4
Proposed National Pollutant Discharge Elimination System Discharge Outfall	--	0.5	--	0.5
Proposed Storm Water Diversion Channel	--	0.4	--	0.4
Monitoring Wells for the Mine	1.0	--	--	1.0
Roads				
East Pit Spur Road	--	0.7	--	0.7
Access Road Upgrade to HPS	--	6.0	--	6.0
Miscellaneous	--	1.0	--	1.0

Table 3.8-2 Vegetation Types Disturbed or Removed by the Proposed Action

Project Component	Sagebrush Shrubland	Grassland	Disturbed/Sparsely Vegetated Land	Total Acres
Ancillary Facilities				
Mine Office Complex	--	4.0	--	4.0
Exploration	--	25.0	--	25.0
Total	**43.8**	**65.1**	**8.1**	**117.0**

Transmission line construction activities would result in approximately 34.7 acres of surface disturbance impacting predominantly sagebrush shrubland vegetation. The majority of the vegetation disturbance (87 percent) is for temporary access roads that would be reclaimed after construction of the transmission line. The remaining surface disturbance (13 percent) is for the proposed Rodeo Creek substation, laydown areas, switchgear facility, and pole placement. As discussed for mine development and surface exploration activities, impacts to the sagebrush shrubland vegetation community may be long-term. Several factors, such as, but not limited to, available moisture, plant nutritional requirements, seed availability, drought conditions, precipitation, soil condition, and soil chemical composition or characteristics determine the length of time for vegetation to re-establish.

Road maintenance activities on Ivanhoe Road and minimal maintenance on Little Antelope Creek Road would not impact upland vegetation communities.

Reclamation would be completed on approximately 117 acres (100 percent) of the total proposed surface disturbance area. To minimize mine and mineral exploration impacts to vegetation, reclamation would be conducted as soon as practical, with concurrent reclamation implemented to the maximum extent possible as discussed in Section 2.4.10, Reclamation and Site Closure. Reclamation activities may include, but are not limited to, grading of final slopes; ripping of compacted soil; application of growth media; and broadcasting of seed. Seed mixes, as described in Section 2.4.10.4, Seed Mixes, would be used for revegetation activities. Satisfactory revegetation of mine and mineral exploration disturbance areas (i.e., assuming the primary goal of soil stabilization through presence of adequate plant cover) is anticipated to occur approximately 3 to 15 years following reclamation. After 25 years, the reclaimed plant communities likely would be at a mature stage and consist of adequate herbaceous plant cover with sufficient diversity to substantially reduce the potential for soil erosion and provide forage for use by livestock and wildlife.

Water Management Activities

As described in Section 3.5, Groundwater Resources and Geochemistry, and Section 3.6, Surface Water Resources and Watersheds, drawdown as a result of geotechnical water removal activities may affect groundwater and surface waters within the project vicinity. Potential hydrologic impacts to wetland and riparian areas are described in Section 3.9, Riparian and Wetland Areas.

It is anticipated that groundwater drawdown from the proposed project would not result in direct impacts to upland vegetation within the maximum extent of the 10-foot groundwater drawdown contour. Most shrubs' roots do not extend below 20 to 25 feet (Branson et al. 1976; Comstock and Ehlerigner 1992; Donovan et al. 1996; Foxx and Tierney 1987; Robertson 1983; Shantz and

Piemeisel 1940), and most grass roots would not extend below 7 feet (Elmore et al. 2006). The water table in the upland areas within the study area is greater than 50 feet below the soil surface, and therefore, these upland plants would not be affected by the lowering of the water table.

3.8.2.2 Mud Springs Road Transmission Line Alternative

Surface Disturbance

Effects to vegetation as a result of the implementation of this alternative would be the same as described for the Proposed Action except 9.5 (North Option) and 15.2 (South Option) fewer acres of sagebrush shrubland would be disturbed as a result of transmission line construction and operation for North and South options, respectively.

Water Management Activities

Effects to vegetation as a result of water management activities would be the same as described for the Proposed Action.

3.8.2.3 Mud Springs Waste Rock Storage Facility Alternative

Surface Disturbance

Impacts to vegetation would be the same as described for the Proposed Action except for an additional 18.9 acres of new disturbance to grassland would occur as a result of construction of the Mud Springs WRSF and relocation of a short segment of the Mud Springs Road. Approximately 30 percent of the 18.9 acres of grassland disturbance occurs in previously burned (2005) areas.

Water Management Activities

Effects to vegetation as a result of water management activities would be the same as described for the Proposed Action.

3.8.2.4 Backfill Alternative

Surface Disturbance

Impacts to vegetation would be the same as described for the Proposed Action except for an additional 10.6 acres of grassland vegetation would be removed for access road upgrades and truck turnouts for backfilling of the two escape raises and HPS. After backfilling and successful reclamation in 3 to 15 years, the disturbed area would return to productive use habitat and range for livestock grazing.

Water Management Activities

Effects to vegetation as a result of water management activities would be the same as described for the Proposed Action.

3.8.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed and the related potential impacts to vegetation resources would not occur. The existing Hollister exploration activities would continue under current permits and authorizations and reclamation activities would be completed as described in the existing Reclamation Plan. Upon successful revegetation of the disturbed areas in 3 to 15 years following cessation of mining and reclamation, the land would return to productive rangeland and habitat.

3.8.3 Cumulative Impacts

The primary past, present, and RFFA that affect vegetation in the CESA include wildfires, grazing, mining and exploration activities. The CESA for vegetation resources is shown in **Figure 3.8-2**. This figure illustrates vegetation types within the Squaw Valley, Tuscarora, and Twenty-Five grazing allotments, which include 883,924 acres of rangeland. Additional vegetation types occur in the CESA but do not occur in the study area; they include salt-desert shrubland, greasewood shrubland, bud sagebrush shrubland, mountain big sagebrush shrubland, and wet meadow. The past, present, and RFFA's are summarized in Section 3.2. **Table 3.2-1** presents surface disturbance acreages in the Carlin Trend due to mining and mineral exploration. **Figure 3.2-1** illustrates mining and mineral exploration projects and disturbance in the Carlin Trend. **Figure 3.2-2** illustrates other features such as the Ruby Pipeline and transmission lines.

Wildfires over the years have disturbed vegetation in the CESA. Approximately 622,868 acres of land has been burned by wildfires in the CESA between 1980 and 2011 (**Figure 3.8-3**).

Past and present actions and RFFAs within the CESA have resulted, or would result, in approximately 8,528 acres of disturbance to vegetation from mining, mineral exploration, and pipeline construction projects in the Carlin Trend north of I-80 and within the vegetation resources CESA (**Table 3.2-1**). The proposed project incrementally would increase disturbance to vegetation by an additional 117 acres (less than 1 percent of the CESA, which is 883,924 acres) resulting in a total cumulative disturbance of approximately 8,645 acres (less than 1 percent of the CESA). Portions of past mine and mineral exploration disturbances in the CESA have been reclaimed, and ongoing reclamation at existing operations would continue to reduce the impacts to vegetation. Pending completion of successful reclamation, the incremental additional impacts to vegetation as a result of the proposed project would be temporary in nature for the majority of the project disturbance area, and the loss of mature shrubs would be minimal relative to the total acreage of woody species communities that occur in the CESA. The removal of shrubs from these areas would result in a long-term change in vegetative structure since it could take up to 25 years for shrub species, of similar stature to become re-established in these areas. However, the desirable plant community consists of a mosaic vegetation pattern with the various stages of plant growth or life ranging from early serial to late serial or mature plants.

Grasses with low densities of native forbs and shrubs would likely be the dominant vegetation on reclaimed areas. Typically, communities of big sagebrush, the most extensive pre-mining plant community, have proven difficult to re-establish on reclaimed land when the soil composition lacks the chemicals in the soil required by sagebrush (BLM 2010d). When the soil composition contains the chemicals in the soil that sagebrush requires to live and grow, sagebrush establishes within the first three growing seasons.

Post-mining vegetation may have lower densities of sagebrush and other shrubs than pre-mining vegetation. However, it is likely that stable, self-sustaining plant communities would develop on reclaimed land. BLM (2010d) reports that there is no area in the state where perennial native species have not been re-established after mining, at a cover and density equal to or greater than that of undisturbed areas.

Previously disturbed land has been reclaimed with a seed mix consisting of native grasses, forbs and shrubs. Currently, these reclaimed areas maintain a diverse well vegetated plant community that is self-sustaining and resistant to erosion. The dominant plants within these reclaimed areas are basin wildrye, bluebunch wheatgrass, black sagebrush (*Artemisia nova)*, Wyoming big sagebrush, and cheatgrass (*Bromus tectorum*) (Cedar Creek Associates 2003).

Reseeding would improve vegetation structure and composition in burned areas and benefit wildlife by providing forage, cover, and nesting habitat. Large areas affected by fire may take years to successfully re-establish native vegetation due to the influx on nitrogen and changes in soil

composition. Completed and planned sagebrush and forage planting in burned areas, once established, would benefit a diversity of wildlife species including mule deer, pronghorn, sage grouse, and pygmy rabbit by providing forage, cover, and breeding habitat.

Wildfires are a major contributing factor in the replacement of shrub communities by grass-dominated communities, often with a high cheatgrass component due to the influx on nitrogen to the soil. Cheatgrass is a nitrogen-dependent plant species. Locally and regionally, wildfires have reduced the density of shrubs and trees. Many of the woody species in the area are slow growing, requiring up to 15 to 25 years to re-establish. The cumulative effect of fires within the CESA is more pronounced because of the increased size and intensity of recent wildfires. The general effect in some areas of recent fires has been conversion of primarily sagebrush habitat to expanses of cheatgrass, which form a persistent, non-native, monoculture that tends to dominate burned areas. The continued establishment of cheatgrass would increase the likelihood of wildfire, and could change the fire regime, community composition, and structure of plant communities indefinitely.

Livestock grazing has and would continue to influence vegetation composition and structure throughout the CESA. Potential for overgrazing may increase as land is converted to mining and transportation uses or temporarily lost to wildfire; however, adjustment of stocking rates to account for changes in land use ensures vegetation communities are not overgrazed. Within the CESA, reductions in permitted grazing use has and would continue to occur as a result of mine development and wildfires; however, these impacts would be short term as subsequent reclamation of mined areas and restoration of burned sites would allow for stocking rates to return to near pre-mining/pre-burn levels.

Because water management-related impacts to upland vegetation would not occur under the Proposed Action, no cumulative impacts to upland vegetation associated with water management activities, are anticipated. Section 3.9.3 describes potential cumulative impacts to riparian and wetland areas as a result of water management activities.

3.8.4 Potential Monitoring and Mitigation Measures

VR-1

Rodeo Creek Gold Inc (RCG) would revegetate disturbed areas in accordance with their Reclamation Plan. Revegetation monitoring also is described in the Reclamation Plan and would focus on measuring reclamation success on an annual basis for a period of 3 or more years after reclamation. RCG would monitor basal and foliar cover of reclaimed vegetation and provide annual monitoring reports to the BLM for review and assessment of reclamation success. RCG also would monitor the presence and absence of noxious weeds and non-native invasive plant species as an indicator of reclamation success. Weed infestations would be monitored and controlled as part of RCG's Noxious Weed Prevention and Control Plan (RCG 2011a), Reclamation Plan, and BLM and Nevada Division of Environmental Protection regulations. If monitoring indicates that reclamation has not yet been successful, RCG would re-seed the affected area with a BLM-approved mixture.

3.8.5 Residual Impacts

Impacts to vegetation under the Proposed Action would be temporary until successful revegetation is achieved. There would be no residual impacts to vegetation.

3.9 Riparian and Wetland Areas

The study area for direct, indirect, and cumulative impacts for riparian and wetland areas is based on the projected maximum extent of the 10-foot groundwater drawdown contour (**Figure 3.9-1**), which has a radius of 7.9 miles from the center of the core project area and encompasses 127,275 acres. It is defined as the area of maximum extent of the 10-foot groundwater drawdown contour, as simulated by the groundwater model (Brown and Caldwell 2010a), and as described in Section 3.5, Groundwater Resources and Geochemistry. The maximum extent of the 10-foot groundwater drawdown contour encompasses the riparian and wetland areas that are potentially impacted by the Proposed Action. The proposed project would result in approximately 117 acres of surface disturbance in addition to the approximately 105 acres of existing authorized disturbance for a total disturbance of approximately 222 acres.

3.9.1 Affected Environment

Riparian habitat includes areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant species relative to nearby uplands while wetlands are characterized as areas of low-lying land that are submerged or periodically inundated with water (Lincoln et al. 1990).

As described in Section 3.6, Surface Water Resources and Watersheds, the United States Army Corps of Engineers (USACE) formally determined that Little Antelope Creek and tributary features in the project area are jurisdictional waters of the U.S. (USACE 2004). That determination was valid through April 2009, and no modifications to that jurisdictional status have been made. According to earlier field surveys in the project area, 2.43 acres of waters of the U.S. and 1.01 acres of wetlands occur along Little Antelope Creek, (JBR Environmental Consultants, Inc. [JBR] 2003a). An additional 0.87 acre of hydrophytic vegetation occurred along Little Antelope Creek at the time of the 2003 survey. It is assumed that the USACE maintains jurisdiction over the previously delineated and confirmed waters of the U.S. and wetlands.

Riparian and wetland areas in the region are characterized as Great Basin foothill and lower montane riparian woodland and shrubland, North American arid west emergent marsh, and open water habitats (U.S. Department of Agriculture-Natural Resources Conservation Service 2010; U.S. Geological Survey 2004). **Figure 3.9-1** illustrates riparian and wetland areas that occur in the study area (i.e., maximum extent of the 10-foot groundwater drawdown contour). Riparian and wetland areas within the study area were delineated based on field surveys, review of National Wetland Inventory maps, and review of May 2006 aerial photography (AECOM 2010a; Bureau of Land Management [BLM] 2011b; JBR 2007, 2003a). **Table 3.9-1** provides a general summary of riparian and wetland areas that occur in the study area and cumulative effects study area (CESA).

Table 3.9-1 Riparian and Wetland Areas that Occur in the Study Area/CESA

Riparian or Wetland Areas	Study Area	
	Number	Acres
Riparian Areas	19	560
Wetland Areas	205	408
Total	**224**	**968**

Sources: AECOM 2010a; BLM 2011b; JBR 2007, 2003a.

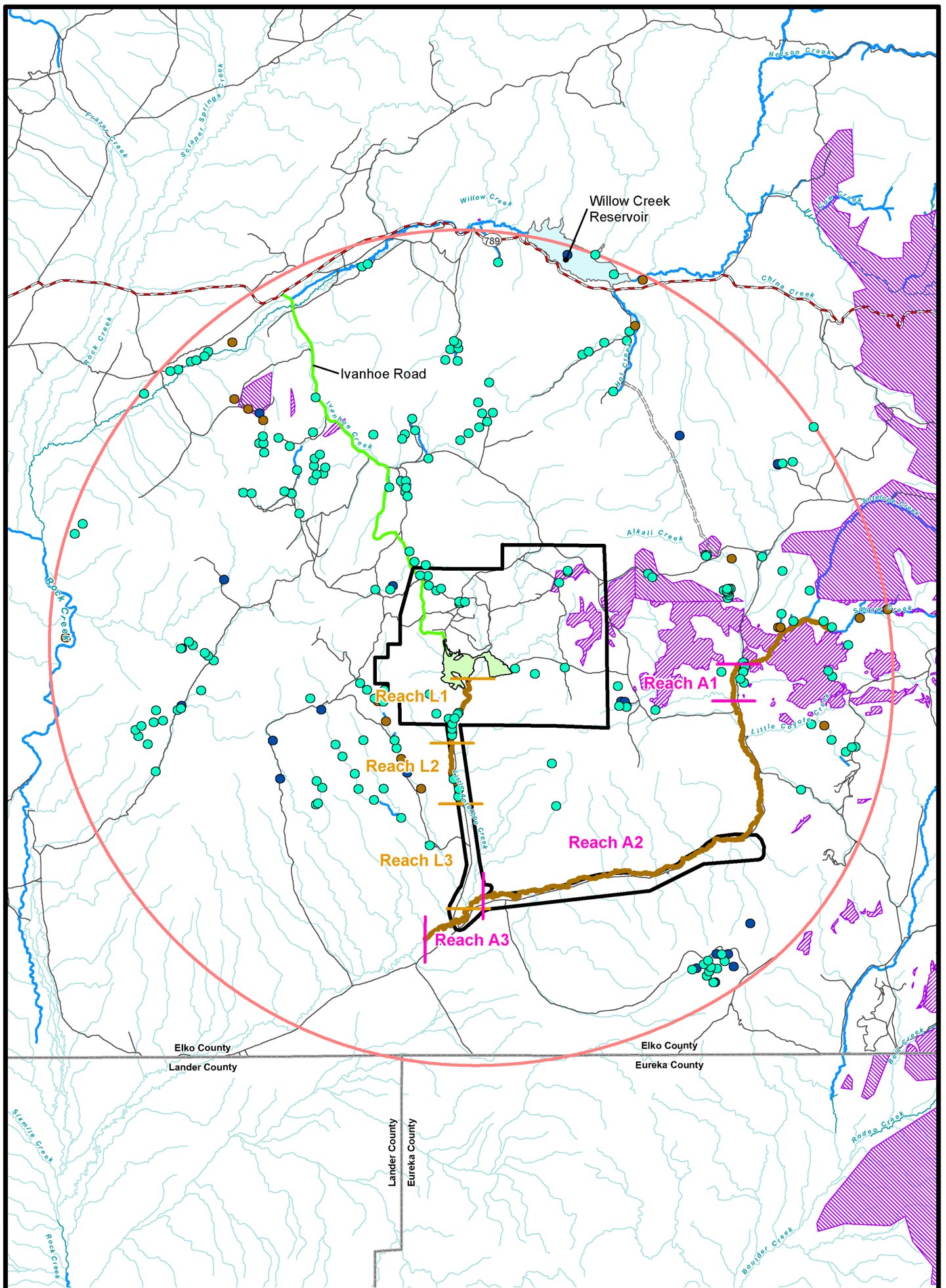
Riparian areas within the study area are associated with Antelope Creek, Little Antelope Creek, Squaw Creek, Willow Creek, and other creeks as tributaries to Rock Creek (**Figure 3.9-1**). Wetlands occur along Little Antelope, Antelope, Willow, and Squaw creeks. Flow occurrence within these creeks primarily is ephemeral (temporary) or intermittent and varies by reach. The source of hydrology supporting the wetlands and riparian areas appears to be derived from snowmelt runoff and groundwater discharge (JBR 2003a). Detailed information regarding streams, seeps, and springs is provided in Section 3.6, Surface Water Resources and Watersheds.

Several field surveys have been completed to identify riparian and wetland areas. In 2003, a delineation of jurisdictional waters (i.e., defined creek channels and wetlands) was completed within the former Hollister Development Block Project area. This survey covered approximately 50 percent of the northern portion of the project area including Little Antelope Creek (JBR 2003a). This survey identified nine wetlands along Little Antelope Creek totaling approximately 1.0 acre and another 0.8 acre of potential wetlands located outside of the survey area based on aerial photograph interpretation (**Figure 3.9-1**). Subsequent to the 2003 field survey, the riparian and wetland vegetation established along Little Antelope Creek was affected by a high flow event that occurred in the winter of 2005-2006. A review of 2006 aerial photography indicated that hydrophytic vegetation occurs along 1.7 miles of Little Antelope Creek in the drainage reaches downstream of the Hollister Site. The majority of this hydrophytic vegetation includes herbaceous species, but some sandbar willow also occurs in these areas. Scattered patches of hydrophytic vegetation also occur farther downstream (JBR 2008).

In 2007, a baseline field survey was conducted in the Rapid Infiltration Basin (RIB) expansion area (i.e., existing East RIB and pipeline) to identify jurisdictional waters (JBR 2007). One wetland, totaling less than 0.1 acre, was observed along the pipeline route to the RIB in the lower portion of Little Antelope Creek. This wetland was not one of the nine wetlands that were previously identified during the 2003 field survey. In 2008, a baseline reconnaissance survey was completed along the proposed electric power transmission line (transmission line) alignments (i.e., proposed 120-kilovolt [kV] and 24.9-kV transmission lines) to identify vegetation (including riparian and wetland areas), potential habitat for special status species, and noxious weed populations.

Dominant riparian and/or wetland species that were observed during these field surveys included sandbar willow (*Salix exigua*), yellow willow (*Salix eriocephala*), curly dock (*Rumex crispus*), Baltic rush (*Juncus balticus*), annual rabbit's-foot grass (*Polypogon monspeliensis*), and meadow barley (*Hordeum brachyantherum*).

In July 2011, BLM staff completed a field review to identify riparian areas along Little Antelope and Antelope creeks (BLM 2011b). Riparian vegetation was observed along Reaches L1 and L2 of Little Antelope Creek, and Reaches A1 through A3 of Antelope Creek (**Figure 3.9-1**). Dominant species observed along Reach L1 of Little Antelope Creek included coyote willow, Baltic rush, and a variety of riparian grass and forb species. Reach L2 of Little Antelope Creek supported dense stands of coyote willow. Reach A1 of Antelope Creek consisted of a series of springs that supported riparian species. Dominant species observed along Reach A2 of Antelope Creek included coyote willow, American bulrush (*Scirpus americanus*), and Nebraska sedge (*Carex nebrascensis*). Reach A3 of Antelope Creek supported a well developed riparian corridor primarily consisting of coyote willow and other riparian species. In addition to these stream reaches, a riparian area was identified along 2 miles of Antelope Creek upstream of Reach A1 to the confluence with Squaw Creek, which was based on the perennial nature of this segment of Antelope Creek, as described in Section 3.6, Surface Water Resources and Watersheds, and review of 2006 aerial photography. Based on field observations made during the July field survey and review of 2006 aerial photography, riparian areas along these reaches of Little Antelope and Antelope creeks had an average width of approximately 15 feet.



Legend

- Project Area Boundary
- Mining Disturbance
- State Highway
- Rural Road
- Vehicular Trail (4WD)
- Ivanhoe Road
- Maximum Extent of the 10-foot Groundwater Drawdown Contour and Cumulative Effects Study Area

Wetland/Riparian Features (AECOM 2010a; BLM 2011b, 2004a; JBR 2010, 2007, 2003a).

- Open Water
- Riparian Area
- Wetland
- Riparian Area (15 feet wide based on Google Earth 2006 aerial imagery)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Stream Features

- Perennial Stream Reach
- Intermittent Stream

N

0 1 2 Miles

Riparian and Wetland Areas in the Study Area/Cumulative Effects Study Area

Figure 3.9-1

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3.9-3

3/26/2012

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Based on information provided in various reports and the review of 2006 aerial photography, approximately 19 riparian areas (560 acres) and 205 wetland areas (408 acres) occur within the study area (**Table 3.9-1**). The majority of the riparian areas are associated with Antelope and Little Antelope creeks. The majority of wetland areas are associated with springs (**Figure 3.9-1**).

3.9.2 Environmental Consequences

3.9.2.1 Proposed Action

Surface Disturbance

Construction of the proposed project would not remove or disturb riparian or wetland areas. The proposed project facilities would be constructed in upland areas, of which a portion of these areas previously have been disturbed by mining activities. The proposed 24.9-kV transmission line would be constructed in upland areas east and west of Little Antelope Creek. The proposed 24.9-kV transmission line would cross Little Antelope Creek at two locations and Antelope Creek at one location in the southern portion of the alignment. Based on the proposed alignment, riparian or wetland areas that are known to occur along Little Antelope and Antelope creeks would not be disturbed with the placement of the transmission line poles in upland areas or disturbance by construction equipment within the transmission line road. The proposed alignment for the 120-kV transmission line would cross Antelope Creek at one location and would cross several intermittent tributaries to Antelope Creek. Riparian areas along Antelope Creek would not be affected by construction activities because transmission line poles would be placed in upland areas, thereby avoiding impacts to riparian vegetation. Construction of the Rodeo Creek Substation would occur in an upland area approximately 0.1 mile north of Antelope Creek, thereby avoiding impacts to riparian areas associated with the creek.

Development of exploration sites and access roads would avoid disturbance to riparian or wetland areas in the exploration portion of the project area. Surface exploration activities, including drill site and road construction, could result in sediment and dust transport to nearby riparian and wetland resources.

Maintenance activities on Ivanhoe and Little Antelope Creek roads would not result in widening the existing roads; however, grading activities would result in loosening the road surface soils making them susceptible to erosion and transport to nearby drainages.

Indirect impacts to riparian and wetland areas as a result of soil erosion and sedimentation from mine facility construction, surface exploration, and road maintenance activities would be minimized with the implementation of erosion control measures, as described in Section 2.4.9, Applicant-committed Environmental Protection Measures.

Development of exploration sites and access roads would avoid disturbance to riparian or wetland areas in the exploration portion of the project area, thereby avoiding impacts to these features.

Water Management Activities

Continuous discharge of water into Little Antelope Creek temporarily (for the 20-year mine life) would enhance existing riparian areas in Reaches L1 (1.5 miles in length) and L2 (1.3 miles in length) and create a riparian area along Reach L3 (2.5 miles in length) downstream of the discharge point (**Figure 3.9-2**). Riparian areas along Reach A3 in Antelope Creek may be enhanced, and riparian vegetation could extend below Reach A3 as a result of continuous discharge of water to this stream reach. There is a low potential for riparian vegetation to become established along a segment of Little Antelope Creek extending from the proposed National Pollutant Discharge Elimination System discharge point to Reach L1 due to rocky substrate within the creek bed. After water discharge has ended, riparian vegetation established along Reach L3 and below Reach A3 may take 3 to 5 years to transition back to upland vegetation.

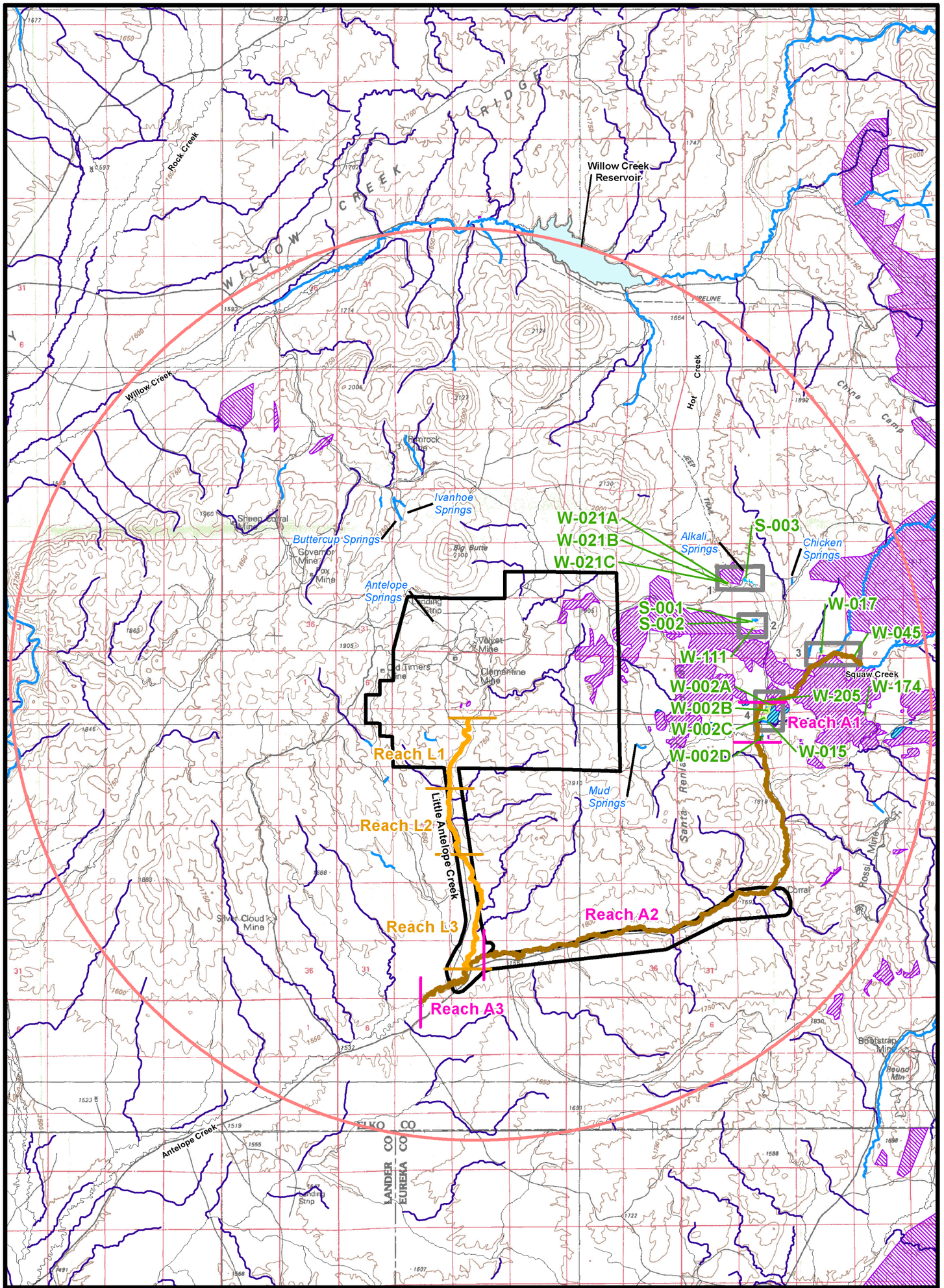
As discussed in Section 3.6, Surface Water Resources and Watersheds, groundwater drawdown within the predicted mine-related maximum extent of the 10-foot groundwater drawdown contour potentially may affect some seeps and springs. **Figures 3.9-2** and **3.9-3** illustrates springs and spring complexes that may be affected by groundwater drawdown. Reduced flows may result in the partial loss of herbaceous riparian and wetland vegetation; cessation of flows would result in the long-term loss of woody and herbaceous riparian and wetland vegetation. **Figure 3.9-2** illustrates riparian and wetland areas potentially affected by groundwater drawdown or water discharge. As provided in **Table 3.9-2**, approximately 12 acres of wetland vegetation that occurs within the maximum extent of the 10-foot groundwater drawdown contour may be impacted from groundwater drawdown. **Table 3.9-2** lists the wetland areas and associated springs that have potential to be affected by groundwater drawdown, and estimated acreages of wetlands that may be affected by groundwater drawdown.

Table 3.9-2 Wetland Areas Potentially Affected by Groundwater Drawdown

Wetland Number	Associated Spring Identification Number or Name	Spring Complex	Potential to be Affected by Groundwater Drawdown[1]	Size of Wetland (acres)
W-205	1295CF	4	High	0.07
S-001	565	2	High	0.88
S-003	Alkali Springs	1	High	2.52
W-017	570, 1295D2	3	High	0.24
W-021A		1	High	0.08
W-021B		1	High	0.03
W-021C	1295C4	1	High	0.13
W-045	Sada 11	3	High	0.80
W-111	566, 1295D6	2	High	0.39
W-174		--	High	0.20
Subtotal				**5.34**
W-015	1295CA	4	Low	0.31
S-002	1295D5, 566	4	Low	0.03
W-002A	571, 1295CE	4	Low	0.94
W-002B	572, 573, 574, 1295CD, 1295CC, Sada 2, Sada 3, Sada 4, Sada 5, Sada 6, Sada 7, Sada 8	4	Low	2.71
W-002C	575, Sada 8, Sada 9, 1295CB	4	Low	0.70
W-002D		--	Low	1.95
Subtotal				**6.64**
Total Acres				**11.98**

[1] High or low potential to be affected by groundwater drawdown was determined according to **Table 3.6-7** information.

Sources: AECOM 2010a; BLM 2000b; JBR 2010; Sada 2007.



Legend

- Project Area Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Spring Complex Areas
- Stream (Intermittent or Ephemeral)
- Perennial Stream Reach

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Wetland and Spring

- Wetlands Potentially Affected by Groundwater Drawdown (AECOM 2010a; BLM 2011b; JBR 2010).
- Riparian Areas Potentially Affected by Groundwater Drawdown (BLM 2011b).
- Riparian Areas Created or Enhanced by NPDES Discharge (BLM 2011b).

N

0 1 2 Miles

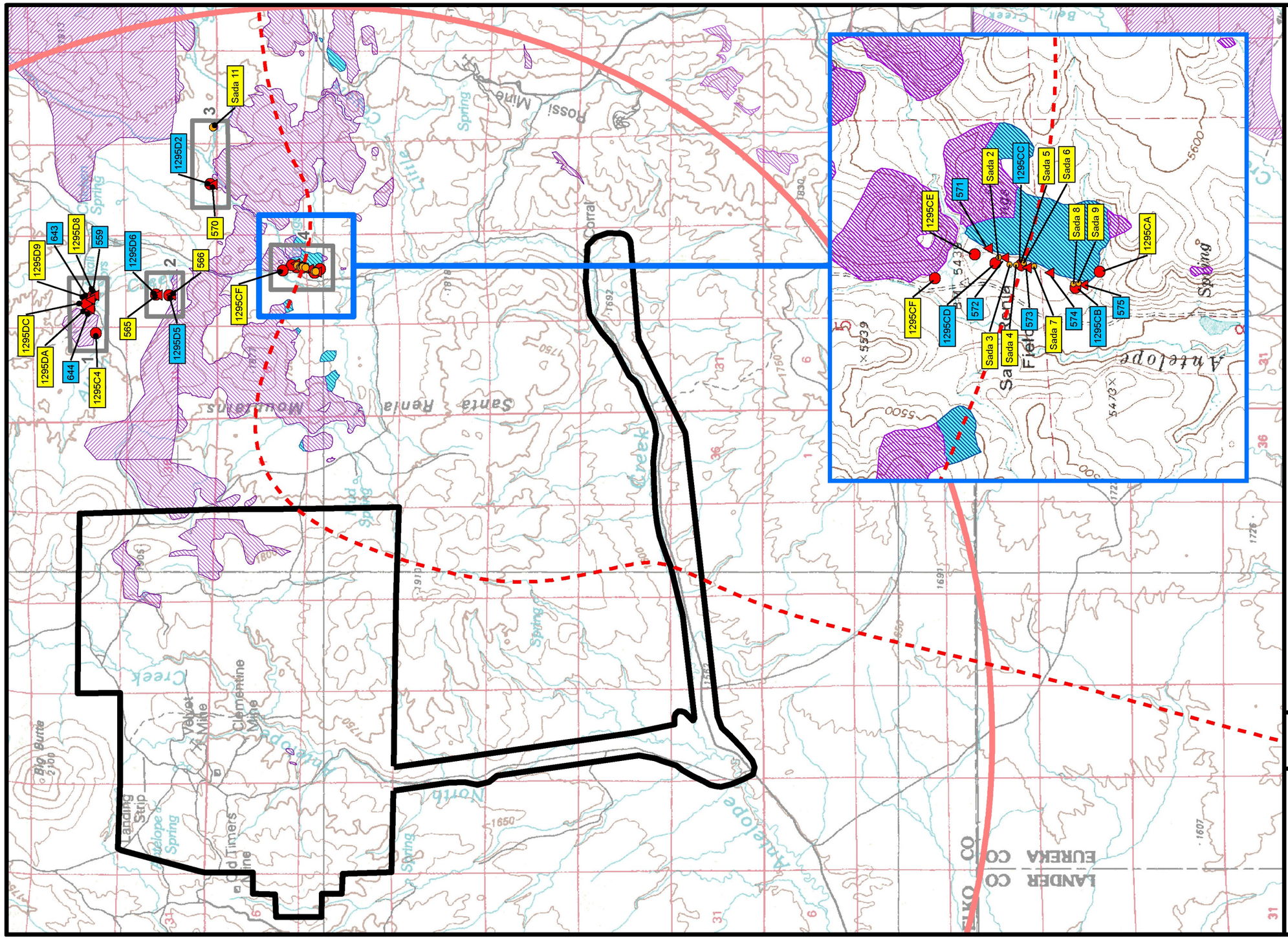
Sources: AECOM 2010a; BLM 2011b; JBR 2010; NBMG 2003; USGS 2005.

Hollister Underground Mine Project EIS

Figure 3.9-2

Riparian and Wetland Areas that are Potentially Impacted by Groundwater Drawdown or NPDES Discharge

3/23/2012



Legend

- Project Area Boundary
- Spring Complex
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Maximum Extent of the Barrick 10-foot Drawdown Contour, Betze Pit SEIS 2007 Model

Seeps/Springs

- Springs (BLM 2006)
- Seeps/Springs (BLM 2000b)
- Springs (Sada 2007)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Spring Labels

- 570 Spring Location
- 570 Probable Duplicated Spring

N

0 1 2 Miles

Sources: BLM 2006, 2000b; Sada 2007.

Hollister Underground Mine Project EIS

Figure 3.9-3

Springs and Spring Complexes Potentially Affected by Groundwater Drawdown and Barrick 2007 Model Drawdown Contour

3/23/2012

Based on the projected groundwater drawdown within and immediately adjacent to the Vinini Formation, it is anticipated that 10 wetland areas have high potential to be affected by groundwater drawdown in the long term and 6 wetland areas have low potential to be affected by groundwater drawdown in the long term. In addition, as described in Section 3.6, Surface Water Resources and Watersheds, reduced flows from springs contributing to Antelope, Alkali, and Squaw creeks may result in the long-term loss of some riparian vegetation. Groundwater flows to springs and seeps potentially impacted by this project are projected to recover in approximately 50 to 100 years following initial drawdown (Brown and Caldwell 2010a).

3.9.2.2 Mud Springs Road Transmission Line Alternative

Surface Disturbance

The proposed 24.9-kV transmission line (North Option), including the substation, would be constructed in upland areas. The 249.9-kV transmission line route would cross one wetland area (0.08 acre) that would be spanned by the transmission line or avoided by construction equipment, thereby avoiding impacts to this wetland.

The entire alignment of the proposed 24.9-kV transmission line (South Option), including the substation, would be constructed in upland areas. Therefore, impacts to riparian or wetland areas are not anticipated from transmission line or substation construction.

Water Management Activities

Impacts to riparian and wetland areas would be the same as those described for the Proposed Action.

3.9.2.3 Mud Springs Waste Rock Storage Facility Alternative

Surface Disturbance

Impacts to wetland and riparian areas would be the same as described for the Proposed Action. No additional wetlands or riparian areas would be impacted by the construction and use of the Mud Springs Waste Rock Storage Facility.

Water Management Activities

Impacts to riparian and wetland areas would be the same as those described for the Proposed Action.

3.9.2.4 Backfill Alternative

Surface Disturbance

Impacts to riparian and wetland areas from the implementation of this alternative would be the same as described for the Proposed Action.

Water Management Activities

Impacts to riparian and wetland areas would be the same as those described for the Proposed Action.

3.9.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed, and the related impacts to riparian and wetland areas would not occur. The existing Hollister exploration activities would continue under current permits and authorizations.

3.9.3 Cumulative Impacts

Past and present actions and reasonably foreseeable future actions are summarized in Section 3.2. **Figure 3.9-4** illustrates the CESA for riparian and wetland areas, which is the maximum extent of the

10-foot groundwater drawdown contour associated with the Proposed Action. This figure also illustrates the cumulative groundwater drawdown contour as illustrated in the Betze Pit Expansion Project Supplemental Environmental Impact Statement (BLM 2008b). Cumulative impacts to riparian and wetland areas would result from ongoing surface disturbance by mining, livestock grazing, and other land uses, mine groundwater pumping and the associated groundwater drawdown and groundwater pumping discharges. Groundwater drawdown associated with the Proposed Action may result in the loss of approximately 12 acres of wetland vegetation and some additional riparian vegetation along Antelope Creek from the potential loss or decrease in water flow from seeps and springs. The impacts from the proposed project would add to the existing and future riparian and wetland impacts within the CESA. Most of these cumulative impacts would result from mine development and water management activities, as well as from livestock grazing, roads, and other surface disturbance activities.

Cumulative groundwater drawdown occurs in the CESA from the ongoing Betze Mine operated by Barrick Goldstrike Mines Inc. (**Figures 3.9-3** and **3.9-4**). In combination with direct drawdown impacts that are anticipated to occur as a result of the proposed Hollister groundwater pumping, regional groundwater levels would undergo additive declines. This would create cumulative impacts in the form of reduced flows from springs, seeps, and groundwater contributions to streamflows and would directly affect riparian and wetland areas.

In particular, **Figure 3.9-4** shows a small overlap between the Hollister maximum extent of the 10-foot groundwater drawdown contour and the Betze maximum extent of the 10-foot groundwater drawdown contour, although each drawdown occurs in a separate and unconnected aquifer. The proposed Hollister project's predicted impacts to wetland and riparian areas would add to the number of such features impacted from drawdown generated by Barrick or Newmont and thus would be an overall cumulative impact. Because each wetland and riparian area is fed by springs from a particular aquifer, cumulative impacts on any particular wetland and riparian area are not anticipated. The riparian and wetland areas that would be impacted, and therefore add to the number of such features cumulatively impacted in the region, are depicted in **Figure 3.9-2** and listed in **Table 3.9-2**.

Other potential sources of cumulative impacts to riparian and wetland areas in the CESA would include existing land uses such as mining disturbance, grazing, and road construction and maintenance. Mine development, road construction, and maintenance activities have resulted in direct impacts to riparian and wetland areas by removing or filling these areas. Grazing has been the major land use in the CESA and is expected to continue to be so in the future. Livestock can impact wetland and riparian areas through trampling and shearing of streambanks, compaction of wetland soils, trampling of plants, and overuse of riparian plant species. Riparian and wetland areas that have been overgrazed are susceptible to invasion by noxious weeds and non-native invasive plant species, which can displace riparian and wetland species over time.

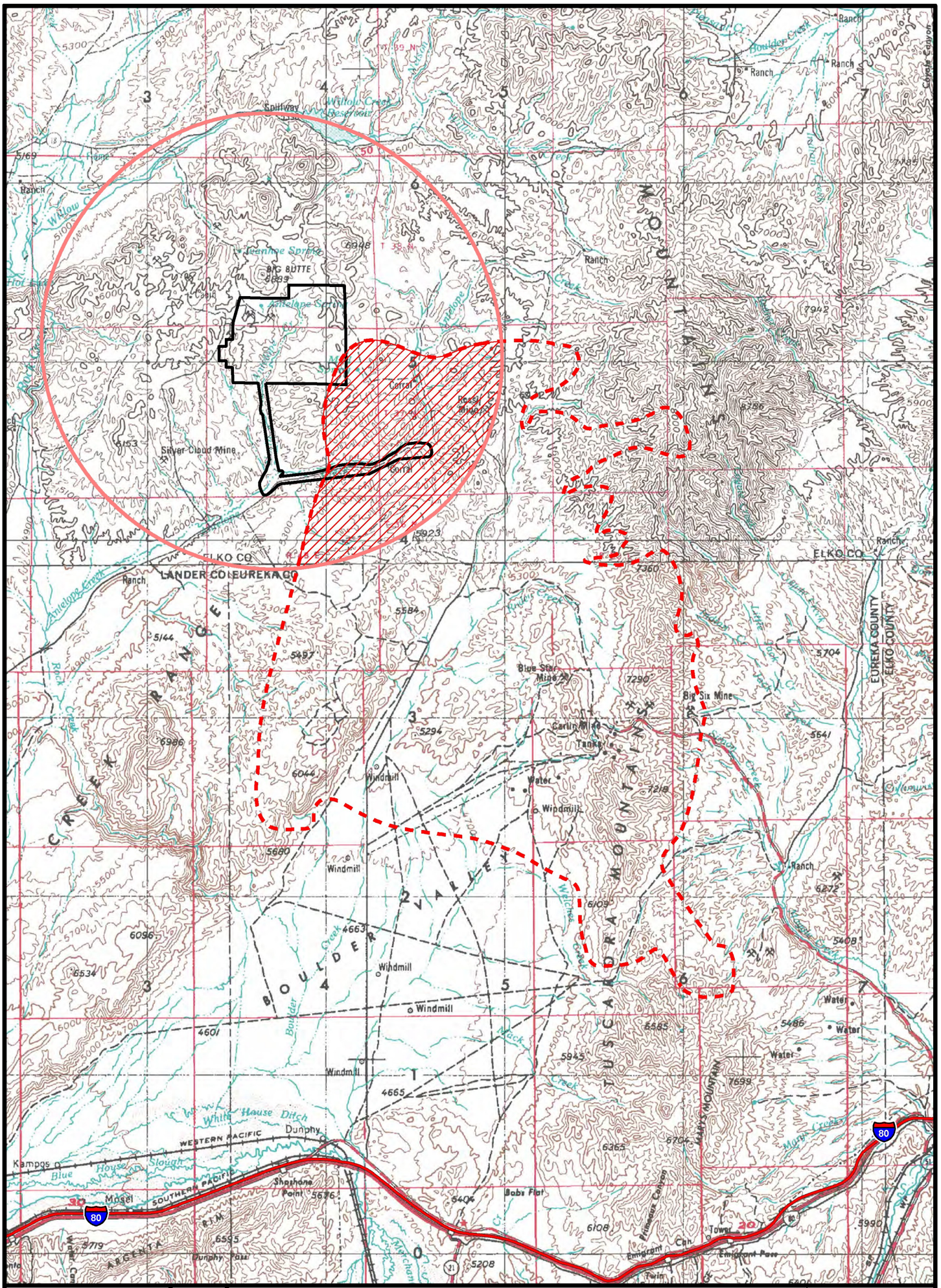
3.9.4 Potential Monitoring and Mitigation Measures

Because 12 acres of wetland vegetation and some riparian vegetation along Antelope Creek may potentially be impacted by groundwater pumping from the proposed project, additional monitoring and mitigation measures are recommended.

The following mitigation measures would be implemented to minimize impacts to riparian and wetland areas.

RW-1

Issue: Potential impacts to spring complexes and associated riparian and wetland vegetation within the maximum extent of the 10-foot groundwater drawdown contour.


Legend
Project Area Boundary
Maximum Extent of Barrick 10-foot Drawdown Contour, Betze Pit SEIS 2007 Model
Maximum Extent of the 10-foot Groundwater Drawdown Contour, Hollister 2010 Model (Study Area and CESA)
Area of Potential Cumulative Impacts from Groundwater Drawdown
Humboldt
Elko
Washoe
Pershing
Lander
Eureka
White Pine
Lyon
Churchill
Nye
Mineral
Lincoln
Esmerelda
Clark
N
0
2
4
Miles
Sources: BLM 2008b; Brown and Caldwell 2010a.
Hollister Underground Mine
Riparian and Wetland Areas Cumulative Effects Study Area
Figure 3.9-4
3.9-10
3/7/2012

Monitoring/Mitigation Measure: Rodeo Creek Gold Inc (RCG) would establish a riparian trust fund for the 12 acres of wetland and riparian habitat potentially impacted by the proposed project. The funds would be placed into an interest bearing account to mitigate for the potential loss of wetland/riparian habitat on the Twenty-Five Allotment due to potential groundwater drawdown. The account would be used to improve wetland and riparian habitat on public and/or private lands within the Twenty-Five Allotment. Such restoration projects would be contingent upon agreement with the private land owner(s).

Effectiveness: The establishment and implementation of a riparian trust fund would provide funding for riparian and wetland habitat improvement to offset potential loss of 12 acres of wetland habitat.

RW-2

Issue: Control of livestock use along Little Antelope Creek for the purpose of mitigating potential surface water and groundwater impacts and allowing for increased growth and establishment of riparian and wetland vegetation resulting from discharge into Little Antelope Creek.

Monitoring/Mitigation Measure: RCG would repair and maintain the exclosures (two adjacent to each other) along Little Antelope Creek for the life of the project. RCG would install one cattleguard on the lower end of the existing exclosure on Little Antelope Creek. RCG would maintain the four cattleguards along the Little Antelope Creek Road. Evaluation of the two exclosures may warrant adjustments to the fencing creating one exclosure instead of two, and changes to the fence line to incorporate the springs into the exclosure. This measure would include the signing of a cooperative agreement for materials, labor, and maintenance with the BLM Elko District.

Effectiveness: This measure would enhance and protect riparian vegetation by excluding cattle grazing from this segment of Little Antelope Creek. This measure would help offset the loss of riparian and wetland areas and enhance water quality by filtering potential runoff from the project area.

RW-3

Issue: Potential impacts to riparian and wetland plant communities from project-related groundwater drawdown, which may include increases in noxious weeds and non-native invasive plant species.

Monitoring/Mitigation Measure: If groundwater drawdown results in reduction of riparian and wetland communities within the maximum extent of the 10-foot groundwater drawdown contour, RCG may take commercially reasonable efforts to come to an agreement with the landowner to allow RCG to control noxious weed infestations in such areas. RCG would not be required to provide any consideration to the landowner in exchange for access, other than performing or paying for such weed control.

Effectiveness: Implementation of noxious weed control measures would enhance riparian habitat along Antelope Creek and minimize the potential spread of noxious weeds and non-native invasive plant species to help offset the loss of riparian and wetland areas.

3.9.5 Residual Impacts

The potential long-term loss of approximately 12 acres of wetland habitat and some additional riparian habitat within the study area would be a residual effect. However, the implementation of the mitigation measures would offset anticipated effects to riparian and wetland areas within the study area.

3.10 Noxious Weeds and Non-native Invasive Plant Species

The noxious weeds and non-native invasive plant species study area for direct and indirect impacts is the project area, the Ivanhoe Road extending from the mine site to its juncture with Midas-Tuscarora Road, and seeps and springs within the maximum extent of the 10-foot groundwater drawdown contour (**Figures 3.10-1** and **3.6-1**). The cumulative effects study area (CESA) for noxious weeds and non-native invasive plant species includes the Carlin Trend area because surface disturbance associated with numerous mining projects have occurred or would occur in the area thereby increasing the potential for establishment of noxious weeds and non-native invasive plant species (**Figure 3.10-2**). Additionally, the decrease or cessation of flow in seeps and springs in the Carlin Trend due to mining projects would over the long term result in a decrease or loss of wetland vegetation. This would provide an opportunity for noxious weeds and non-native invasive plant species to become established because they readily invade areas supporting sparse or no vegetation. Excessive water also may provide habitat for noxious weeds and non-native invasive plant species to become established. Definitions of terms and a brief listing of applicable regulations governing noxious weeds and non-native invasive plant species are provided in the following section.

3.10.1 Affected Environment

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

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

Noxious weeds and non-native invasive plant species have the ability to readily establish and spread rapidly, particularly in disturbed areas, and may cause damage to agriculture, range resources, riparian and wildlife habitat, and forestry, as well as increase fire susceptibility. Noxious weeds and non-native invasive plant species may spread either by seed, root, or plant parts. Plant growth stimulation varies per species and may be caused by various means such as fire, ground disturbance, cutting off plants, and using the wrong chemicals to spray the plant. They are spread by a variety of means including vehicles, construction equipment, construction and reclamation materials, livestock, wildlife and wind. Vehicle traffic is a major contributor to weeds invading a new area because seeds and plant parts can become embedded in tire treads and any mud carried on a vehicle from an infested area. Weeds would then establish themselves most easily along roadways.

Seeds and plant parts can get caught in construction equipment or imbedded in soil and dust that collects on construction equipment. After the construction equipment has been transported to another site, the weed seeds and plant parts can be washed off the equipment as a result of precipitation

events, which results in the spread of noxious weeds and non-native invasive plant species into new areas. Construction materials (e.g., gravel and soil) and reclamation materials (e.g., mulch and plant seed) can be contaminated with noxious weeds and non-native invasive plant species, which can be transported and used at a new site, causing contamination and establishment of new weed infestations. Road maintenance activities, such as grading and adding gravel to roads, also is a means of spreading noxious weeds and non-native invasive plant species to roadside shoulders and ditches. Animals also can spread seeds and plant parts that attach to their hair or fur and get caught in their hooves.

A list of the noxious weed species designated by the state and BLM Elko District Office is provided in **Table 3.10-1**. Under NRS 555.010-555.220, noxious weeds are classified into three categories: A, B, and C. Each category has specific control requirements, with the most stringent requirements for those species found in Category A.

Category A includes noxious weeds, which are:

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

Category B includes noxious weed species, which are:

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

Category C includes noxious weeds, which are:

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

Baseline vegetation studies, which included field assessments and subsequent documentation of noxious weeds and non-native invasive plant species occurrences, were conducted within the project area in 2004, 2007, 2008, and 2010 (AECOM 2010b; JBR Environmental Consultants, Inc. 2008, 2007, 2004b). Noxious weeds and non-native invasive plant species found on site during those surveys include low whitetop (*Cardaria draba*) in 2007 and 2008; Canada thistle (*Cirsium arvense*) in 2008; and Scotch thistle (*Onopordum acanthium*) and black henbane (*Hyoscyamus niger*) in 2010 (**Figure 3.10-1**). Canada thistle was found in the Hollister Site, usually associated with water or moist areas. Scotch thistle was found along Little Antelope Creek and Mud Springs roads, likely brought in on vehicles visiting the Hollister Site or passing through. Black henbane was found along the Ivanhoe and Midas-Tuscarora roads. Hoary cress or low whitetop is located along roads that provide access to the project area. These roads (Izzenhood, Antelope Creek, Silver Cloud, Mud Springs, and Tuscarora-Midas) are frequently used as travel routes, which provides the potential for these species to spread to the project area. In 2007, hoary cress infestations were found along these roads (BLM 2011c).

Midas-Tuscarora Road

Ivanhoe Road

Proposed Mine Office Complex

Proposed NPDES Surface Discharge

West Pit

Proposed HPS

East Pit Facilities

Mud Springs Road

Coyote Creek Substation

Little Antelope Creek Road and Buried RIB Pipeline

Proposed 24.9-kV Transmission Line

West RIBs (2) and Growth Media Stockpiles

East RIB

Antelope Creek Road

Proposed Rodeo Creek Substation

Proposed 120-kV Transmission Line

T 38 NR 47 E

T 37 NR 47 E

T38N, R48E T38N, R49E

T37N, R48E T37N, R49E

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline

Noxious and Invasive Weeds

- Study Area
- Scotch thistle
- Black henbane
- Canada thistle

Source: AECOM 2010b.

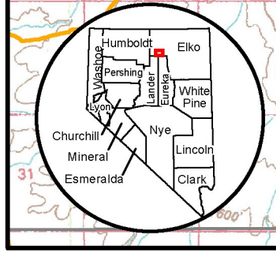
N

0 1 2 Miles

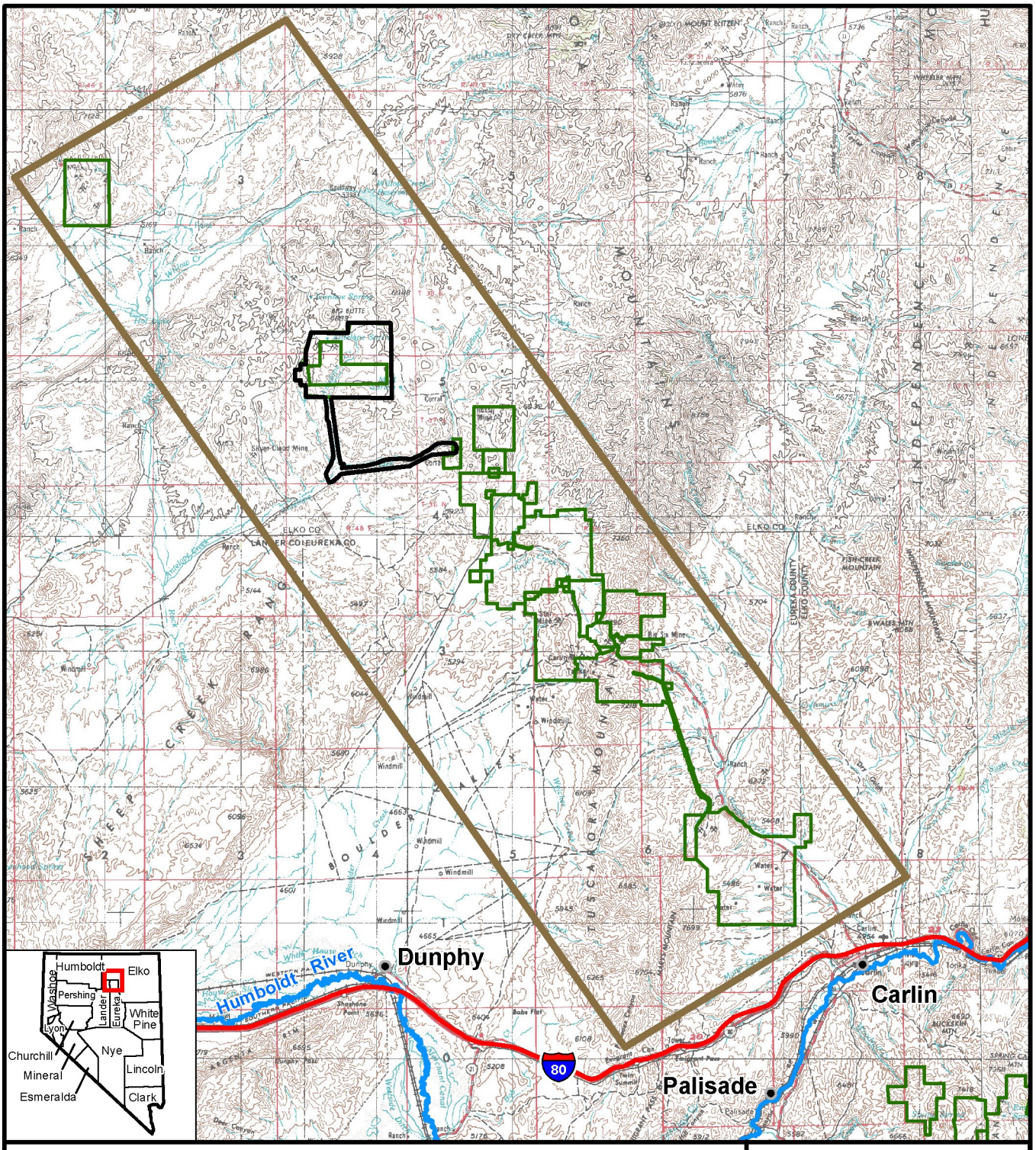
Hollister Underground Mine Project EIS

Figure 3.10-1

Documented Noxious Weeds Located in the Study Area



3/2/2012



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Other Mine Plan Boundaries

N

0 2.5 5 7.5 10 Miles

Source: BLM 2009b.

Hollister Underground Mine Project EIS

Figure 3.10-2

Noxious Weeds and Non-native Invasive Species Cumulative Effects Study Area

1/19/2012

Table 3.10-1 Designated Noxious Weed Species Potentially Occurring within Elko County, Nevada

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

Table 3.10-1 Designated Noxious Weed Species Potentially Occurring within Elko County, Nevada

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

[1] No additional noxious weeds or non-native invasive plant species were identified for additions to this list by Elko County. Elko County manages for the species listed by the State of Nevada in their jurisdiction.

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

Cheatgrass (*Bromus tectorum*) is a non-native invasive grass species that is prevalent in burned and disturbed areas. It is a minor component of the adjacent undisturbed plant communities. Cheatgrass is a concern within the understory of the sagebrush scrub community as cheatgrass provides very little habitat for threatened and sensitive species such as the greater sage-grouse and the pygmy rabbit that rely upon sagebrush vegetation for food and shelter. Cheatgrass also is able to alter the natural fire regimes of the sagebrush community. The dry, dead cheatgrass stems produce a continuous layer of fuel to carry sagebrush fires. Cheatgrass has increased in the vegetation understory in the vicinity of the project area as a result of the 2001 Hot Lakes Fire, 2005 Esmeralda Fire, and 2006 North Antelope and Sheep fires.

3.10.2 Environmental Consequences

Primary issues associated with the Proposed Action related to noxious weeds and non-native invasive plant species include direct and indirect impacts. Direct impacts associated with the introduction or spread of noxious weeds and non-native invasive plant species includes the establishment of infestation areas and the loss or degradation of native vegetation communities.

Potential indirect impacts associated with noxious weeds and non-native invasive plant species infestations may include loss of wildlife habitat and loss of rangeland for grazing due to the diminished native vegetation communities, soil erosion due to shorter-lived annual species invasions, and consequent increased fire susceptibility due to dry dead stands of annual non-native invasive plant species (e.g., cheatgrass stands). Left untreated, infestations of noxious weeds or non-native invasive plant species sites would increase, eventually eliminating the native vegetation and replacing the plant regime with an undesirable plant community. Weed infestations at the Hollister Site have been most commonly found along roads and waterways.

Direct impacts could occur in the project area where vehicle traffic is common as well as along the access roads, electric power transmission line (transmission line) corridor, and in the areas accessed for surface exploration. Indirect impacts such as soil erosion could occur on the site. However, the fence system surrounding the Hollister Site precludes its use by livestock. Therefore, the access road, waterways, and surface exploration areas are most susceptible to indirect impacts such as habitat degradation and fire susceptibility.

Vehicles and equipment transported to and working at the Hollister Site may bring in noxious weeds or non-native invasive plant species from other locations, causing new infestations to develop within the project area or along roadways unless washed prior to arriving at the Hollister Site. Gravel or soil brought into the project area from locations contaminated with noxious weeds or non-native invasive plant species for road maintenance and mine facility construction may transport weed seed or plant parts to the Hollister Site creating potential new infestations.

Indirect impacts from the Proposed Action may include vehicles and equipment leaving the Hollister Site that have worked in an area infested with noxious weeds or non-native invasive plant species. If not washed prior to leaving the Hollister Site, vehicles may transport and spread noxious weeds or non-native invasive plant species to other locations away from the project area. Animals in the area also could transport noxious weeds or non-native invasive plant species seed to the project area in their fur and hooves. Birds that have eaten seeds and wind dispersion are additional possible seed vectors.

3.10.2.1 Proposed Action

Surface Disturbance

Noxious weeds and non-native invasive plant species readily invade areas that have been subject to surface disturbance, which typically lack, or have minimal vegetative cover. Under the Proposed Action, mine development and operation would remove or disturb approximately 92 acres of vegetation in addition to the approximately 80 acres of previously authorized mining surface disturbance. A total of 34.7 of the 92 acres would be for construction of the transmission line. An additional 25 acres would be disturbed by exploration activities for a total of 50 acres of disturbance associated with surface exploration. Approximately 222 acres would be disturbed at the Hollister Site as a result of previous authorizations combined with the Proposed Action. All surface disturbance would be reclaimed.

The salvage of growth media and the application for growth media as part of the reclamation of surface disturbance areas may increase the potential for the establishment of noxious weeds and non-native invasive plant species if seeds are present in the growth media. Rodeo Creek Gold Inc (RCG) would expand surface exploration activities on the Hollister mining claims to further delineate known ore zones and to target potential mineralized resource areas. Surface exploration activities consist of surface geologic or geophysical surveys, frequent driving along access routes, drill site preparation, and drilling. These activities also could increase the spread of noxious weeds and non-native invasive plant species along access routes and drill sites.

Noxious weed invasion would potentially increase due to the road maintenance activities along Ivanhoe Road and Little Antelope Creek Road. Blading the Ivanhoe Road would potentially spread seeds and propagules along the road shoulder.

Transmission line construction activities also would potentially increase noxious weed invasion due to overland construction traffic and additional surface disturbance created by trucks and construction vehicles from off-site.

Implementation of RCG's Reclamation Plan (see Section 2.4.10, Reclamation and Site Closure) would reduce the potential for noxious weeds and non-native invasive plant species establishment in the study area. However, minor populations of noxious weeds or non-native invasive plant species (e.g., halogeton, cheatgrass) may become established in localized areas for short periods of time.

To stabilize the growth media, reduce soil erosion, and minimize the potential for the establishment of noxious weeds and non-native invasive plant species, growth media stockpiles would be reclaimed with an interim seed mix created from the plant list presented in Section 2.4.10.4, Seed Mixes. Successful reclamation of mine and mineral exploration disturbance areas (including pit backfill areas) would result in the establishment of a permanent vegetative cover, which would minimize the potential establishment of noxious weeds and non-native invasive plant species in the long term.

As described in the Reclamation Plan, certified weed-free seed mixes and mulches would be used for reclamation. If noxious weeds or non-native invasive plant species become established in project-related disturbance areas, a weed removal or spraying program would be implemented for at least a minimum of 3 years following reclamation. All chemicals used to treat weeds would be approved for use on public lands. As described in Section 2.4.10.5, Noxious Weed Management, and RCG's Noxious Weed Prevention and Control Plan (RCG 2011a) weed monitoring and control practices would be implemented during vegetation establishment to limit the growth and spread of noxious weeds or non-native invasive plant species and to facilitate successful revegetation with the proposed seed mixes. Weed control practices follow BLM and Nevada Division of Environmental Protection (NDEP) regulations and are already in place at the Hollister Site to control weed populations as they are located. The weed control program would continue to be implemented in coordination with the BLM to limit the spread and introduction of noxious weeds or non-native invasive plant species in the study area.

Water Management Activities

In the event of a continued decrease or cessation of flow in seeps and springs within the mine-related maximum extent of the 10-foot groundwater drawdown contour (**Figure 3.6-2**) and Vinini Formation, areas may increase in likelihood of potential establishment of noxious weeds and non-native invasive plant species known to invade riparian/wetland habitats (e.g., Scotch thistle, other thistles, and cheatgrass). The decrease or cessation of flow in seeps and springs over the long term would result in a decrease or loss of wetland vegetation, which would provide an opportunity for noxious weeds and non-native invasive plant species to become established because they readily invade areas supporting sparse or no vegetation.

With an increase in flow in Little Antelope and Antelope creeks, water-loving species such as tamarisk, Russian olive, and purple loosestrife have the potential to become established along the margins of the creeks. Tamarisk occurs in disturbed and undisturbed streams, waterways, bottomlands, banks and drainage washes of natural or artificial water bodies, moist rangelands and pastures, and other areas where seedlings can be exposed to extend periods of saturated soil for establishment (U.S. Forest Service 2006).

Various methods have been used to attempt to control existing stands of tamarisk along western rivers, including chemical, mechanical, and biological controls (U.S. Geological Survey [USGS] 2006). Chemical control has been successfully used for site-specific removal (e.g., application to cut stumps) or for larger areas (aerial spraying). Mechanical control generally involves cutting or bulldozing the aboveground material, raking up the root crowns, and burning the slash. Biological control agents (herbivorous insects from tamarisk's native range in Asia) have recently been released at a number of field sites. Biological control is potentially more sustainable than other methods, but it is controversial because it involves introducing another non-native organisms, with potentially unforeseeable consequences (USGS 2006).

3.10.2.2 Mud Springs Road Transmission Line Alternative

Surface Disturbance

The potential introduction or spread of noxious weeds and non-native invasive plant species would be lower than the Proposed Action because 9.5 and 15.2 fewer acres of disturbance would occur from the construction of the North and South options of this alternative, respectively.

Water Management Activities

The potential introduction or spread of noxious weeds and non-native invasive plant species as a result of loss or reduction in flow at seeps or springs would be the same as described for the Proposed Action.

3.10.2.3 Mud Springs Waste Rock Storage Facility Alternative

Surface Disturbance

Construction and operation of this alternative would result in additional surface disturbance (21 acres) as compared to the Proposed Action, which would increase the potential for establishment and spread of noxious weeds and non-native invasive plant species. Implementation of RCG's noxious weed management practices, as described in Section 2.4.10.5, Noxious Weed Management, would minimize the potential for establishment and spread of new noxious weeds and non-native invasive plant species populations within surface disturbance areas during project operation and reclamation.

Water Management Activities

The potential introduction or spread of noxious weeds and non-native invasive plant species as a result of loss or reduction in flow at seeps or springs would be the same as described for the Proposed Action.

3.10.2.4 Backfill Alternative

Surface Disturbance

The potential establishment of noxious weeds and non-native invasive plant species within the project area from the implementation of this alternative would be the same as described for the Proposed Action except that 10.6 additional acres of land would be disturbed and thus open to potential establishment of noxious weeds and non-native invasive plant species.

Water Management Activities

The potential introduction or spread of noxious weeds and non-native invasive plant species as a result of loss or reduction in flow at seeps or springs would be the same as described for the Proposed Action.

3.10.2.5 No Action Alternative

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

3.10.3 Cumulative Impacts

The CESA for noxious weeds and non-native invasive plant species is shown in **Figure 3.10-2**. The past, present, and reasonably foreseeable future actions in this area are identified in Section 3.2, **Table 3.2-1**. Mining operations are illustrated in **Figure 3.2-1**.

Surface Disturbance

The CESA (455,584 acres) was developed for the Carlin Trend because it is an area of a large amount of surface disturbance created by similar types of activities to the Proposed Action. Noxious weeds and non-native invasive plant species populations already exist within the CESA in unreclaimed previously disturbed areas and along existing roads. The common elements associated with most weed infestations are ground disturbance, wildfire, grazing, or use of motorized vehicles. Maintenance on other roads outside the project area, such as Tuscarora-Midas, Mud Springs, Antelope Creek, and Silver Cloud roads, can transport noxious weeds and non-native invasive plant species into the area. Surface disturbances associated with mining typically create areas that are devoid of vegetation or are sparsely vegetated until desirable vegetation can become established after reclamation. Intensive long-term grazing in localized areas and burned areas as a result of wildfires can reduce the vegetative cover provided by native vegetation. Past and recent wildfires have converted what was once primarily sagebrush habitat to expanses of cheatgrass in some areas within the CESA. Surface disturbances from off-road recreational vehicle use and vehicles in general, as well as road maintenance equipment can result in the loss of vegetative cover. Noxious weeds and non-native invasive plant species readily become established in areas that have been subjected to surface disturbances that have removed or reduced vegetative cover. After the weeds are introduced into an area and infestations become established, they generally continue to spread into adjacent areas. The spread of weeds results in the displacement of native vegetation important to some wildlife.

Cheatgrass infestations prevalent in the Carlin Trend initially resulted from the 1964 wildland fires that burned vast acreage from Boulder Valley to the base of the Tuscarora Mountains, converting the dominant vegetation type from sagebrush community to a cheatgrass community. Cheatgrass has been spread in the past by placing soil contaminated with cheatgrass seed onto reclaimed areas. The mines avoid this practice. Growth media stockpiles are now planted with vegetation (e.g., crested wheatgrass [*Agropyron cristatum*]) to compete with cheatgrass. Non-cheatgrass contaminated soil, such as the Carlin Formation, also is used as growth medium during reclamation to combat the spread of cheatgrass.

Tamarisk began showing up in the Carlin Trend as a result of the dewatering activities from mines, growing in the wet areas such as tailing impoundments, sediment ponds, water infiltration areas, reservoirs, wetlands and moving into streams and natural waterways. Noxious weeds in the Carlin Trend consist mostly of Scotch thistle, Canada thistle, various thistles, hoary cress, and tamarisk. The mines currently treat known infestations of the noxious weeds and non-native invasive plant species within their project areas.

Recreational users of the lands within the CESA can unknowingly promote weed infestations when they bring recreational vehicles from an invested area to drive on- or off-road, spreading seeds as they travel. Foot traffic on trails also can spread seeds from infested mud on boots or on camping equipment.

Wildlife and domestic livestock also can spread seeds and plant parts that become embedded in their fur or feet.

Most infestations are associated with surface disturbance areas cleared for construction of facilities, exploration drill sites, or roads. Road maintenance has increased the spread of noxious weeds and non-native invasive plant species along the roadways by grading roads with untreated infestations of noxious weeds and non-native invasive plant species. Vehicles are probably the most common means of spreading noxious weeds and non-native invasive plant species with people driving through infestations without washing vehicles and equipment.

Currently disturbed or unreclaimed areas, including the East Pit mining facilities, road shoulders, two-track roads, surface exploration areas, laydown areas, and areas open to grazing, all provide an additional opportunity for weeds to spread to new disturbance areas during Proposed Action activities. The past disturbances, present on-going activities, and proposed disturbances may have a cumulative negative effect by increasing the introduction and spread of noxious weeds and non-native invasive plant species.

Implementation of RCG's Reclamation and Noxious Weed Prevention and Control plans, in association with the Proposed Action and other authorized actions, would minimize the introduction or spread of noxious weeds and non-native invasive plant species within the study area and, thereby minimize the proposed project's contribution to cumulative effects in the CESA.

Mud Springs Road Transmission Line Alternative

The Mud Springs Road Transmission Line Alternative would result in 9.5 and 15.2 acres of less disturbance for the North and South options, respectively within the CESA, when compared with the Proposed Action. As a result, fewer acres would be available for the introduction of noxious weeds and non-native invasive plant species.

Mud Springs Road Waste Rock Storage Facility and Backfill Alternatives

The Mud Springs Road Waste Rock Storage Facility and the Backfill alternatives would result in 21 and 10.6 acres of disturbance, respectively, in addition to the disturbance for the Proposed Action that would be susceptible to the spread of noxious weeds and non-native invasive plant species in the CESA.

Water Management Activities

Cumulative impacts caused by the introduction or spread of noxious weeds and non-native invasive plant species as a result of decreased or cessation of flow in seeps, springs, and riparian habitats may result from cumulative groundwater drawdown. The decrease or cessation of flow in seeps and springs over the long term would result in a decrease or loss of wetland vegetation, which would provide an opportunity for noxious weeds and non-native invasive plant species to become established because they readily invade areas supporting sparse or no vegetation.

3.10.4 Potential Monitoring and Mitigation Measures

During construction, operation, and reclamation, RCG would identify and monitor the project area for the establishment of noxious weeds and non-native invasive plant species. RCG would treat weed infestations according to their Noxious Weed Prevention and Control Plan (RCG 2011a), including BLM and NDEP regulations. Treatment would consist of grubbing and spraying with chemicals approved for use on public lands.

3.10.5 Residual Impacts

Residual impacts from noxious weeds and non-native invasive plant species are not anticipated from the implementation of the proposed project. However, infestations of cheatgrass in the area may increase in size.

3.11 Range Resources

The range resources study area for direct and indirect impacts encompasses the maximum extent of the 10-foot groundwater drawdown contour (**Figure 3.11-1**) because that is the limit of direct or indirect impacts on grazing from the Proposed Action. The cumulative effects study area (CESA) encompasses the Twenty-Five, Squaw Valley, and Tuscarora grazing allotments, which are administered by the Bureau of Land Management (BLM) (**Figure 3.8-2**). The CESA is the entire three allotments in order to calculate the total impacts to grazing and range resources from mining in the allotments.

3.11.1 Affected Environment

Livestock grazing and production is one of the major uses of the vegetative resources within the study area. The study area occurs in the northern portion of the Twenty-Five Allotment and southern portion of the Squaw Valley Allotment. In addition, a parcel of fenced land associated with the existing Hollister operation occurs within the Twenty-Five Allotment, which includes BLM-administered public lands with excluded grazing (depicted as white area and labeled Hollister Site on **Figures 3.11-1** and **3.8-2**). These lands would be reclaimed upon the cessation of mining and made available for livestock grazing after BLM has determined that this area has been successfully reclaimed. All of these allotments are predominantly used for cattle grazing, although some sheep and horse grazing occurs as well. In addition to these allotments, the Tuscarora Allotment occurs within the CESA. The allotments, kinds of livestock, permitted use dates, and animal unit months (AUMs) is provided in **Table 3.11-1**. An AUM is the amount of forage required for a cow/calf pair for 1 month. The BLM has authorized a total of 70,092 AUMs for livestock grazing in the following allotments: Tuscarora (9,166 AUMs); Twenty-Five (34,130 AUMs); and Squaw Valley (26,796 AUMs) allotments. A small number of AUMs are associated with rangeland in the study area. The Twenty-Five and Squaw Valley allotments are currently undergoing livestock grazing evaluations by the BLM.

Table 3.11-1 Permits within Grazing Allotments

Grazing Allotment	Category	AUMs Per Allotment	Livestock Operator and Operator Number	Livestock	Permitted Use Dates
Twenty-Five	Improve	34,130	2703240	Cattle/ horse	March 1 – February 28
Squaw Valley	Improve	21,970	2703451	Cattle/ horse, sheep	March 16 – November 30
	Improve	4,826	2700109	Cattle/ horse, sheep	April 8 – July 15; October 21 – November 20
Tuscarora	Improve	9,166	2701607	Cattle/ horse	March 1 – February 28
Total		**70,092**			

Source: BLM 2010h.

A variety of range improvements are located within the allotments and include but may not be limited to water developments (e.g., pipelines and water troughs or stock water ponds), fences, cattleguards, and seedings. Water-related features with stockwatering rights, seeps, and springs that occur in the study area are listed in **Table 3.11-2** and are illustrated in **Figure 3.11-1**.

Table 3.11-2 Water-related Features with Stockwatering Rights within the Study Area

Grazing Allotment	Spring Name	Owner	Legal Description		
			Township	Range	Section
Twenty-Five	26 Ranch Spring #24	26 Ranch Inc.	38N	49E	32 (SE¼ of NW¼)
	26 Ranch Spring #25	26 Ranch Inc.	38N	49E	32 (SE¼ of NW¼)
	Willow Creek Spring	BLM	37N	48E	18 (NE¼ of NE¼)
	Mud Springs	26 Ranch Inc.	37N	48E	12 (NE¼ of SW¼)
	Santa Renia Field Spring	26 Ranch Inc.	37N	49E	8 (NW¼ of SE¼)
	26 Ranch Spring #6	26 Ranch Inc.	37N	49E	21 (NW¼ of NE¼)
Squaw Valley	Ivanhoe Spring	Unknown	38N	48E	17 (NW¼ of NW¼)
	Russell Spring	Unknown	38N	48E	20 (SW¼ of NW¼)
	Alkali Spring	26 Ranch Inc.	38N	49E	29 (NW¼ of SW¼)
Tuscarora	Chicken Spring	26 Ranch Inc.	38N	49E	28 (NW¼ of SW¼)

Source: BLM 2010h.

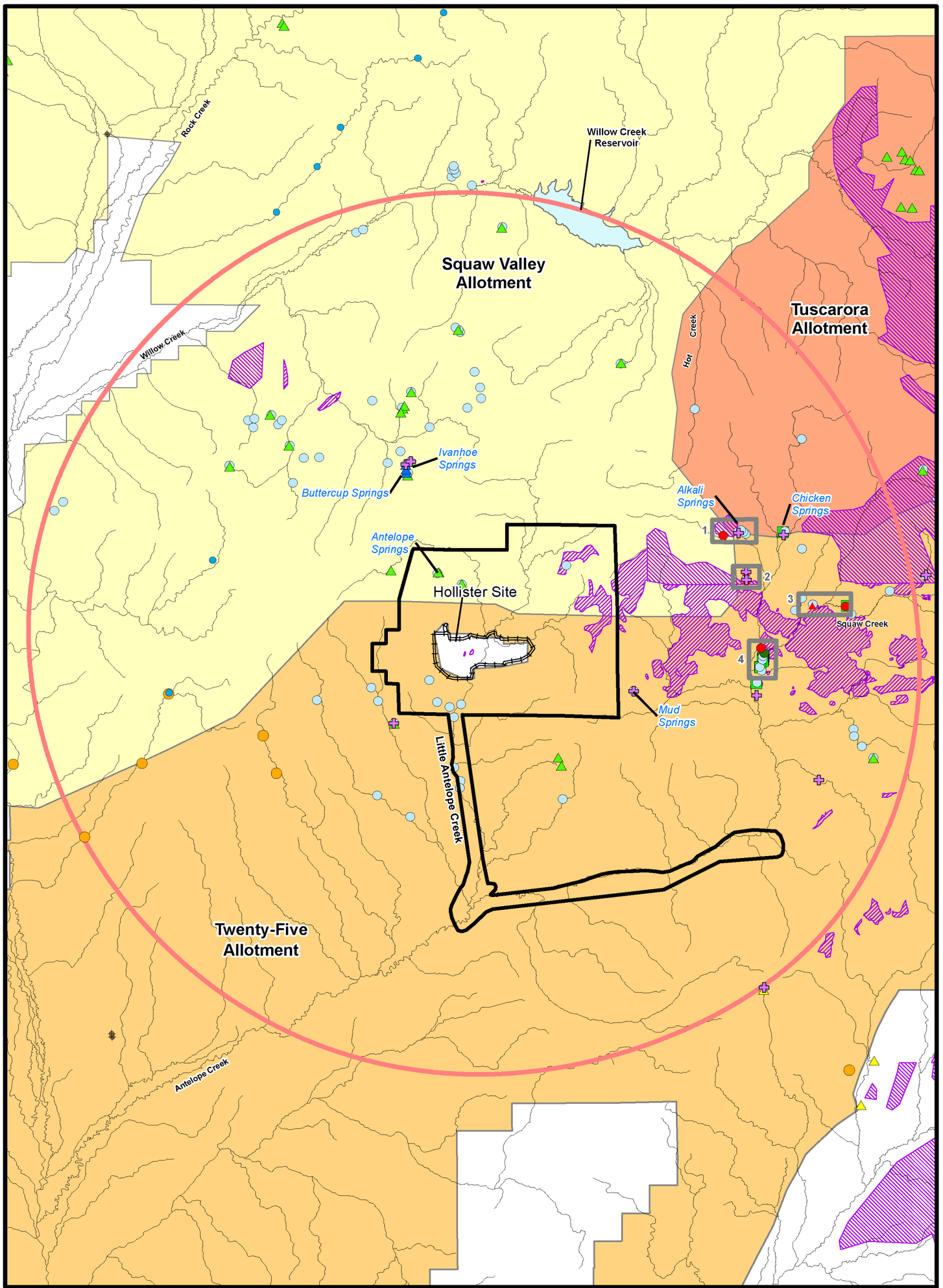
3.11.2 Environmental Consequences

Primary issues related to range management resources include: potential loss of active AUMs by allotment due to direct disturbance or the potential for reduced forage production following reclamation; potential impacts to existing water sources including water-related range improvements; and potential impacts to seasonal livestock movement within grazing allotments.

3.11.2.1 Proposed Action

Surface Disturbance

Under the Proposed Action, the existing fence along the perimeter of the existing Hollister facilities would not be expanded and remain in place as it currently exists. Therefore, the majority of rangeland in the project area currently utilized for livestock grazing would continue to be available for livestock grazing during the project mine life. The Proposed Action would result in the disturbance or loss of approximately 117 acres of vegetation, which includes 43.8 acres of sagebrush shrubland, 65.1 acres of grassland, and 8.1 acres of disturbed/sparsely vegetated land. Approximately 56 acres of the 117 acres of vegetation that would be disturbed by the proposed project occurs within the existing



Legend

- Project Area Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Spring Complex Areas
- Fenceline

Water-related Features

- Active Spring Water Right
- Ranch/ Stock Pond
- Pond
- Windmill

Seeps/Springs (BLM 2000; Sada 2007)

- Seeps/Springs with High Potential to be Affected
- Seeps/Springs with Low Potential to be Affected
- Seeps/Springs with No Potential to be Affected

Springs (BLM 2006)

- Spring with High Potential to be Affected
- Spring Complex with No Potential to be Affected
- Spring with No Potential to be Affected
- Spring/Seep with No Potential to be Affected

Springs (Sada 2007)

- Spring/Seep with Low Potential to be Affected

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Grazing Allotments

- Squaw Valley Allotment
- Twenty-Five Allotment
- Tuscarora Allotment

N

0 1 2 Miles

Note: White areas are excluded from grazing or are other grazing allotments.
Sources: BLM 2006, 2000b; Brown and Caldwell 2010b; NBMG 2003; Sada 2007; USGS 2005.

Figure 3.11-1
Water Rights for Rangeland Use, Seeps, and Springs in the Study Area

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3.11-3

3/1/2012

fenced area at the Hollister Site that is not currently available for livestock grazing. This is the area where the proposed mine facilities would be located within the Twenty-Five allotment. The remaining 61 acres (including 34.7 acres of disturbance associated with the electric power transmission line [transmission line] and components) of vegetation that would be disturbed is currently available for livestock grazing since it is located outside of the existing fenced area. Of the 61 acres, approximately 48.6 and 12 acres of vegetation occur in the Twenty-Five and Squaw Valley allotments, respectively. The 48.6 acres of vegetation disturbance within the Twenty-Five allotment would be the result of construction of the proposed transmission line and surface exploration activities for the proposed project. The Squaw Valley allotment's 12 acres of vegetation disturbance would result from proposed surface exploration activities. These surface disturbances would reduce forage available for livestock grazing in the long term until successfully reclaimed. The loss of this vegetation in either of the allotments would result in the reduction of less than 1 AUM in each allotment based on an average stocking rate of 56 acres per AUM until successfully reclaimed. Approximately 117 acres of surface disturbance associated with the Proposed Action is in addition to the previously authorized 105 acres for a total project disturbance of approximately 222 acres.

After closure, reclamation would be completed in disturbed areas as needed and at locations where transmission structures, exploration, or mining facilities were removed. Monitoring would be completed for at least 3 years in reclaimed areas to ensure that reclamation success is achieved and rangeland vegetation would be available for livestock grazing.

Satisfactory revegetation of disturbance areas (i.e., assuming the primary goal of soil stabilization through presence of adequate plant cover) is anticipated to occur approximately 3 to 5 years following reclamation. After 3 to 5 years, the reclaimed plant communities would likely consist of adequate herbaceous plant cover with sufficient diversity to provide forage for use by livestock. Livestock grazing would be allowed in reclaimed areas once the re-establishment of vegetative cover is considered capable of supporting grazing.

The construction of the proposed project is not expected to impede the movement of livestock within the Twenty-Five and Squaw Valley allotments. Livestock grazing would continue in the same manner as it has since mining for gold began in 1989. The potential for livestock mortalities is not expected to increase because traffic is expected to be the same as current levels associated with existing operations.

Water Management Activities

Groundwater drawdown from the proposed project may result in the long-term loss of seeps and springs within the four spring complexes within the Twenty-Five, Squaw Valley, and Tuscarora allotments (Section 3.6, Surface Water Resources and Watersheds). **Figure 3.6-5** illustrates seeps, springs, and other water features that may be affected by groundwater drawdown. The potential loss of these water sources may affect livestock distribution within portions of these allotments. Springs with active water rights for stockwatering purposes that would be affected by groundwater drawdown are discussed in detail in Section 3.6.2.1, Proposed Action (**Figure 3.11-1**). It is anticipated that groundwater drawdown would not result in direct impacts to upland vegetation within the maximum extent of the 10-foot groundwater drawdown contour. The continuous discharge of water into Little Antelope Creek would provide an additional source of water for livestock in the Twenty-Five Allotment for the 20-year mine life unless fenced to protect the riparian vegetation from grazing. Increased flows in Little Antelope Creek would result in the enhancement and expansion of riparian vegetation present along the creek. Without the construction of an exclusion fence, riparian vegetation would likely be continuously grazed by livestock. **Figure 3.6-4** illustrates the portions of Antelope Creek that may be affected by groundwater drawdown impacts on seeps and springs. Flows in Antelope Creek potentially could decrease as a result of groundwater drawdown thereby decreasing the amount of water available to livestock within the Twenty-Five Allotment.

3.11.2.2 Mud Springs Road Transmission Line Alternative

Surface Disturbance

Impacts to range resources would be the same as those described for the Proposed Action with the exception of approximately 9.5 fewer acres (North Option) and 15.2 fewer acres (South Option) of rangeland vegetation would be disturbed in the Twenty-Five Allotment.

Water Management Activities

Water management-related impacts to range resources, as a result of groundwater drawdown within the predicted maximum extent of the 10-foot groundwater drawdown contour, would be the same as described for the Proposed Action. The proposed alternative transmission line would have no impacts to the water management activities.

3.11.2.3 Mud Springs Waste Rock Storage Facility Alternative

Surface Disturbance

Impacts to range resources would be the same as described for the Proposed Action, with the exception that an additional 18.9 acres of grassland vegetation would be disturbed. This disturbance would occur within the existing fenced mine area, which excludes livestock grazing. Therefore, the loss of forage during mine operation would not result in the loss of additional AUMs.

Water Management Activities

Water management-related impacts to range resources, as a result of groundwater drawdown within the predicted maximum extent of the 10-foot groundwater drawdown contour, would be the same as described for the Proposed Action.

3.11.2.4 Backfill Alternative

Surface Disturbance

Impacts to range resources would be the same as described for the Proposed Action except that 10.6 additional acres of grassland vegetation would be temporarily disturbed. The loss of forage during mine and exploration operations would result in the loss of less than two AUMs. Backfilling the shafts and reclaiming the disturbed areas would permanently close the shafts and allow for future livestock grazing by restoring the land or range for use by livestock and wildlife.

Water Management Activities

Water management-related impacts to range resources, as a result of groundwater drawdown within the predicted maximum extent of the 10-foot groundwater drawdown contour, would be the same as described for the Proposed Action.

3.11.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed and the related potential impacts to range resources would not occur. The existing underground exploration and bulk sampling operation associated with the Hollister Site would continue under existing authorizations. Rodeo Creek Gold Inc (RCG) would reclaim mine and mineral exploration disturbance areas. Reclaimed areas would be available for livestock grazing following successful reclamation.

3.11.3 Cumulative Impacts

The CESA for range resources encompasses the entire Twenty-Five, Squaw Valley, and Tuscarora allotments in order to fully assess potential cumulative impacts to range resources from past, present, and reasonably foreseeable future actions (RFFAs) (**Figure 3.8-2**). The mining and mineral

exploration related past, present, and RFFAs in the CESA are identified in **Table 3.2-1**; their locations are shown in **Figure 3.2-1**.

Cumulative effects on grazing result from wildfire, introduction of noxious weeds and non-native invasive plant species, energy development, and mining activity. Reclamation of mine and mineral exploration disturbances in the CESA would be incremental as various operations reach the end of active mining and begin closure activities. Approximately 7,778 acres would be reclaimed to provide livestock grazing. Approximately 487 acres would remain as open pits, some partially filled with water. From 2001 through 2006 about 55 percent (approximately 466,011 acres) of land encompassed by the 3 allotments comprising the CESA have been affected by wildfire. Stocking rates and seasons of use are periodically reviewed and adjusted by BLM in response to the severity of burns in the various allotments affected. Restoration and reseeding efforts to mitigate losses from wildfire have had varying degrees of success. Some areas seeded during the first appropriate season following a fire (fall or winter) exhibited successful seedling establishment, while other areas became infested with noxious weeds and non-native invasive plant species (e.g., cheatgrass), reburned within a year or two, or did not respond, possibly due to drought or other climatic conditions. Some areas had adequate native perennial grasses and did not require herbaceous reseeding following wildfires (BLM 2010d).

Other restoration projects have included fencing burned areas to allow vegetation to recover and adjusting stocking rates and seasonal use to reflect available forage in the various pastures within each affected allotment.

Past and present actions and RFFAs within the CESA have resulted, or would result, in the permanent loss of approximately 487 acres (9 AUMs – assuming an average stocking rate of 56 acres per AUM) from active grazing preference. The proposed project incrementally would reduce the active grazing preference by up to additional 61 acres (117 acres minus approximately 56 acres previously fenced) (less than 2 AUMs) resulting in a total cumulative disturbance of approximately 547 acres (10 AUMs – less than 1 percent of AUMs within the CESA).

Flows associated with seeps and springs potentially could decrease or cease, thereby reducing the amount of available water or eliminating a water source for livestock use from the Proposed Action. The loss of seeps and springs from cumulative groundwater drawdown within the CESA would likely affect livestock distribution within the grazing allotments unless replacement water sources are developed for livestock watering. Livestock movement within these allotments would not be affected.

The reduction in available water within the CESA may result in a decrease in available forage from active grazing areas until such time that adequate herbaceous cover with sufficient diversity becomes established for livestock consumption or change grazing patterns. The loss of wetland vegetation adjacent to seeps and springs may result in a long-term change in vegetation structure, thus potentially reducing the available forage quantity for livestock grazing within these areas.

3.11.4 Potential Monitoring and Mitigation Measures

RR-1

Issue: Groundwater drawdown may result in the long-term loss of water sources (e.g., springs and improved springs) for livestock, which may affect livestock distribution within the grazing allotments.

Monitoring/Mitigation Measure: If monitoring identifies project-related impacts within the maximum extent of the 10-foot groundwater drawdown contour, RCG would replace water sources (e.g., springs) lost as a result of groundwater drawdown by developing replacement water sources for livestock. RCG would coordinate with the BLM regarding the locations and types of replacement water sources to be developed within the affected allotments. Augmentation measures could include hauling or piping water to the affected springs or drilling wells.

Effectiveness: The development of replacement water sources would ensure that livestock distribution within the allotments is maintained in the long term.

3.11.5 Residual Impacts

Residual impacts to range resources are not anticipated with the implementation of the Proposed Action.

3.12 Wildlife Resources

The study area for direct and indirect impact assessments for wildlife resources includes the area within the project boundary and riparian, stream, spring/pond, and wetland habitats within the maximum extent of the 10-foot groundwater drawdown contour. The cumulative effects study areas (CESAs) for wildlife resources generally extend from the northern end of the Independence Range northeast of the study area, south to the Humboldt River and northern end of the Piñon Range. The CESAs were determined by the Bureau of Land Management (BLM) and Nevada Department of Wildlife (NDOW) based on wildlife use in the region and include contiguous areas that provide important seasonal habitat for wildlife species such as mule deer, pronghorn, and elk (**Figures 3.12-1** through **3.12-4**). Past, present, and reasonably foreseeable future actions (RFFAs) are summarized in Section 3.2.

3.12.1 Affected Environment

As discussed in Section 3.8, Vegetation Resources, three vegetation cover types and disturbed land (i.e., industrial/commercial) are located within the study area. The vegetation cover types include sagebrush shrubland, grassland, and riparian/wetland habitats. Grassland is the most common vegetation type within the study area.

Wildlife species and habitats found within the study area are typical of the Great Basin Region (AECOM 2010b,c,d; Rawlings and Neel 1989). Riparian/wetland habitats within the study area, particularly those that maintain open water and riparian vegetation, support a greater diversity and population density of wildlife species than any other habitat types occurring in the study area (Rawlings and Neel 1989). Currently, the primary riparian/wetland habitat within the study area occurs along Little Antelope Creek and Antelope Creek, which originate northeast of the study area in the Santa Renia and Tuscarora mountains, respectively. Little Antelope Creek and Antelope Creek are classified as intermittent creeks through the study area.

Information regarding wildlife species and habitat within the study area and CESAs was obtained from a review of existing published sources, BLM, NDOW, and United States Fish and Wildlife Service (USFWS) file information, as well as Nevada Natural Heritage Program (NNHP) database information, and site-specific field surveys.

3.12.1.1 Big Game Species

Mule deer, pronghorn, and elk are the primary big game species that may occur within the study area (Miller 2010a; NDOW 2010a,b). The study area occurs entirely within NDOW's Management Area 6, specifically Hunting Unit 068.

Population numbers for mule deer, pronghorn, and elk fluctuate slightly from year to year based on fluctuations in habitat conditions. Water availability and amount of quality habitat are the limiting factors within the study area. Water availability, forage quality, cover, and weather patterns typically determine the level of use and movement of big game species through the study area. Winter use in the study area depends on snow depth and forage availability.

<u>Mule Deer</u>

Population numbers for mule deer in Management Area 6 have demonstrated a general decline from historic population levels over the last 10 years due to a reduction in winter habitat quality, primarily resulting from wildfires. Large scale fires from 1999 to 2007 have caused a severe reduction in available forage (i.e., shrub browse) and an overall increase of noxious weeds and non-native invasive plant species such as cheatgrass (*Bronus tectorum*), thistle (*Onopordum acanthium*), and low white-top (*Cardaria draba*) (BLM 2008b; NDOW 2010b). However, improved habitat conditions in 2009 as a result of abundant moisture, caused a 12 percent increase in mule deer populations in 2010

(NDOW 2010b). During spring 2011 helicopter surveys, NDOW classified approximately 3,810 mule deer in Management Area 6 (NDOW 2011). Mule deer use of the study area is highly variable but typically peaks during fall and spring migrations. A majority of the mule deer in the project region typically spend the summer months in the Bull Run and Tuscarora mountain ranges north and east of the study area and winter in the Dunphy Hills area south and west of the study area (NDOW 2010a). Several habitat types including limited use, transitional, and crucial winter habitat intersect the study area. Approximately 11,256 acres of undisturbed (e.g., not burned) limited use habitat and 5,262 acres of undisturbed transitional habitat occur within the study area. No undisturbed crucial winter habitat occur within the study area. NDOW data indicates that a historic mule deer migration corridor passes through the study area. However, mule deer migrating through the study area typically avoid the Hollister Site and migrate through undisturbed habitat southeast and northwest of the Hollister Site. Mule deer habitat and migration corridors within the study area are presented in **Figure 3.12-5**.

Pronghorn

Pronghorn numbers have been stable to increasing in Management Area 6 over the past several years (BLM 2008b; NDOW 2010b). NDOW ground surveys classified 766 animals during January 2011 surveys (NDOW 2011). Use of the study area by pronghorn is highly dependent on water and forage availability. The majority of the study area is summer habitat for pronghorn (**Figure 3.12-6**). Approximately 14,920 acres of undisturbed (e.g., not burned) summer habitat occurs within the study area.

Elk

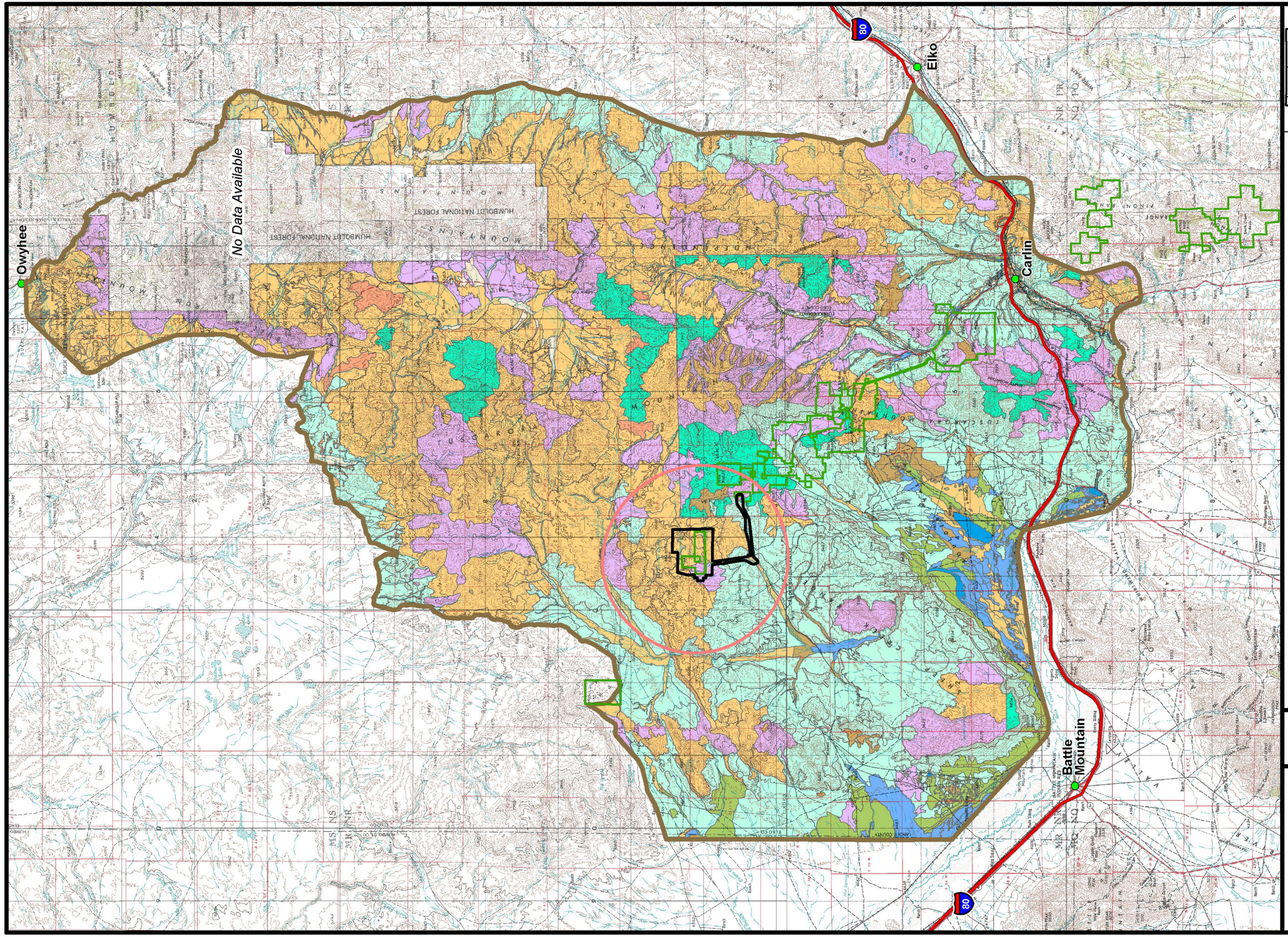
Elk numbers in Management Area 6 have increased over the last several years due to an increase in herbaceous forage as a result of wildfires (NDOW 2011). NDOW currently estimates the herd at approximately 550 animals (Miller 2010a; NDOW 2011). Elk are not typically found within the study area but may occur within the study area depending on snow depth and forage conditions. Elk low-density habitat occurs throughout the majority of the study area and crucial winter habitat occurs in the southeast portion of the study area (**Figure 3.12-7**). Approximately 14,118 acres of undisturbed (e.g., unburned) low-density habitat and 2,399 acres of undisturbed crucial winter habitat occurs within the study area.

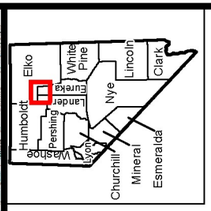
Mountain Lion

In Nevada, mountain lions also are classified as a big game species. Mountain lions are fairly common in north-central Nevada and typically occupy the higher elevations surrounding the study area. They often travel between mountain ranges and valleys depending on prey availability. Mountain lion populations in eastern Nevada have remained stable over the past 5 years despite a decrease in the mule deer population (NDOW 2010b).

3.12.1.2 Small Game Species

Several upland game bird species are found within the study area including greater sage-grouse, chukar, gray partridge, and mourning dove. Chukar are found in the hills within the study area, especially on rocky ridges and hillsides with cheatgrass. Gray partridge are found in riparian areas along Little Antelope Creek and Antelope Creek (AECOM 2010c; BLM 2004a; NDOW 2009b). Mourning doves are found in a wide range of habitats in close proximity to water and are most likely to occur within the study area during spring, summer, and early fall (Floyd et al. 2007; Wildlife Action Plan Team 2006). The greater sage-grouse is a BLM sensitive species and is discussed in detail in Section 3.14, Special Status Species.





N

0 5 10 Miles

Legend

- Project Area Boundary
- Other Mine Plan Boundaries
- Cumulative Effects Study Area
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Vegetation Types

- Big Sagebrush Shrubland
- Basin Big Sagebrush Shrubland
- Bud Sagebrush Shrubland
- Wyoming Big Sagebrush Shrubland
- Mountain Big Sagebrush Shrubland
- Low Sagebrush Shrubland
- Salt-desert Shrubland
- Greasewood Shrubland
- Grassland
- Wet Meadow

Source: Based on ecological sites from USDA-NRCS 2011.

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Figure 3.12-1

Wildlife Habitat and Vegetation Types in the Study Area and Cumulative Effects Study Area

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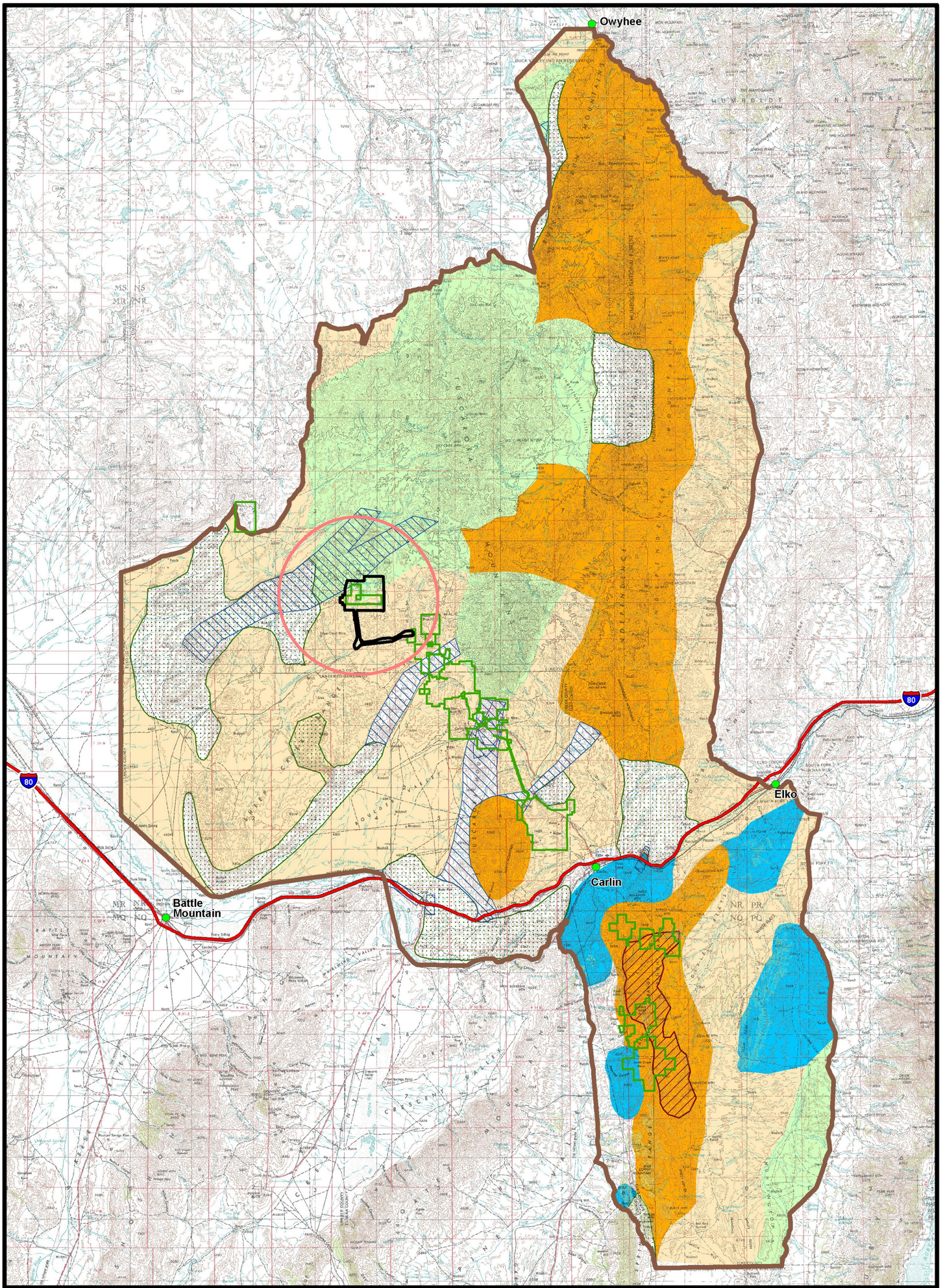

Figure 3.12-2

Mule Deer
Cumulative Effects
Study Area

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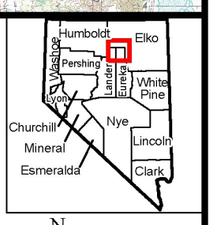
Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Other Mine Plan Boundary
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Crucial Summer Habitat
- Movement Corridor
- Crucial Winter Habitat
- Winter Habitat
- Limited Use Habitat
- Summer Habitat
- Transition Habitat

Source: BLM 2011d.

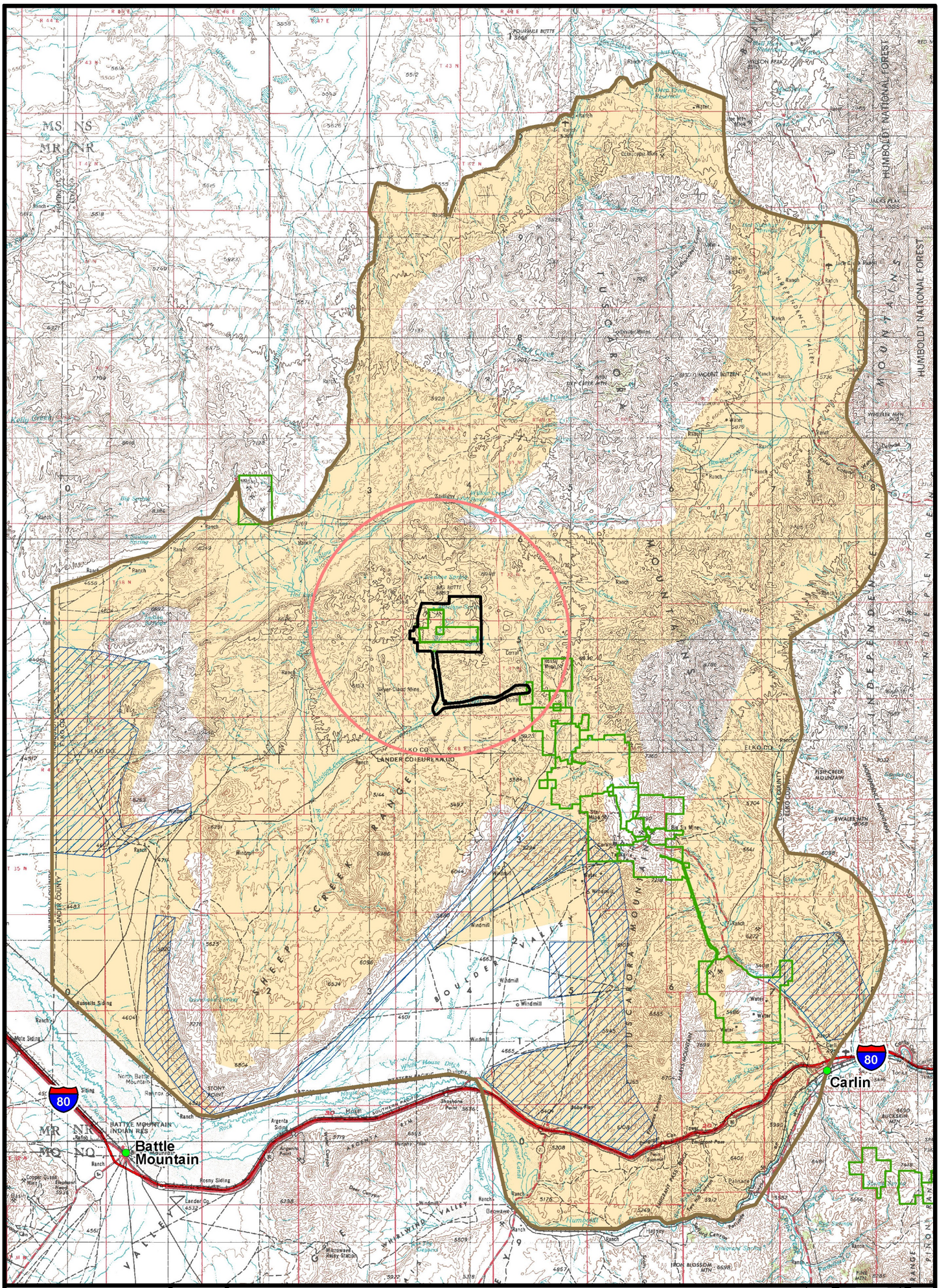


N

0 5 10 Miles

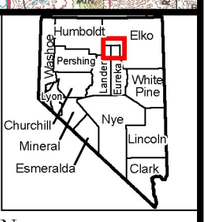
3.12-4

3/2/2012



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Other Mine Plan Boundaries
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Crucial Winter Habitat
- Summer Habitat



N

0 2.5 5 10 Miles

Source: BLM 2011d.

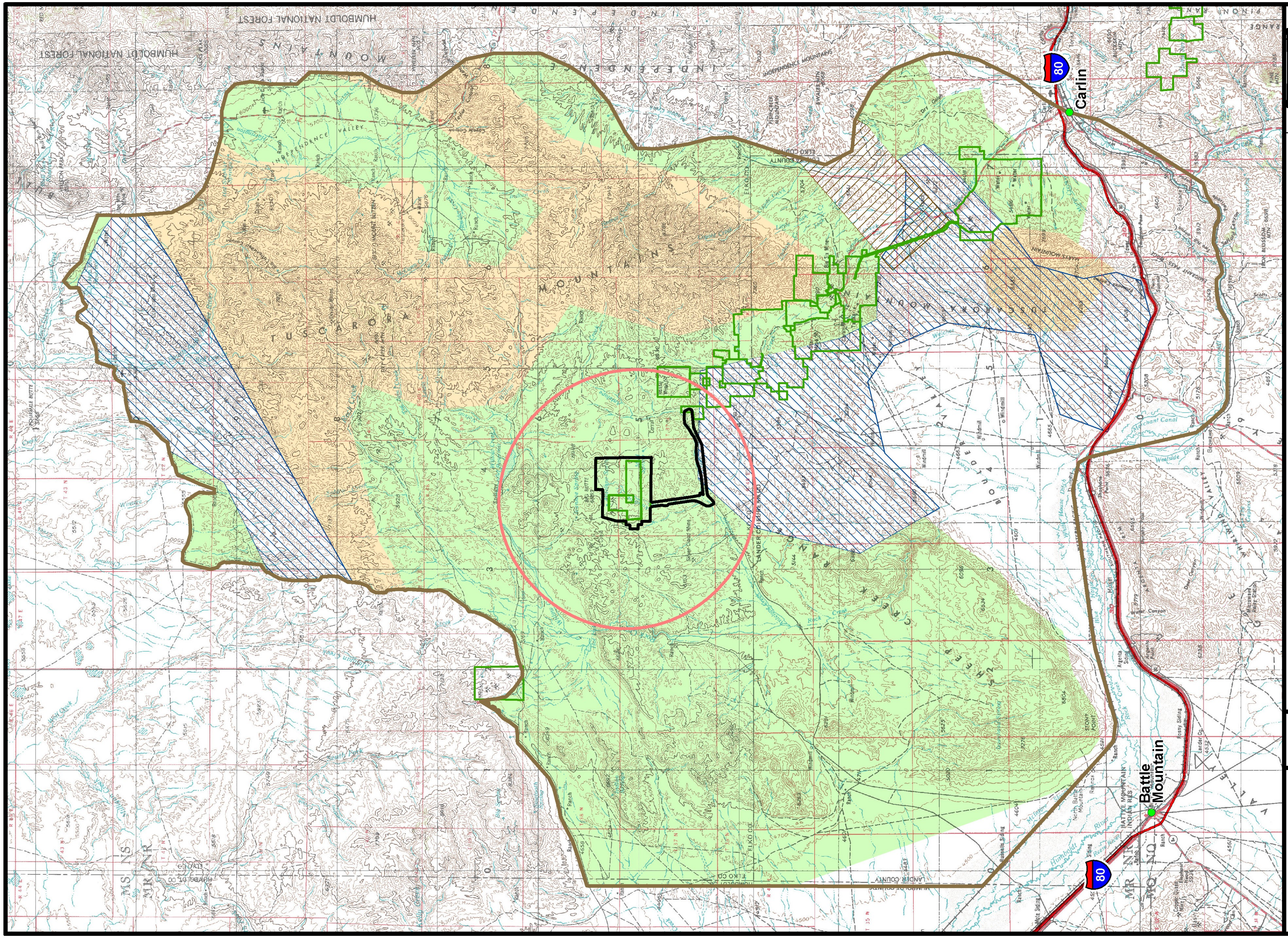
Hollister Underground Mine Project EIS

Pronghorn Cumulative Effects Study Area

Figure 3.12-3

3.12-5

3/2/2012



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Other Mine Plan Boundaries
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Crucial Winter Habitat
- Movement Corridor
- Low-Density Habitat
- Summer Habitat

Miles: 0 2.5 5 10

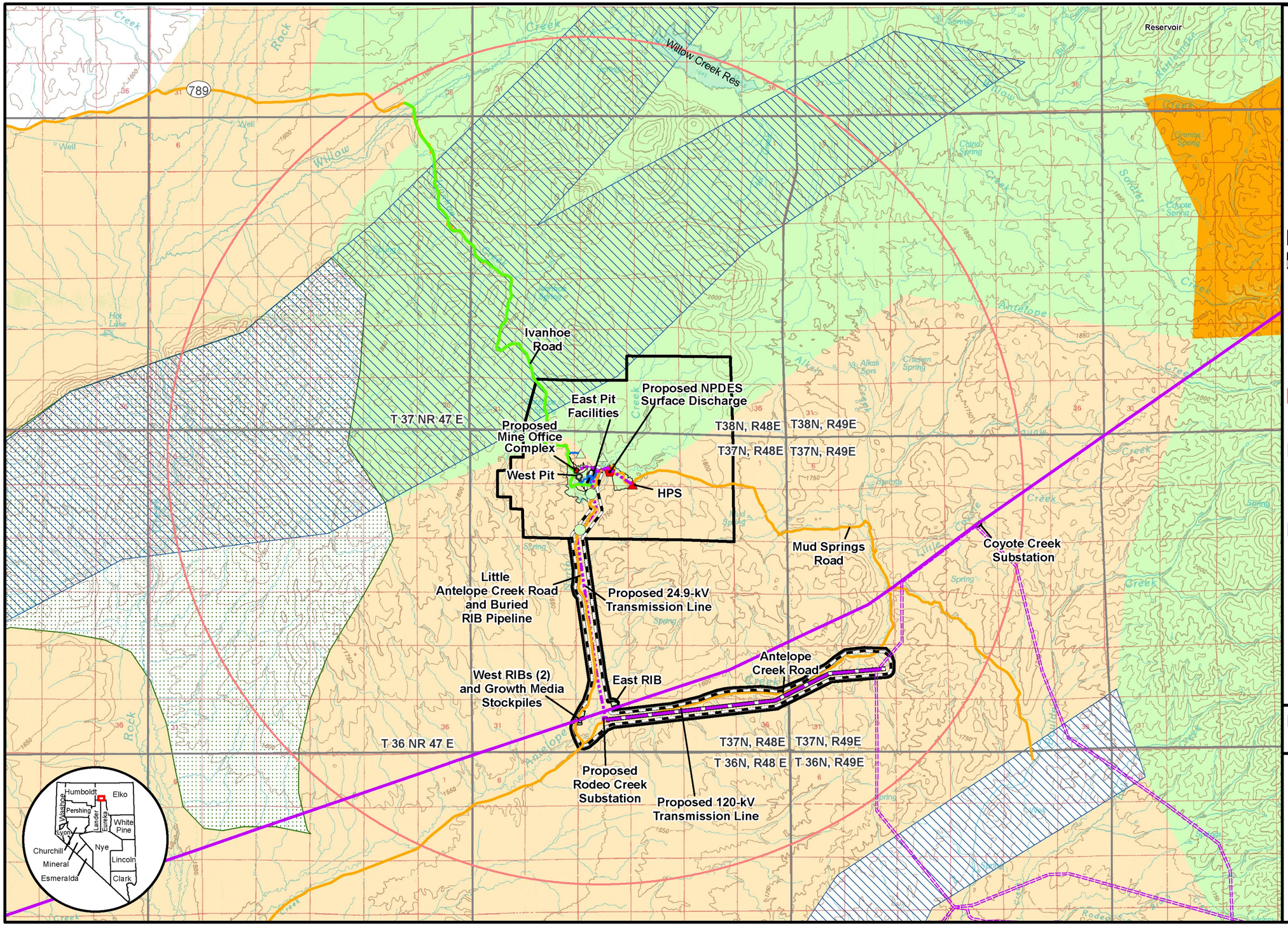
Source: BLM 2011d.

Hollister Underground Mine Project EIS

Figure 3.12-4

Elk Cumulative Effects Study Area

3/2/2012



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Buried Pipeline
- Crucial Winter Habitat
- Summer Habitat
- Transitional Habitat
- Limited Use Habitat
- Movement Corridor

Source: BLM 2011d.

N

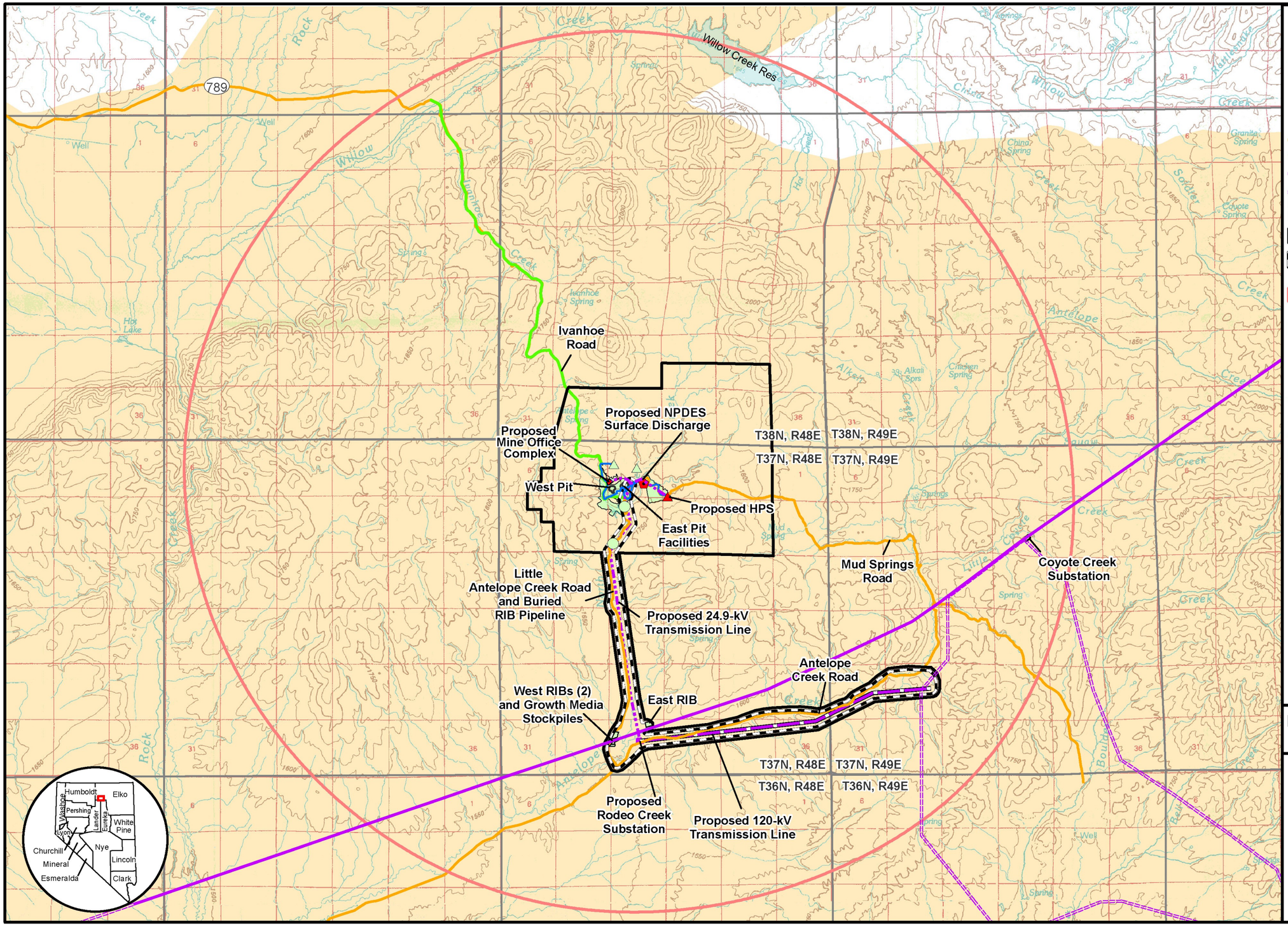
0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.12-5

Mule Deer Habitat in the Study Area

3/2/2012



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Summer Habitat

Source: BLM 2011d.

N

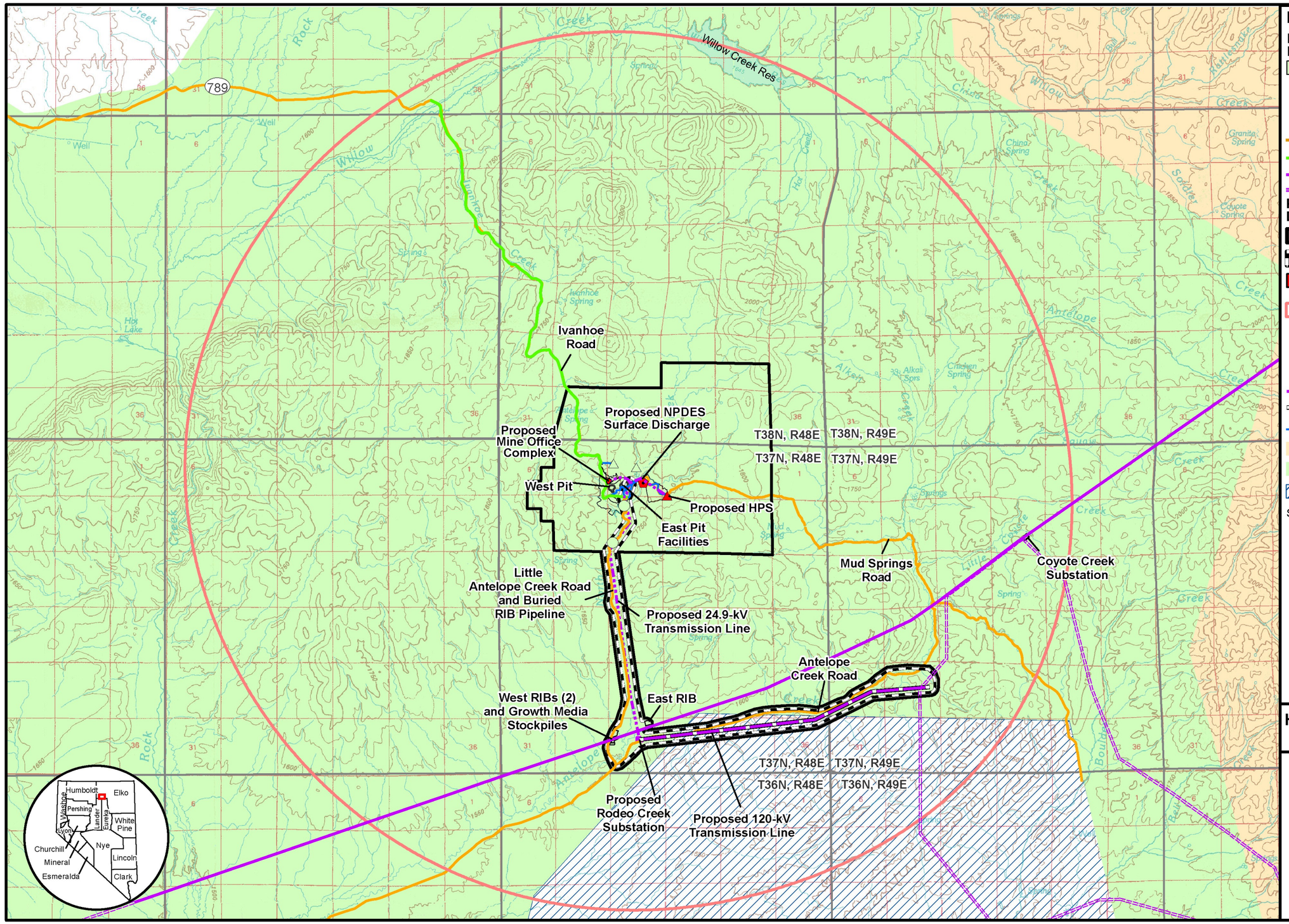
0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.12-6

Pronghorn Habitat in the Study Area

3/2/2012



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- Maximum Extent of the 10-foot Groundwater Drawdown Contour
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Summer Habitat
- Low-Density Habitat
- Crucial Winter Habitat

Source: BLM 2011d.

N

0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.12-7

Elk Habitat in the Study Area

3/2/2012

Several rabbit species are known to occur within the study area including cottontail and pygmy rabbit. The pygmy rabbit has been documented at four locations in the study area and are typically found in areas with deeper developed soils in taller sagebrush habitat (BLM 2004b; NDOW 2010a). Although the pygmy rabbit is considered a game species in Nevada (NDOW 2009b), it also is a BLM sensitive species and is discussed in Section 3.14, Special Status Species.

Nevada Administrative Code (NAC) 503.025 classifies several mammal species as furbearers. Furbearer species that may occur within the study area include gray fox, kit fox, bobcat, muskrat, and mink (Wildlife Action Plan Team 2006). Due to increased structural diversity and available food sources, a higher diversity of furbearers is likely present along the riparian areas along Little Antelope Creek and Antelope Creek. Other mammal species that may occur within the study area include coyote, badger, short-tailed weasel, long-tailed weasel, spotted skunk, and black-tailed jackrabbit.

Due to limited habitat, waterfowl concentrations are limited to ponds, springs, and streams located in the study area. Species that are likely to be found within the study area include mallard, blue-winged teal, wigeon, gadwall, and pintail (AECOM 2010c; Floyd et al. 2007; Wildlife Action Plan Team 2006).

3.12.1.3 Nongame Species

A diversity of nongame species (e.g., small mammals, passerines, raptors, reptiles, and amphibians) occupies a wide range of trophic levels and habitat types within the study area. Habitats found within the study area (i.e., sagebrush shrubland, grassland, riparian/wetland) support a variety of resident and seasonal nongame species. Nongame mammals include the deer mouse, western harvest mouse, vagrant shrew, Merriam's shrew, Ord's kangaroo rat, sagebrush vole, golden-mantled ground squirrel, least chipmunk, and desert woodrat (BLM 2008b; NDOW 2010a; Wildlife Action Plan Team 2006). Rodent populations provide a large prey base for predators found within the study area.

Bats

A number of bat species are known to inhabit the project region; however, detection surveys for bat species has not been conducted within the study area. Due to the presence of seeps, springs, and creeks, the study area contains suitable roosting and foraging habitat for several bat species including pallid bat, Townsend's big-eared bat, big brown bat, small-footed myotis, little brown myotis, California myotis, long-eared myotis, long-legged myotis, Yuma myotis, and western pipistrelle bat (BLM 2004a; Bradley et al. 2006; NDOW 2010a). All of the bats identified as potentially occurring within the study area are currently BLM sensitive species and/or Nevada protected species (Bradley et al. 2006; NNHP 2010a). These species are presented in detail in Section 3.14, Special Status Species.

Migratory Birds

Nongame birds encompass a variety of passerine and raptor species including migratory bird species that are protected under the Migratory Bird Treaty Act (MBTA) (16 United States Code 703-711) and Executive Order (EO) 13186 (66 Federal Register 3853). Pursuant to EO 13186, a Memorandum of Understanding (MOU) between the BLM and USFWS outlines a collaborative approach to promote the conservation of migratory bird populations. The purpose of the MOU is to strengthen migratory bird conservation by identifying and implementing strategies that promote conservation and avoid or minimize adverse impacts on migratory birds in coordination with state, tribal, and local governments. This MOU identifies specific activities where cooperation between the BLM and USFWS would contribute to the conservation of migratory birds and their habitat. In addition, the BLM Nevada State Office prepared Migratory Bird Best Management Practices for the Sagebrush Biome in order to assist BLM field offices in the consideration of migratory birds in land management activities (BLM 2003). In Nevada, all birds protected under the MBTA also are state protected (NAC 503.050). Many of the sensitive migratory bird species found in Nevada also are identified in the Nevada Partners in Flight (PIF) Bird Conservation Plan (Neel 1999). This plan, along with the Birds of Conservation Concern

(BCC) Plan (USFWS 2008), prioritizes migratory bird species for management actions according to habitat types.

In order to document migratory bird species that occur within the study area, a breeding bird survey was conducted May 22 to 26, 2010, along Little Antelope Creek and Antelope Creek. A total of 45 avian species were observed and recorded and are presented in **Table 3.12-1** (AECOM 2010c).

Table 3.12-1 Inventory of Migratory Bird Species Potentially Occurring within the Study Area

Common Name	Scientific Name	Status[1]	Observed in Study Area[2]
American robin	*Turdus migratorius*		Yes
American kestrel	*Falco sparverius*		Yes
Bald eagle	*Haliaeetus leucocephalus*	BCC	No
Black-billed magpie	*Pica pica*		Yes
Black-chinned hummingbird	*Archilochus alexandri*		Yes
Black-crowned night heron	*Nycticorax nycticorax*		Yes
Black-headed grosbeak	*Pheucticus melanocephalus*		Yes
Blue-gray gnatcatcher	*Polioptila caerulea*		Yes
Brewer's blackbird	*Euphagus cyanocephalus*		Yes
Brewer'sparrow	*Spizella breweri*	BCC	Yes
Bullock's oriole	*Icterus bullockii*		Yes
Burrowing owl	*Athene cunicularia*	BLM, PIF	Yes
Cinnamon teal	*Anas cyanoptera*		Yes
Chipping sparrow	*Spizella passerina*		Yes
Cliff swallow	*Hirundo pyrrhonota*		Yes
Common raven	*Corvus corax*		Yes
Common snipe	*Gallinago gallinago*		Yes
Ferruginous hawk[3]	*Buteo regalis*	BLM, PIF	Yes
Golden eagle	*Aquila chrysaetos*	BLM, BCC	Yes
Greater sage-grouse	*Centrocercus urophasianus*	BLM, BCC, PIF	No
Horned lark	*Eremophila alpestris*		No
Juniper titmouse	*Baeolophus ridgwayi*	BLM, PIF	No
Killdeer	*Charadrius vociferus*		Yes
Lark sparrow	*Chondestes grammacus*		Yes
Lazuli bunting	*Passerina amoena*		Yes
Lewis' woodpecker	*Melanerpes lewis*	BLM, BCC, PIF	No
Loggerhead shrike	*Lanius ludovicianus*	BLM, BCC, PIF	Yes
Long-eared owl	*Asio otus*	BLM, PIF	No
MacGillivray's warbler	*Oporornis tolmiei*	PIF	Yes

Table 3.12-1 Inventory of Migratory Bird Species Potentially Occurring within the Study Area

Common Name	Scientific Name	Status[1]	Observed in Study Area[2]
Mallard	*Anas platyrhynchos*		Yes
Mourning dove	*Zenaida macroura*		Yes
Northern flicker	*Colaptes auratus*		Yes
Northern harrier	*Circus cyaneus*		Yes
Piñon jay	*Gymnorhinus cyanocephalus*	BLM, BCC, PIF	No
Prairie falcon	*Falco mexicanus*	BLM, PIF	Yes
Red-tailed hawk	*Buteo jamaicensis*		Yes
Red-winged blackbird	*Agelaius phoeniceus*		Yes
Rough-legged hawk	*Buteo lagopus*		No
Sage sparrow	*Amphispiza belli*	BCC, PIF	No
Sage thrasher	*Oreoscoptes montanus*	BCC, PIF	No
Say's phoebe	*Sayornis saya*		Yes
Short-eared owl	*Asio flammeus*	BLM, PIF	Yes
Snowy egret	*Egretta thula*		Yes
Swainson's hawk	*Buteo swainsoni*	BLM, PIF	No
Turkey vulture	*Cathartes aura*		Yes
Vesper sparrow	*Pooecetes gramineus*	BLM, PIF	No
Willow flycatcher	*Empidonax trailii*	BCC, PIF	Yes
Western kingbird	*Tyrannus verticalis*		Yes
Western meadowlark	*Sturnella magna*		Yes
Western tanager	*Piranga ludoviciana*		Yes
Western wood-peewee	*Contopus sordidulus*		Yes
Wilson's warbler	*Wilsonia pusilla*	PIF	Yes
Yellow-breasted chat	*Icteria virens*	BLM, PIF	No
Yellow-headed blackbird	*Xanthocephalus xanocephalus*		Yes
Yellow warbler	*Dendroica petechia*		Yes
Yellow-rumped warbler	*Dendroica coronata*		Yes

[1] BLM = BLM Sensitive.
BCC = USFWS Birds of Conservation Concern.
PIF = Nevada Partners in Flight Priority Bird Species.

[2] Identified during the riparian bird survey May 22 to 26, 2010.

[3] Identified during the Columbia spotted frog and Pacific chorus frog survey June 15 to 17, 2010.

Sources: AECOM 2010c,d; BLM 2004a; Floyd et al. 2007; NDOW 2010a; Neel 1999; USFWS 2008.

Many of these species are associated with a variety of habitat types, and some species occur within the study area year-round (e.g., red-tailed hawk, chukar, gray partridge). However, due to the higher level of plant diversity and structure, more abundant potential nest sites, and greater food base, the riparian areas along Little Antelope Creek and Antelope Creek support the highest diversity of bird species within the study area.

Raptor species that could potentially occur as residents or migrants within the study area include eagles (bald and golden eagles), buteos (e.g., red-tailed hawk, Swainson's hawk, ferruginous hawk), falcons (e.g., prairie falcon, American kestrel), accipiters (e.g., Cooper's hawk, sharp-shinned hawk), owls (e.g., great-horned owl, burrowing owl, long-eared owl, short-eared owl), northern harrier, and turkey vulture (Floyd et al. 2007; Herron et al. 1985). Twelve raptor nests were documented during field surveys within the study area including two American kestrel, one short-eared owl, one ferruginous hawk, one red-tailed hawk, and seven unknown raptor nests (AECOM 2010c). Four of the 10 raptor nests were located on the existing 345-kilovolt (kV) electric power transmission line (transmission line) that crosses the study area north of Antelope Creek. According to NDOW records, a historic prairie falcon nest occurs approximately 2 miles northeast of the Hollister Site (NDOW 2010a). In addition, a suspected raptor migration route occurs near the study area along the Tuscarora Mountains and Sheep Creek Range (Herron et al. 1985). Surveys performed to date have not identified any raptor nests within areas proposed for new surface disturbance.

Details on sensitive bird species such as golden eagle, prairie falcon, short-eared owl, vesper sparrow, and loggerhead shrike are discussed further in Section 3.14, Special Status Species.

Reptiles and Amphibians

Several species of reptiles and amphibians (collectively referred to as herptiles) are known to occur within the study area including Great Basin whiptail, bull snake, western rattlesnake, Great Basin collared lizard, desert horned lizard, western skink, and western fence lizard (NDOW 2010a). Amphibian presence is limited to areas with seasonal flow and riparian vegetation present (e.g., willows, sedges, etc.). Pacific chorus frogs have been documented within the study area along Little Antelope Creek and Antelope Creek (**Figure 3.13-2**) (AECOM 2010d; BLM 2004a; NDOW 2010a). Details on sensitive species such as the Columbia spotted frog are discussed in Section 3.14, Special Status Species.

3.12.2 Environmental Consequences

Wildlife-related issues addressed by this analysis were determined through consultation with BLM, NDOW, and USFWS. The primary issues related to wildlife include: loss or alteration of native habitats, increased habitat fragmentation, animal displacement, direct loss of wildlife, and impacts associated with water management.

Potential impacts on terrestrial wildlife may include the temporary (short-term and long-term) and permanent reduction or loss of habitat. Short-term impacts arise from habitat removal and disturbance as well as from activities associated with mine operation; these impacts would cease upon mine closure and completion of successful reclamation. Long-term impacts consist of changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success. Permanent impacts are typically associated with construction/expansion of open pits and therefore, are not included in the impact analysis for the proposed project.

Direct impacts to wildlife populations could include limited direct mortalities from mine development, habitat loss or alteration, incremental habitat fragmentation, and animal displacement. Indirect impacts could include increased noise, additional human presence, and the potential for increased vehicle-related mortalities. The riparian habitat along Little Antelope Creek and Antelope Creek within the study area supports a greater number of species than other habitat types within the study area. As a result, project-related impacts may be prominent for species closely associated with riparian

corridors. The degree of the impacts on terrestrial wildlife species and their upland habitats would depend on factors such as the sensitivity of the species, seasonal use patterns, type and timing of project activity, and physical parameters (e.g., topography, cover, forage, and climate).

3.12.2.1 Proposed Action

Surface Disturbance

The Proposed Action would result in the long-term loss of approximately 117 acres of wildlife habitat, including 25 acres associated with exploration activities and 34.7 acres would be associated with the transmission line. The Proposed Action disturbance would be in addition to the previously authorized approximately 105 acres of disturbance for a total of approximately 222 acres. The disturbance associated with the Proposed Action would be reclaimed following completion of mining activities.

Impacts to wildlife from mine and exploration surface disturbance activities would include the temporary reduction or loss of habitat. Habitat loss or alteration would result in direct losses of smaller, less mobile species of wildlife, such as small mammals and reptiles, and the displacement of more mobile species into adjacent habitats. In areas where habitats are at, or near, carrying capacity, animal displacement could result in some unquantifiable reductions in local wildlife populations. Mine and exploration surface disturbance also would result in an incremental increase in habitat fragmentation at the Hollister Site until reclamation has been completed and vegetation has been re-established. It is anticipated that the potential displacement and habitat fragmentation effects would be highest for wildlife species that use the riparian corridors along Little Antelope Creek and Antelope Creek.

Game Species

Potential direct impacts to mule deer would include the incremental long-term reduction of potential forage and the incremental increase of habitat fragmentation from vegetation removal associated with mine development activities. The proposed project would disturb approximately 84 acres of the 11,256 acres (<1 percent) of undisturbed mule deer limited use habitat within the study area and approximately 33 acres of the 5,262 acres (<1 percent) of undisturbed mule deer transitional habitat within the study area. These habitats consist primarily of grassland and sagebrush shrubland. Additional loss of habitat, especially unburned sagebrush shrublands, would result in an incremental reduction in the amount of available mule deer habitat in the study area. No mule deer crucial winter habitat would be disturbed as a result of the proposed project.

Impacts to pronghorn would be similar to those previously discussed for mule deer. Potential direct impacts would include the incremental long-term reduction of approximately 117 acres of the 14,920 acres (<1 percent) of undisturbed pronghorn summer habitat within the study area. Similar to mule deer, additional loss of habitat, especially unburned sagebrush shrublands, would result in an incremental reduction in the amount of available pronghorn habitat in the study area. No pronghorn low density habitat would be disturbed as a result of the proposed project.

Potential direct impacts to elk would include the incremental long-term reduction of approximately 105 acres of the 14,118 acres (<1 percent) of undisturbed low-density habitat within the study area and approximately 12 acres of the 2,399 acres of undisturbed crucial winter habitat within the study area. However, unlike mule deer and pronghorn, elk prefer grasses to sagebrush and are therefore less susceptible to the effects of large scale fires. In fact, the conversion of large tracts of sagebrush habitat to grassland habitat favors elk and may lead to population increases and expansion into previously unoccupied habitat.

Impacts to mountain lions are expected to be low, as these species occur at low densities in and around the study area.

Direct impacts to small game species (e.g., chukar, Hungarian partridge, mourning dove) would include the long-term loss of approximately 117 acres of potentially suitable habitat. Impacts also would include displacement from the disturbance areas and increased habitat fragmentation, until reclamation has been completed and vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas would be available for use by these species. However, displacement would increase competition and could include some local reductions in wildlife populations if adjacent habitats are at carrying capacity. Potential impacts also could include nest and burrow abandonment or loss of eggs or young. These temporary losses would reduce productivity for that breeding season, given the duration of construction activities in a specific area.

Nongame Species

Impacts to nongame species would be similar to those previously discussed for small game species. Direct impacts to nongame species (e.g., small mammals, passerines, raptors, and reptiles) would include the long-term loss of approximately 117 acres of potentially suitable habitat. Impacts also would include displacement from the disturbance areas and increased habitat fragmentation, until vegetation is re-established. In most instances, suitable habitat adjacent to disturbance areas would be available for use by these species. However, displacement would increase competition and could result in some local reductions in wildlife populations if adjacent habitats are at carrying capacity. Potential impacts also could include nest and burrow abandonment or loss of eggs or young. These temporary losses would reduce productivity for that breeding season, given the duration of construction activities in a specific area.

Migratory Birds

A variety of resident and migratory bird species (e.g., raptors and passerines) have been identified as potentially occurring within the study area. Potential direct impacts to bird species would include the long-term loss of approximately 117 acres of potentially suitable breeding, roosting, and foraging habitat. However, this temporary loss is expected to have little effect on local bird populations based on the amount of suitable breeding and foraging habitat in the surrounding area. Continuous mine water discharging into Little Antelope Creek may expand riparian habitat along Little Antelope Creek as the amount of surface water increases. This would create additional habitat and water sources for migratory bird species, thus creating a beneficial impact to migratory bird species that utilize the riparian areas along Little Antelope Creek for the 20-year life of the project. It is anticipated that this newly created riparian habitat and available surface water along Little Antelope Creek would decline once groundwater pumping operations cease. This would have a negative impact on migratory bird species that utilize these riparian areas. If construction or development of the proposed facilities was to occur during the breeding season (approximately March 1 through July 31, depending on species), direct impacts to breeding birds could include the possible direct loss of nests or indirect effects (e.g., abandonment) from increased human noise and human presence within close proximity of an active nest site. In order to minimize impacts to raptors during the breeding season, Rodeo Creek Gold Inc (RCG) has committed to conducting a breeding raptor survey and implementing appropriate mitigation measures, such as buffer zones around occupied nests, as needed. In addition, for the protection of breeding songbirds, RCG has committed to avoiding habitat removal on currently undisturbed lands, to the extent possible, between March 1 and July 31 or, alternately, conducting breeding bird surveys and implementing appropriate mitigation in coordination with the BLM and NDOW. With implementation of these measures, residual impacts to nesting bird species within the study area would be limited to temporary habitat loss. This loss is anticipated to have little impact given the extent of native habitats in the surrounding region.

As described in Section 2.4.6.1, Electrical Power, a 24.9-kV transmission line and 120-kV transmission line would be constructed to supply power to the Hollister Site. These transmission line segments would run approximately 4.5 miles and 5.4 miles along Little Antelope Creek and Antelope Creek, respectively. As described in Section 2.4.6.1, surface disturbance from the transmission line would result in the long-term disturbance of 21 acres of wildlife habitat. Transmission lines pose an

electrocution hazard for raptor species attempting to perch on the structures. To minimize this potential impact, RCG has committed to using Avian Power Line Interaction Committee (APLIC) raptor-deterring design measures which may include, but would not be limited to, a 60-inch separation between conductors and/or grounded hardware in eagle-use areas as well as the use of insulating or cover up materials for perch management. The transmission line also would incrementally increase the collision potential for migrating and foraging bird species. However, collision potential typically is dependent on variables such as the location in relation to high-use habitat areas (e.g., nesting, foraging, and roosting), line orientation to flight patterns and movement corridors, species composition, visibility, and line design (APLIC 2006).

Human Presence and Noise

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

Studies also have shown that reductions in bird population densities in both open grasslands and woodlands also may be attributed to a reduction in habitat quality produced by elevated noise levels (Reijnen et al. 1997, 1995). Although visual stimuli in open landscapes may add to density effects at relatively short distances, the effects of noise appear to be the most critical factor since breeding birds of open grasslands (threshold noise range of 43 to 60 decibels on the A-weighted scale [dBA]) and woodlands (threshold noise range of 36 to 58 dBA) respond very similarly to disturbance by traffic volume (Reijnen et al. 1997). Reijnen et al. (1996) determined a threshold effect for bird species to be 47 dBA, while a New Mexico study in a piñon-juniper community found that impacts of gas well compressor noise on bird populations were strongest in areas where noise levels were greater than 50 dBA. However, moderate noise levels (40 to 50 dBA) also showed some effect on bird densities in this study (LaGory et al. 2001).

Based on the results of the noise measurement conducted in and around the Hollister Site (see Section 3.23, Noise), existing levels of noise at and near the Hollister Site are relatively low and not expected to increase significantly as a result of the proposed project. Therefore, impacts to wildlife species from increased noise are anticipated to be low. Details regarding noise impacts to greater sage-grouse are presented in Section 3.14, Special Status Species.

Several factors would combine to help minimize the potential effects related to human presence in the study area. First, the Proposed Action is an expansion of an existing Hollister Site where human activity associated with underground exploration operations continues to date. Second, RCG would continue to implement its mandatory employee education program for all personnel working in and around the Hollister Site. Third, the potential for increased wildlife mortalities from vehicles along the mine access roads is expected to remain negligible, due to mine-regulated speed limits on mine roads, and bus/van transportation to and from the Hollister Site for mine employees traveling from Winnemucca, Nevada.

Water Management Activities

As discussed in Section 3.6, Surface Water Resources and Watersheds, disposal of excess mine water into Little Antelope Creek, is not anticipated to affect groundwater quality or the surface water quality of associated seeps, springs, or gaining reaches of streams (e.g., Little Antelope Creek). As a result, there would be no associated impacts to wildlife species associated with water quality.

Under the Proposed Action, continuous mine water discharging into Little Antelope Creek may expand riparian habitat along Little Antelope Creek as the amount of surface water increases. This would create additional habitat and water sources for wildlife, thus creating a beneficial impact to wildlife species that utilize the riparian areas along Little Antelope Creek for the 20-year life of the project. It is anticipated that this newly created riparian habitat and available surface water along Little Antelope Creek would decline to current levels once groundwater pumping operations cease. This would have a negative impact to wildlife species that have been accustomed to utilizing these riparian areas. It is likely that impacts would be more pronounced for species such as migratory birds and amphibians due to their association with riparian habitats and water sources.

Under the Proposed Action, RCG would continue groundwater pumping operations at the Hollister Site and increase pumping rates from current levels of 400 gallons per minute (gpm) to an estimated maximum of 1,100 gpm. As discussed in Section 3.6, Surface Water Resources and Watersheds and Section 3.9, Riparian and Wetland Areas, groundwater drawdown under the Proposed Action has the potential to impact surface water features (e.g., seeps, springs) in four spring complexes and 12 acres of associated wetland habitat and riparian habitat within the maximum extent of the 10-foot groundwater drawdown contour (**Figure 3.6-2**). Given the total of 408 acres of wetland habitat and 560 acres of riparian habitat within the maximum extent of the 10-foot groundwater drawdown contour, the Proposed Action may impact 2.9 percent and 1.6 percent of the wetland habitat and riparian habitat, respectively. Therefore, impacts to wildlife that utilize any impacted wetland and riparian habitats within the maximum extent of the 10-foot groundwater drawdown contour would increase as a result of increased groundwater pumping, but would decrease once geotechnical water removal operations cease and groundwater levels rebound. Therefore, impacts would include a potential decrease in available surface water and associated riparian and wetland vegetation.

Hazardous Materials Spill

The possibility of a transportation-related spill of process chemicals along the transportation route is discussed in Section 3.24, Hazardous Materials and Solid Waste. The potential for wildlife exposure to toxic chemicals as a result of a transportation-related spill would be greatest if an accident were to occur near aquatic habitats. Spills in dryland habitat would pose only minimal risk to most wildlife species since these spills would be adjacent to highways and could be rapidly contained and cleaned up. In general, the materials of greatest concern would be sulfuric acid and diesel fuel. The effects of a sulfuric acid release would be highly variable and would depend on the quantity released, the location of the release (e.g., dry upland area, wet meadow area, or flowing stream area), the species exposed, and the chemical conditions at the release location. The most likely effect of a potential release of sulfuric acid would be the poisoning of terrestrial or aquatic species. Animal species that drink contaminated water could suffer severe effects or death depending on the concentration of sulfuric acid and the volume of the water consumed. A diesel spill has the potential to contaminate soil, surface water, and groundwater in addition to harming aquatic life and vegetation. Although unlikely, such a spill also could ignite from the accident and cause a wildfire. Since cleanup actions would take place immediately, diesel contamination has a low potential to result in long-term impacts to soil, surface water, and possibly groundwater. Hazardous chemicals would be transported via U.S. Department of Transportation-certified containers and transporters, and transportation of sulfuric acid and other chemical reagents would be in accordance with all applicable rules and regulations. In addition, as discussed in Section 3.24, Hazardous Materials and Solid Waste, RCG would implement their Spill Prevention, Control, and Countermeasures Plan that establishes procedures for responding to accidental spills or releases of hazardous materials to minimize environmental risks.

3.12.2.2 Mud Springs Road Transmission Line Alternative

Impacts to wildlife resources would be the same as described for under the Proposed Action except the transmission line under this alternative would disturb 9.5 and 15.2 fewer acres of vegetation (50 percent sagebrush shrubland and 50 percent grassland) for North and South Options, respectively. This would reduce the extent of impacts associated with habitat disturbance, habitat fragmentation, and bird/bat collisions with the transmission line.

3.12.2.3 Mud Springs Waste Rock Storage Facility Alternative

Impacts to wildlife resources would be the same as described for the Proposed Action except for an additional 18.9 acres of disturbance to grassland habitat as a result of the Mud Springs Waste Rock Storage Facility (WRSF) and Mud Springs Road Diversion. The Mud Springs Road Diversion has the potential to increase habitat fragmentation; however, 30 percent of the 18.9 acres of grassland habitat disturbance occurs in previously burned (2005) habitat. Consequently, this area has already experienced habitat loss and fragmentation as a result of wildfires and any additional impacts to wildlife resources as a result of this alternative are expected to be low. Developing a stable land form design for the Mud Springs Waste Rock Facility that compliments the surrounding topography may reduce impacts to wildlife associated with human presence and noise.

3.12.2.4 Backfill Alternative

Impacts to wildlife resources would be the same as described for the Proposed Action except for an additional 10.6 acres of primarily grassland habitat would be lost temporarily until reclamation activities are completed. After closure and reclamation, noise and activity associated with the Backfill Alternative would be eliminated. Areas would be returned to wildlife habitat once re-seeded and successfully reclaimed.

3.12.2.5 No Action Alternative

Under the No Action Alternative, the Hollister Development Block Project would continue to operate under existing authorizations. The proposed project would not be developed, and the associated potential impacts to wildlife would not occur.

3.12.3 Cumulative Impacts

The CESAs for wildlife resources encompass a portion of NDOW's Management Area 6 (Hunting Units 062, 064, 067, and 068) as depicted in **Figures 3.12-1**, **3.12-2**, and **3.12-3**. The CESAs were determined by the BLM and NDOW based on wildlife use in the region and include a contiguous area that provides very important seasonal habitat for general wildlife species as well as mule deer and pronghorn. Generally, the CESAs extend from the northern end of the Independence Range in the north to the Humboldt River and northern end of the Piñon Range to the South. Cumulative impacts to wildlife resources would primarily be directly related to habitat loss, habitat fragmentation, and animal displacement. Cumulative effects on wildlife in the CESAs have resulted primarily from wildfires, mineral exploration, mining activities, noxious weeds and non-native invasive plant species, livestock grazing, drought, urbanization, and seeding of native range with introduced herbaceous species (BLM 2010d,e). Other industrial development activities in the area that result in habitat disturbance, fragmentation, and animal displacement include power plants, transmission lines, pipelines, and roads (BLM 2010d,e). Development of reasonably foreseeable mine projects would continue to impact big game in their respective CESAs. However, most mine areas proposed for development within the Carlin Trend typically have been within or adjacent to existing mine areas (BLM 2010d,e).

Past and present actions and RFFAs (Section 3.2) for mining activities in the wildlife, mule deer, and pronghorn CESAs resulted, or would result, in the direct disturbance of habitat (**Table 3.12-2**). A portion of the cumulative disturbance areas have been, or would be, reclaimed or has recovered

materially (i.e., wildfire areas). The reclaimed areas, and areas associated with habitat conversion, would be capable of supporting wildlife use; however, species composition and densities may change.

Within the wildlife, mule deer, pronghorn, and elk CESAs (**Figures 3.12-1** through **3.12-4**) mining has removed wildlife habitat, primarily as a function of fencing and/or land disturbance associated with mining operations. The proposed project and other mining operations within the Carlin Trend are located in the vicinity of migration corridors that connect important summer and winter range for big game (primarily mule deer and pronghorn). By definition, a wildlife movement corridor is a linear habitat with a primary function of connecting at least two significant habitat areas (Sawyer et al. 2005). Throughout the western U.S., big game species rely on seasonal ranges to satisfy their annual nutritional and energetic requirements (Sawyer et al. 2005). Over the past 10 to 20 years, seasonal big game movement corridors have been restricted due to mining operations in the project region (Area 6 Mule Deer Working Group 2010; BLM 2010d,e 2008b).

Within the mule deer CESA, a large herd of mule deer migrates south from their summer range in the Tuscarora Range, Independence Range, and Santa Renia Mountains to their winter range in the lower elevations of Boulder Valley, Dunphy Hills, Izzenhood area, and the southern end of the Sheep Creek Range (Area 6 Mule Deer Working Group 2010; BLM 2010d,e 2008b; NDOW 2010b). The Carlin Trend and surrounding areas developed by mining operations, including Betze/Post, Genesis/Blue Star, Lantern, Mill #1, Bootstrap /Capstone, Tara, Rossi, Dee, and Ren mines, is a mule deer migration corridor for movement to and from the winter range in the Dunphy Hills. Up to 4,000 deer migrate through this area twice annually. Due to the recent expansion of mining developments along the Tuscarora Range, little opportunity remains for north/south big game movement in Management Area 6 (Area 6 Mule Deer Working Group 2010; BLM 2008b; NDOW 2010b). This restriction has created a significant impact to the mule deer migration in this part of the Carlin Trend. In addition, wildfire has created one of the primary cumulative effects on these species. **Figure 3.12-1** describes wildlife habitat and vegetation. As shown in **Figure 3.2-3** and **Table 3.12-2**, from 1980 to 2009, thousands of acres of wildlife habitat have been impacted by large-scale wildfires. Wildfire has resulted in the long-term loss of shrubs that provide forage and cover as habitat components, which has caused reductions in mule deer and pronghorn herds throughout their respective CESAs. Effects of wildfires to terrestrial wildlife species include loss of habitat (forage and cover), which can lead to die-offs of mule deer and pronghorn as well as other species. The loss of shrub canopy cover and forb and grass diversity is prevalent across the burned areas and the recovery of these plant communities varies in terms of time and cover. In many areas, native shrub communities have been replaced by cheatgrass-dominated grasslands (Area 6 Mule Deer Working Group 2010; BLM 2010d,e). A breakdown of cumulative disturbance by the Proposed Action, wildfire, and mining operations is presented in **Table 3.12-2**.

Nesting raptor species also would be susceptible to these cumulative impacts since encroaching human activities along the Carlin Trend have resulted in bird displacement and habitat fragmentation in areas that may be at their relative carrying capacity for these resident species. Mine groundwater pumping activities within the CESAs could result in a reduction or loss of flows in springs and seeps that support wildlife and wildlife habitat (i.e., wetlands and riparian areas) (BLM 2010d). Reductions or elimination of flows in springs and seeps could impact wildlife species dependent on these sites (e.g., birds and amphibians) and may impact the distribution and use of habitat by other species of wildlife (e.g., big game and bats).

Many of the local wildlife populations (e.g., small game, migratory birds) that occur in the CESA would continue to occupy their respective ranges and breed successfully, although population numbers may decrease relative to the amount of cumulative habitat loss and disturbance from incremental development and groundwater pumping activities.

Table 3.12-2 Cumulative Wildlife, Mule Deer, and Pronghorn Habitat Disturbance

CESA and Habitat Type[1,2]	Total Acres of Habitat	Acres of Habitat Disturbed by Fire[3]	Acres Disturbed by Proposed Action	Acres of Habitat Disturbed by Mining Operations (Past, Present, RFFAs[4])	Total Acres of Habitat Disturbed
Wildlife	2,389,947	1,131,690 (47%)	129[5] (<1%)	38,622 (2%)	1,170,441 (49%)
Mule Deer - Limited Use	1,087,735	468,225 (43%)	84 (<1%)	31,448 (3%)	499,757 (46%)
Mule Deer - Transitional	553,849	315,304 (57%)	24[5] (<1%)	3,978 (4%)	319,306 (58%)
Pronghorn - Summer	1,199,893	723,871 (60%)	117 (<1%)	36,452 (3%)	760,440 (63%)
Elk - Low-density	776,312	496,482 (64%)	96[5] (<1%)	23,348 (3%)	519,926 (67%)
Elk - Crucial Winter	256,765	183,622 (>2%)	12 (<1%)	2,651 (1%)	186,285 (73%)

[1] The special status CESA is identical to the wildlife CESA, excluding greater sage-grouse.

[2] Habitat types such as mule deer summer habitat and pronghorn crucial winter habitat are not impacted by the proposed project and therefore not included in the cumulative analysis.

[3] Fire data used for this analysis has been further refined and modified since the Betze Pit Expansion Supplemental Environmental Impact Statement (BLM 2008b).

[4] See **Table 3.2-1** for breakdown of mining projects.

[5] Includes 12 acres of potentially impacted wetland habitat within the maximum extent of the 10-foot groundwater drawdown contour as a result of groundwater pumping. Riparian habitat also would be impacted, but is not quantified.

Source: BLM 2011d; U.S. Geological Survey 2004.

Cumulative impacts to wildlife resources for the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives generally would be the same as described for the Proposed Action. The exception would be 9.5 or 15.2 acres less habitat disturbance and reduced habitat fragmentation associated with the Mud Springs Road Transmission Line Alternative (North and South Options), 18.9 acres more surface disturbance for the Mud Springs WRSF, and 10.6 acres more disturbance for the Backfill Alternative.

3.12.4 Potential Monitoring and Mitigation Measures

No additional mitigation measures have been identified for wildlife resources.

3.12.5 Residual Impacts

All disturbance from the Proposed Action would be reclaimed. Residual impacts to wildlife resources under the Proposed Action would include the long-term loss of 43.8 acres of sagebrush shrubland. The loss of shrub-dominated communities would represent a long-term change in wildlife habitat composition (i.e., shrub-dominated communities to grass/forb dominated communities) under the Proposed Action because it would take up to approximately 25 years for mature shrubs to become established in these communities. In addition, 12 acres of wetland habitat and some riparian habitat may be impacted in the long-term under the Proposed Action due to the impacts associated with groundwater pumping within the maximum extent of the 10-foot groundwater drawdown contour.

3.13 Aquatic Biological Resources

The aquatic biological resources study area for direct and indirect impacts and the cumulative effects study area (CESA) encompasses the Little Antelope Creek and Antelope Creek drainages located within the Rock Creek Valley Hydrographic Basin (62) (**Figure 3.13-1**). Both the study area for direct and indirect impacts and the CESA include the lower portion of Antelope Creek downstream to the confluence with Rock Creek. The rationale for the study area boundary is based on drainages that potentially could be directly or indirectly affected by project construction and operation. Past, present, and reasonably foreseeable future actions (RFFAs) are described in Section 3.2. The types of information used to characterize aquatic biological resources consist of aquatic habitat and distribution/occurrence information for fish, amphibian, and invertebrate species or groups. Special status aquatic species also are discussed in this section.

3.13.1 Affected Environment

3.13.1.1 Habitat

Aquatic habitat in the project area includes streams, wetlands, and springs located within the Little Antelope Creek drainage (**Figure 3.13-2**). Most of the habitat consists of intermittent and ephemeral creeks and springs that provide water only during spring run-off and seasonal storm events (Bureau of Land Management [BLM] 2004a). Little Antelope Creek is considered an intermittent creek with numerous unnamed ephemeral tributaries. The mainstem portion of Little Antelope Creek is characterized as a broad, poorly defined channel with gravel, cobble, and boulder substrates (BLM 2004a; Brown and Caldwell 2011b). The average channel width in the vicinity of the Hollister Site is 5 feet. Little Antelope Creek flows into Antelope Creek approximately 5 miles south of the Hollister Site. Antelope Creek flows in a southwesterly direction and enters Rock Creek approximately 6 miles from the Little Antelope and Antelope creek confluence.

Based on wetland surveys conducted within the project area by JBR Environmental Consultants, Inc. (JBR) (2003a), several small areas of perennial flow were identified along Little Antelope Creek (**Figure 3.9 1**). The areas are considered wetlands that are located within or immediately adjacent to the stream. These wetlands ranged in size from <0.1 to 0.3 acre (JBR 2003a) (**Figure 3.9-1**). Riparian vegetation along the wet portions of the stream included Baltic rush (*Juncus balticus*), willows (*Salix exigua* and *S. lutea*), and creeping spikerush (*Eleocharis macrostachya*). Fire closure monitoring of riparian vegetation in 2006 indicated proper functioning conditioning at two sites along Little Antelope Creek within and below the BLM enclosure area (Evans 2008). As discussed in Section 3.9, Riparian and Wetland Areas, riparian vegetation is present in most of Antelope Creek within the study area.

General aquatic habitat observations also were made in Antelope Creek, as part of wildlife and amphibian surveys conducted by AECOM in May and June 2010 (AECOM 2010d). Flow was noted in an approximate 6-mile section of Antelope Creek upstream of its confluence with Little Antelope Creek. Stream widths ranged from approximately 4 to 20 feet, while depths varied from less than 0.5 to 4 feet. Habitat consisted of a mixture of pools, riffles, and runs. After spring runoff is completed, the creek is considered to have intermittent flow in late summer through the winter months.

Springs represent the other type of aquatic habitat in the overall region. Spring habitat within the project area is limited to several unnamed and named intermittent springs (e.g., Antelope Springs), which are wet after snowmelt and precipitation events. Mud Springs, which is located 1,400 feet east of the project area boundary, is estimated to be 0.7 acre in size and it contains a small perennial reach below the pond outflow. This area supports wetland vegetation including cattails (Evans 2010). Adjacent riparian areas also exist near springs within the Antelope Creek spring complexes (BLM 2011b).

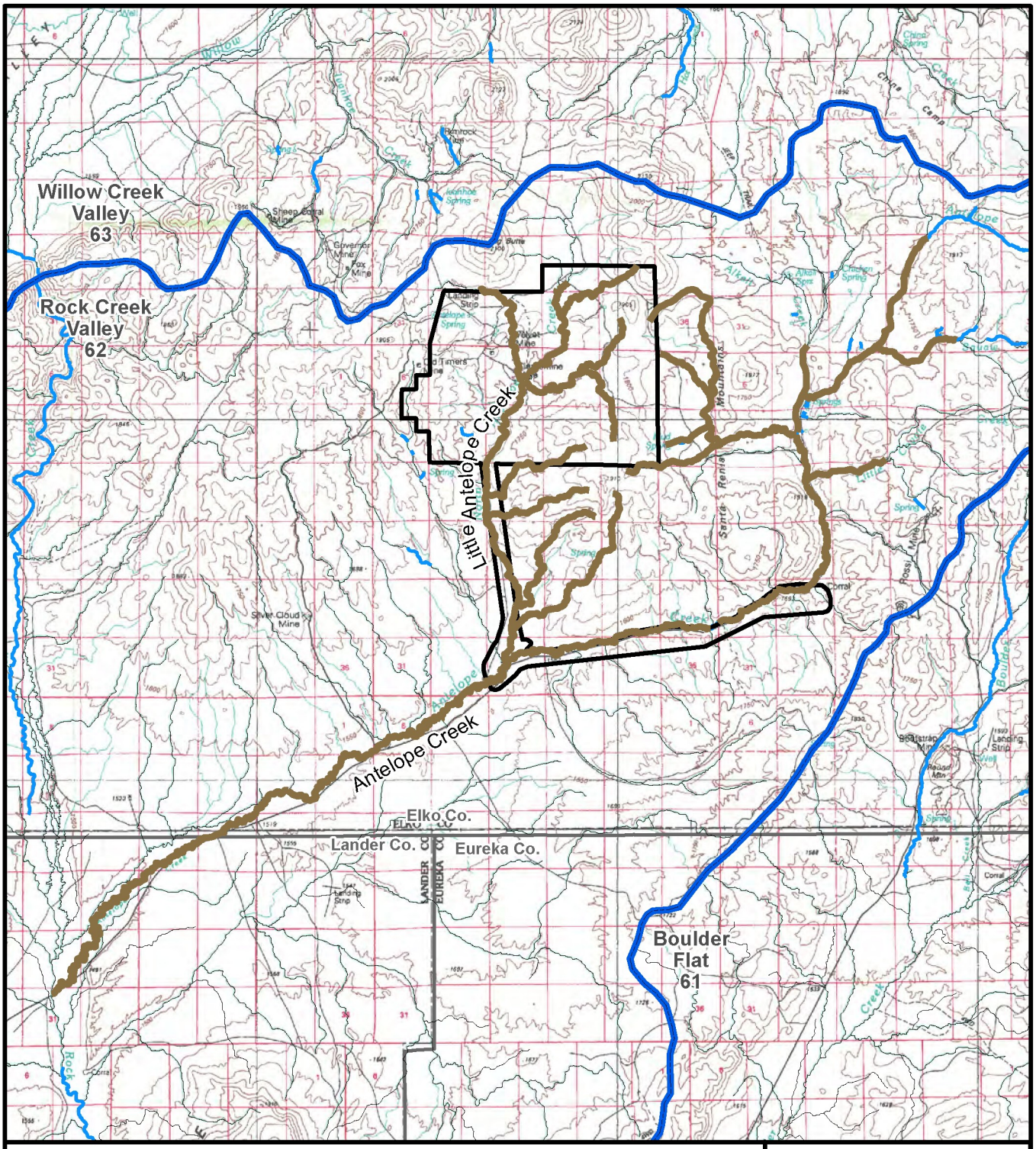


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Figure 3.13-1

Aquatic Resources Direct, Indirect, and Cumulative Effects Study Area

3/8/2012

Ivanhoe Road
Proposed Mine Office Complex
West Pit
Proposed NPDES Surface Discharge
Proposed HPS
East Pit Facilities
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
West RIBs (2) and Growth Media Stockpiles
East RIB
Antelope Creek Road
Proposed 120-kV Transmission Line
Proposed Rodeo Creek Substation
Mud Springs Road
Coyote Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E
Ivanhoe Spring
Antelope Spring
Alkali Creek
Alkali Spgs
Crutchen Spring
Mud Spring
Little Coyote Spring
Antelope Creek
Little Antelope Creek
Squaw Creek
Boulder Creek

Legend

Existing/Authorized Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- Proposed HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Aquatic Occurrence Locations

- Benthic Macroinvertebrate Sampling (Tetra Tech 2010)
- Springsnails

Pacific Chorus Frog

- NDOW Surveys
- AECOM Survey (Adults)
- AECOM Survey (Tadpoles)
- AECOM Survey (Habitat)

Sources: AECOM 2010d; Brown and Caldwell 2010a; Evans 2010; NDOW 2010a; Sada 2007.

N

0 0.45 0.9 Miles

Humboldt, Elko, Washoe, Pershing, Lander, Eureka, White Pine, Lyon, Churchill, Nye, Mineral, Lincoln, Esmeralda, Clark

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Figure 3.13-2

Aquatic Biological Resources Occurrence Information

3/20/2012

3.13.1.2 Aquatic Communities

Fish

Due to the limited amount of perennial surface water in Little Antelope and Antelope creeks, potential fish habitat is restricted to a few wetland areas or stream sections that provide surface water on a consistent annual basis. A previous survey in 1990 in the upper portion of Antelope Creek collected Lahontan speckled dace (*Rhinichthys osculus robustus*) and Lahontan mountain sucker (*Catostomus platyhynchus*) (JBR 1994). Lahontan speckled dace, redside shiner, and suckers (species not mentioned) also were observed in isolated pools in Antelope Creek by McGuire (1995). Fish (likely speckled dace) also were observed in Antelope Creek upstream of the confluence with Little Antelope Creek during the 2010 AECOM amphibian survey (AECOM 2010d). Suckers, redside shiners, and Lahontan speckled dace were observed to be abundant in perennial sections of Antelope Creek during July 2011 (BLM 2011b). These species could occur in other areas with perennial flow in the project area. In addition, fish occurrence could be expanded temporarily from these perennial water sources during storm events or high water years.

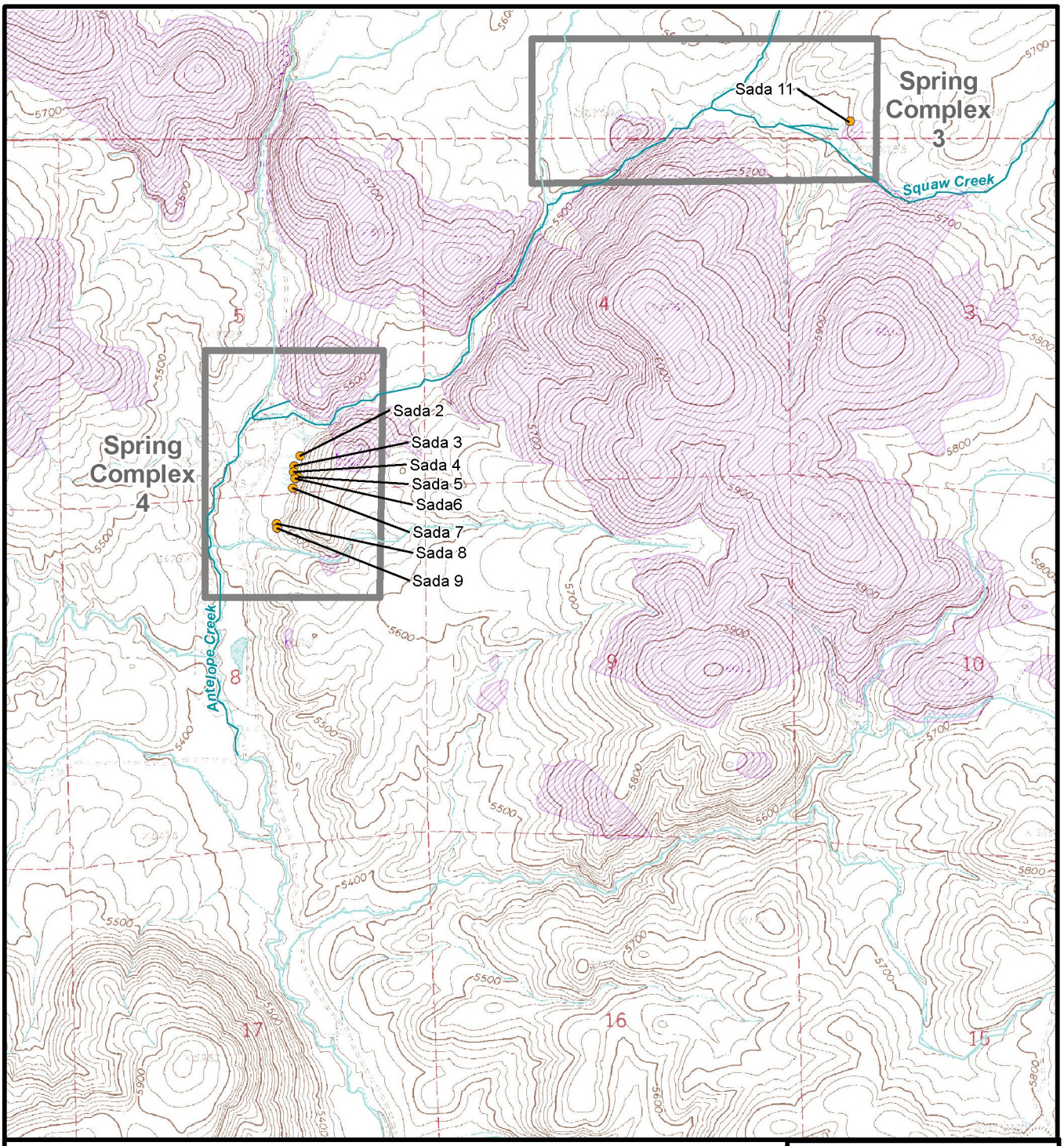
Amphibians

Potential habitat for amphibians includes perennial and intermittent reaches, wetlands, springs, and ephemeral ponds. Amphibian "visual encounter surveys" were conducted by AECOM from June 14 to 18, 2010, in Little Antelope and Antelope creeks. The survey protocol followed methods described by the Nevada Department of Wildlife (NDOW) (Hatch and Simandle, No Date). In Little Antelope Creek, Pacific chorus frogs (*Pseudacris regilla*) were observed at two locations, one with adult and tadpole life stages and the other with tadpoles. In Antelope Creek, adult or tadpole Pacific chorus frogs were observed at six locations (**Figure 3.13-2**). Potential amphibian habitat also was noted at six locations in this stream. Pacific chorus frog also was documented in Little Antelope Creek and Mud Springs in a previous NDOW survey (Evans 2010; NDOW 2010a) (**Figure 3.13-2**). This species also was observed near Antelope Creek in 2001 by JBR (2001) as cited in JBR (2008). This amphibian species uses perennial and ephemeral ponds and wetlands for breeding and early life stage development. Breeding typically occurs in late winter or spring. After the breeding season is completed, this species disperses back into upland habitat surrounding the waterbodies. Adults return to the same waterbody in subsequent years for breeding (Bernard 2010). Approximately 10 to 20 percent of the adults can survive more than one breeding season.

Invertebrates

In June 2009, Tetra Tech (2010) conducted an invertebrate survey at three stream locations along Little Antelope (**Figure 3.13-2**). In total, 11 taxonomic groups were collected at the stream locations, with the most abundant groups consisting of water beetles (Coleoptera), damselflies/gragonflies (Odonata), water mites (Hydracarina), caddisflies (Trichoptera), and worms (Oligochaeta).

Invertebrate communities in spring habitats depend on the type of water source (permanent or temporary), water chemistry, outflow discharge, substrate, and other habitat features (Erman 2002). Five major invertebrate groups typically are present in all types of springs including nematodes, aquatic worms (Oligochaeta), water mites (Acari), caddisflies (Trichoptera), and chironomid midges. Several groups such as flatworms and stoneflies are present only in springs with permanent water sources. Erman's studies also showed that the highest number of species were associated with stable springs that maintained water levels throughout the 20-year period of study. Invertebrate composition in Mud Springs and an unnamed spring near Little Antelope Creek included eight orders, with the most abundant groups consisting of Hirudinea (leeches), Coleoptera, Hydracarina, and Odonata (Tetra Tech 2010). Five invertebrate groups were present in each spring. Nine springs in the Antelope Creek drainage and one spring near Squaw Creek contain the springsnail, *Pyrgulopsis gibba* (McGuire 1996, 1995; Sada 2007) (**Figure 3.13-3**). *P. gibba* occurs in northern Nevada, eastern California, and southern Oregon, including 13 populations near the Carlin Trend (Sada 2007).



Legend

- Spring Complex
- **Springs (Sada 2007)**
  - Springsnail
- **Vinini Formation**
  - 1:24k Geologic Maps (NBMG)

N

0 1,300 2,600 Feet

Source: Sada 2007.

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Figure 3.13-3

Springsnail Springs Potentially Affected by Groundwater Pumping

1/18/2012

Springsnails are indicators of springs with water being present on a persistent basis and good water quality. Additional discussion of springsnails is provided in Section 3.14, Special Status Species.

3.13.2 Environmental Consequences

The primary issues related to aquatic resources include the following potential direct and indirect effects:

- Habitat alteration and sedimentation on aquatic species due to surface disturbance activities;
- Potential adverse water quality effects on aquatic species from water discharge;
- Potential flow changes on aquatic habitat due to water discharge and groundwater pumping; and
- Potential spills from vehicle traffic, equipment, and storage of diesel and gasoline products near waterbodies containing aquatic biological resources.

3.13.2.1 Proposed Action

Surface Disturbance Activities

Construction activities associated with the National Pollutant Discharge Elimination System (NPDES) surface discharge point, new electric power transmission lines (transmission lines), and road maintenance grading on the existing Little Antelope Creek Road would disturb soils near Little Antelope and Antelope creeks. This disturbance could result in potential sediment input to these drainages. The extent of sedimentation on downstream areas would depend on riparian vegetation. Sediment would be minimized in the portion of Little Antelope Creek inside the exclosures that support well vegetated and stabilized streambanks. This filtering effect on sediment would not occur in sections of the stream without riparian vegetation. As part of the construction activities, applicant-committed erosion control measures outlined in the project's Storm Water Pollution Prevention and Reclamation Plan would be implemented to reduce erosion and sediment transport in these streams. In addition, engineered storm water diversions would be designed and constructed to divert runoff away from the mine facilities. Storm water would be directed back to the natural drainage features associated with Little Antelope Creek. As a result, project-related effects of sediment on aquatic habitat are considered to be minor.

Construction of the 120-kilovolt (kV) and 24.9-kV transmission lines would result in temporary alteration of aquatic habitat in Little Antelope and Antelope creeks. For example, the 24.9-kV transmission line would cross Little Antelope Creek at three locations and three unnamed intermittent tributaries. The 120-kV transmission line would cross nine unnamed intermittent tributaries to Antelope Creek. Transmission line construction would involve vehicle traffic through these creeks. Instream construction for the transmission line structures are not anticipated at the intermittent creek crossings. The temporary disturbance to these creeks could result in mortalities to aquatic macroinvertebrates at locations with water flow. Fish are not expected to occur in the waters associated with construction areas due to an absence of persistent flow. After construction is completed, bottom substrates would return to pre-construction conditions. Macroinvertebrate species, if present, would be expected to recover within 6 months as the areas are recolonized, assuming flow or water is present on a periodic basis (Waters 1995).

Water Management Activities

The current mine water management facilities and operations would continue to be used as part of the mine water management system. Groundwater within the underground workings would be pumped at a rate of approximately 400 to 1,100 gallons per minute (gpm) over a 20-year life-of-mine period. Based on studies by Brown and Caldwell (2010a, 2003), groundwater pumping within the Vinini Formation is not expected to affect flows in Little Antelope Creek for the following reasons:

- Source of stream flows is snowmelt and precipitation runoff;
- Groundwater in the project area does not recharge Little Antelope and Antelope creeks; and
- Presence of clay-hydraulic boundary that restricts groundwater exchange between the Vinini Formation and overlying Tertiary volcanic units.

Based on groundwater modeling using the maximum extent of the 10-foot groundwater drawdown contour, groundwater pumping in the Vinini Formation could reduce flows and water levels in four spring complexes and potentially affected segments in Antelope, Alkali, and Squaw creeks in the CESA. As shown in **Figure 3.13-3**, eight springs associated with springsnails are located as a series in spring complex 4 in a wetland area adjacent to Antelope Creek. Seven of these Antelope Creek springs are considered low potential impact for groundwater pumping. The northern most spring (Sada 2) is considered a high potential impact. One additional spring (Sada 11) associated with springsnails, in spring complex 3 (high potential impact) is located in the Squaw Creek drainage. Although these nine springs associated with springsnails are located just outside of the Vinini Formation, they are within the maximum extent of the 10-foot groundwater drawdown contour, and groundwater could contribute flow to these springs. As a result, there is a risk that groundwater pumping could adversely affect spring habitat and species. Effects on habitat could include no change, slight to moderate reductions in spring water levels, or a total loss of wetted area depending on the volume of flow reduction. The effects of reduced flow would be more pronounced in small springs where changes in habitat conditions could represent a substantial portion of the habitat. Invertebrates are known to inhabit spring habitats (Erman 2002). Flow changes could shift the occurrence of invertebrates along the spring brook segment (i.e., inflow or outflow channel from spring). For example, spring invertebrates often move along a spring outflow gradient in response to changes in their thermal environment, located food sources, and find more suitable larval development sites. In addition, flow-related water quality changes could contribute to changes in community composition and taxonomic richness due to increased temperature and sedimentation and altered algae assemblages. Potential effects on springsnails, which occur in nine springs, are discussed in Section 3.14, Special Status Species.

Groundwater pumping also could reduce flow in the wetland areas in Antelope and Squaw creeks, referenced above for the nine springs. These areas could represent potential habitat for amphibian species, based on surveys conducted by McGuire (1996) and Sada (2007). If present, amphibian breeding, rearing, and adult habitat could be adversely affected by flow and water level reductions.

Groundwater pumping also could reduce flows in Antelope Creek and its tributaries, as a result of decreased spring flow input from the eight springs located adjacent to Antelope Creek. Flows could be reduced in approximately 10.4 miles of Antelope Creek upstream of the confluence with Little Antelope Creek. Fish and invertebrate densities could be reduced in this 10.4-mile segment of Antelope Creek due to a decrease in habitat or wetted area.

After treatment, the inflow water would be discharged to Little Antelope Creek at a rate of up to 1,100 gpm. The effects of the discharge on Little Antelope Creek flows are discussed in Section 3.6, Surface Water Resources and Watersheds, and evaluated in an analysis by Brown and Caldwell (2011b). Utilization of the NPDES outfall would result in increased flow in Little Antelope Creek, which would create additional aquatic habitat. The additional aquatic habitat during discharge would be temporary. After the discharge ceases, aquatic habitat would be reduced to pre-discharge conditions. Stream reaches with increased flow would provide habitat for aquatic macroinvertebrates and possibly nongame native fish species that have been observed in nearby drainages (e.g., speckled dace and Lahontan mountain sucker) and amphibians. Due to a predominance of losing reaches in Little Antelope and Antelope creeks (i.e., stream water infiltrates into a subsurface aquifer through the streambed, causing a net loss of surface water), increased flow may not persist throughout the downstream portions of these creeks below the NPDES discharge point.

As a result of increased discharge into Little Antelope Creek, water depths would increase at the three stream crossings by Little Antelope Creek Road. Currently, vehicles drive through the channel at relatively low water levels. Culverts could be required at these road crossings due to the increased water depths and flow conditions. Culvert construction would result in short-term disturbance to stream substrates and cause macroinvertebrate mortalities. Fish would likely move away from the construction area. Macroinvertebrates would recolonize the disturbed area within several months.

As discussed in Section 3.6, Surface Water Resources and Watersheds, comparisons of existing water quality conditions to stream standards indicates exceedences for dissolved oxygen, total dissolved solids, and sulfates in Little Antelope Creek. Mine discharge into Little Antelope Creek would require that stream water quality standards be met under the NPDES permit. Water quality monitoring would be required to confirm that these standards are met. By adhering to the NPDES permit requirements, no adverse effects of water quality on aquatic species would occur in Little Antelope Creek.

Spill Risks

Vehicle and equipment use in areas near creeks and springs would pose a risk to aquatic species from fuel spills or leaks reaching these waterbodies. In addition, the transport and storage of diesel and gasoline near waterbodies also would represent a risk if products enter the aquatic environment. If a spill occurred, the magnitude of the impact would depend upon the volume spilled and the extent of dispersal within the waterbody. Spilled fuel products could result in mortalities to aquatic species or sublethal effects on physiological functions or degradation of habitat due to effects on water quality. Rodeo Creek Gold Inc (RCG) would implement a Spill Prevention, Control, and Countermeasures (SPCC) Plan (RCG 2008a) to prevent and contain potential spills that could affect aquatic species and their habitat. The SPCC Plan would reduce the spill risks to a low level.

The Proposed Action also would involve ore transport by truck to the Esmeralda Mill in Mineral County or the Midas Mill in Elko County or other suitable processing facility. The estimated number of truck trips per day is 18 to 25, with frequency up to 7 days per week (described in Section 2.4.4.4, Ore Transport). Existing roads would be used for the ore transport, with no road upgrades or other surface disturbance activities. Truck transport poses a fuel spill risk along the route. In terms of potential fuel risks, the shorter transportation route to the Midas Mill would cross fewer perennial streams than the Esmeralda route. Aquatic species and their habitat could be affected if a fuel spill entered a perennial stream at a road crossing. Examples of streams crossed by the transport route include Willow Creek and Rock Creek. As previously discussed, the SPCC Plan (RCG 2008a) would be applied to ore transport activities, which would reduce the spill risk to a low level.

Exploration

Exploration activities would continue under the Proposed Action and involve additional surface disturbance of approximately 25 acres and 600 to 800 new drill holes over the 20-year life of the project within the project study area. No drilling would be allowed within 400 feet of springs, based on the Elko Resource Management Plan (BLM 1986a). No amphibians were observed in the small wetlands within the proposed exploration areas. Applicant-committed environmental protection measures involving sediment-control measures would be implemented to minimize sediment input to waterbodies. In addition, drill holes would be properly plugged and abandoned to avoid water quality effects to the environment.

3.13.2.2 Mud Springs Road Transmission Line Alternative

Construction of this alternative would result in temporary disturbance within the proposed right-of-way from vehicle traffic and installation of structures. This alternative would cross nine intermittent creeks (two in Little Antelope Creek, one at the Mud Springs outflow, four in Alkali Creek, and two in Coyote Creek). Habitat would be disturbed if vehicles crossed the creeks. If water is present during the time of

construction, sediment also could enter the drainage. As previously discussed, applicant-committed erosion control measures would be implemented to minimize sediment input to these creeks. By implementing these measures, sediment-related impacts would be considered minor. Based on the intermittent nature of these creeks, impacts to aquatic species would likely be limited to macroinvertebrates, which can develop in creek reaches with seasonal water availability. In comparison to the transmission line associated with the Proposed Action, this alternative would cross nine intermittent creeks compared to 15 intermittent creeks for the Proposed Action. Therefore, temporary disturbance to intermittent creeks and aquatic habitat (if water is present) would be less in comparison to the Proposed Action.

3.13.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under this alternative, the Mud Springs Waste Rock Storage Facility (WRSF) would be constructed instead of backfilling the West Pit with waste rock. Impacts to aquatic resources from the Mud Springs WRSF Alternative would be similar to the Proposed Action. Construction and operation of this alternative would overlap and disturb three small intermittent unnamed streams. No springs would be affected by this alternative. Aquatic habitat in these intermittent streams would be limited to spring runoff and periods after precipitation events. Water would be absent during most of the summer, fall, and winter months. Aquatic species inhabiting these streams would include invertebrates and algae that are suited for temporary habitat conditions. Construction of the Mud Springs Road diversion would not disturb any aquatic habitat. As discussed for other alternatives, applicant-committed erosion control measures would be implemented to minimize sediment input to these streams located along the perimeter of the WRSF. Impacts to aquatic habitat and associated species in the intermittent streams would be considered minor.

3.13.2.4 Backfill Alternative

This alternative would have the same impacts to aquatic resources as discussed for the Proposed Action. Waste rock removal and backfill activities would be conducted by implementing applicant-committed erosion control measures that would avoid sediment input to intermittent or spring habitats. The additional vehicle trips associated with this alternative would not cross aquatic habitats.

3.13.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be approved. Proposed surface disturbance activities, increased ore transport, and water discharge to Little Antelope Creek for the proposed project would not occur. Currently approved exploration activities would continue under this alternative. None of these activities currently result in surface disturbance or habitat alteration near Little Antelope or Antelope creeks or springs in the project area.

3.13.3 Cumulative Impacts

The CESA for aquatic resources includes Little Antelope Creek, Mud Springs, and Antelope Creek drainages downstream to the confluence with Rock Creek located within the Rock Creek Valley Hydrographic Basin (62) (**Figure 3.13-1**). The RFFAs are described in Section 3.2. Livestock grazing, mining operations, industrial development, presence of invasive noxious weeds and non-native invasive plant species, and agricultural activities in the CESA would act cumulatively in affecting aquatic biological resources. Potential cumulative adverse effects on aquatic habitat would include surface disturbance and loss of riparian vegetation from livestock grazing, conversion of native riparian vegetation to noxious weeds and non-native invasive plant species, wildfire, and disturbance and groundwater pumping from mining. The Proposed Action would result in minor adverse effects on aquatic biological resources in the Little Antelope and Antelope creek drainages as a result of surface disturbance activities and low risk from potential fuel spills.

Flow changes could occur in portions of the CESA due to groundwater pumping. Flow reductions could adversely affect habitat for fish and invertebrates due to potential groundwater pumping effects on springs along Antelope Creek. This adverse effect would exist upstream of the confluence with Little Antelope Creek. Beneficial effects on aquatic habitat could occur in Little Antelope Creek from mine water discharges as additional wetted areas could be added to Little Antelope and Antelope creeks. Some creek reaches may be able to contain water on a more consistent basis throughout the year. Additional habitat would be provided for macroinvertebrates and possibly fish and amphibians. These impacts would combine with other past, present, and future actions in the Little Antelope and Antelope creek drainages. Actions that have resulted in past disturbance within these drainages include the previous surface mining conducted at the Ivanhoe Mine and surface exploration at the Hollister Development Block Project. Past and current grazing also has occurred in the northern portion of Antelope Creek, which has affected riparian vegetation, sedimentation, and substrate alteration in creek channels. Other past and current mining operations in the region such as the Betze Project required dewatering that could affect some of the nearby drainages such as Boulder Creek. Monitoring has been implemented for the Betze Project EIS to detect potential groundwater pumping effects. It includes existing monitoring in the Boulder Creek Subbasin and Antelope Creek. Springs in Upper Boulder Creek, Antelope Creek, and upper Bell Creek also are being monitored to detect potential changes in water levels, outflows, and water quality (BLM 2008b). Post-mining monitoring has indicated that mine dewatering appears to have impacted flows of springs at two sites along Boulder Creek located downstream of the Bootstrap Mine (AATA International 2010). No dewatering effects were evident at the other four monitoring sites in the Boulder Creek catchment. In addition, there is no evidence that flows and water quality in the Antelope Creek, Little Antelope Creek, and Rock Creek catchment basins have been affected by the Betze/Post Mine.

Groundwater pumping from the Hollister Mine could reduce flow in nine springs associated with springsnails, which are fed by the Vinini Formation. These springs are located along Antelope Creek and Squaw Creek. Flow could decrease in these springs and result in flow reductions in Antelope Creek. Water level and flow reductions would result in adverse effects on springsnails in springs and fish and invertebrates in Antelope Creek.

Ore transport to the Midas Mill as an option under the Proposed Action would result in lower spill risks to streams crossed by the truck route due to the shorter transport distance compared with ore transport to the Esmeralda Mill. The SPCC Plan (RCG 2008a) would be implemented to prevent or contain any potential fuel spills. The Proposed Action would contribute minor impacts in the CESA.

Construction of the Mud Springs Road Transmission Line Alternative would result in short-term impacts to nine intermittent creeks. Due to the intermittent nature of these creeks, impacts would be limited to macroinvertebrates, if water was present during the time of construction. Applicant-committed erosion-control measures would be implemented to reduce sediment effects on water quality and macroinvertebrate communities. As a result, this alternative would contribute minor effects on aquatic habitat and biota within the CESA. Other past mining projects, along with past and present grazing, has resulted in sediment effects on intermittent streams to Antelope and Little Antelope creeks.

Cumulative impacts to aquatic resources under the Mud Springs WRSF and Backfill alternatives would be the same as discussed for the Proposed Action.

3.13.4 Potential Monitoring and Mitigation Measures

AR-1

Issue: Springsnail populations may be at risk from groundwater pumping because this pumping could potentially affect springs and wetlands.

Monitoring/Mitigation Measure: A cooperative monitoring plan would be developed for the monitoring of springs containing springsnails that may be affected by groundwater drawdown. Access to springs on private land would require permission from the land owner(s). RCG would fund the monitoring efforts.

Effectiveness: This measure would be effective in determining changes in springsnail population numbers and habitat conditions that are an important part of population maintenance. However, the measure would not be effective in preventing the loss of a population if water levels are reduced to a level that adversely affects the species.

In addition to AR-1, mitigation measure RW-1 described in Section 3.9, Riparian and Wetland Areas, would be implemented to try to reduce potential groundwater pumping impacts on springsnail springs.

3.13.5 Residual Impacts

Residual beneficial effects on aquatic habitat and species could result from the Proposed Action as a result of the NPDES discharge into Little Antelope Creek, for the life of the mine. The magnitude of the beneficial effect would depend on the discharge volume and the ability of the stream reaches to maintain flow. Residual adverse effects of groundwater pumping could occur if water levels are reduced in springs containing aquatic species. There is a potential for a loss of springsnail populations further discussed in Section 3.14, Special Status Species.

3.14 Special Status Species

Special status species are those species for which state or federal agencies afford an additional level of protection by law, regulation, or policy. Included in this category are federally listed species that are protected under the Endangered Species Act (ESA), and species designated as sensitive by the Bureau of Land Management (BLM). In addition, there is a Nevada State protected animal list (Nevada Administrative Code 501.100-503.104) that the BLM has incorporated, in part, into the BLM's sensitive species list.

In accordance with the ESA, as amended, the lead agency (BLM) in coordination with the United States Fish and Wildlife Service (USFWS) must ensure that any action that they authorize, fund, or carry out would not adversely affect a federally listed threatened or endangered species. In addition, as stated in Special Status Species Management Policy 6840 (6840 Policy) (Rel. 6-125), it also is the BLM's policy "to conserve and/or recover ESA-listed species and the ecosystems on which they depend so that ESA provisions are no longer needed for these species, and to initiate proactive conservation measures that reduce or eliminate threats to BLM sensitive species to minimize the likelihood of and need for listing of these species under the ESA." The following discussion summarizes known data for the special status species identified for the proposed project by the applicable agencies.

The study area for direct and indirect impact assessments for special status species includes the area within the project boundary and riparian, stream, spring/pond, and wetland habitats within the maximum extent of the 10-foot groundwater drawdown contour. The cumulative effects study area (CESA) for special status species, excluding greater sage-grouse, is the same as described for general wildlife (**Figure 3.12-1**). The CESA for greater sage-grouse is presented in **Figures 3.14-1** and **3.14-2**, which show the Tuscarora Population Management Unit (PMU).

3.14.1 Affected Environment

A total of 46 special status species were identified as potentially occurring within the study area (Nevada Department of Wildlife [NDOW] 2010a; Nevada Natural Heritage Program [NNHP] 2010a,b; USFWS 2010). These species, their associated habitats, and their potential for occurrence within the study area are summarized in **Appendix E, Table E-1**, Special Status Species. Occurrence potential within the study area and CESA was evaluated for each species based on their habitat requirements and/or known distribution. Based on these evaluations, nine special status wildlife species have been eliminated from detailed analyses based on their habitat requirements and/or known distributions as discussed in **Appendix E, Table E-1**, Special Status Species. These species include western red bat, river otter, northern goshawk, peregrine falcon, least bittern, black-rosy finch, Mattoni's blue, Lahontan cutthroat trout, and interior redband trout. The remaining 37 special status wildlife species identified as potentially occurring within the study area are described in the following sections. No sensitive, threatened, or endangered plants are known to occur within the study area.

3.14.1.1 Mammals

Special Status Bat Species

Federal and state sensitive bat species that have been identified as potentially occupying appropriate habitat types within the study area are presented in **Table E-1**, Special Status Species. Bat species that could occur within the study area include pallid bat, Townsend's big-eared bat, big brown bat, silver-haired bat, hoary bat, California myotis, small-footed myotis, long-eared myotis, little brown myotis, long-legged myotis, Yuma myotis, western pipistrelle bat, and Brazilian free-tailed bat. Due to the presence of seeps, springs, and creeks, suitable foraging habitat is present in portions of the study area (BLM 2004a; Bradley et al. 2006; NDOW 2010a). Roosting habitat within the study area includes rock outcrops. Higher elevation forest habitats and cliffs are present east of the study area in the Tuscarora Range and may provide potential roosting habitat for bats.

Pallid Bat

The pallid bat is a year-round resident in Nevada. Found primarily at low and mid elevations (1,300 to 8,400 feet above mean sea level [amsl]), this species occupies a variety of habitats such as piñon-juniper, blackbrush, cresote, sagebrush, and salt desert scrub (Bradley et al. 2006). This species feeds primarily on large ground-dwelling arthropods (e.g., scorpions, centipedes, grasshoppers), but also feeds on large moths (Bradley et al. 2006). The pallid bat is a colonial species, roosting in groups of up to 100 individuals (Arizona Game and Fish Department [AGFD] 1993). Roost sites consist of rock outcrops, mines, caves, hollow trees, buildings, and bridges (AGFD 1993; Bradley et al. 2006). The pallid bat is intolerant of roost sites in excess of 40 degrees Celsius (Bradley et al. 2006). This species has been documented south of the study area along Rock Creek and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Townsend's Big-eared Bat

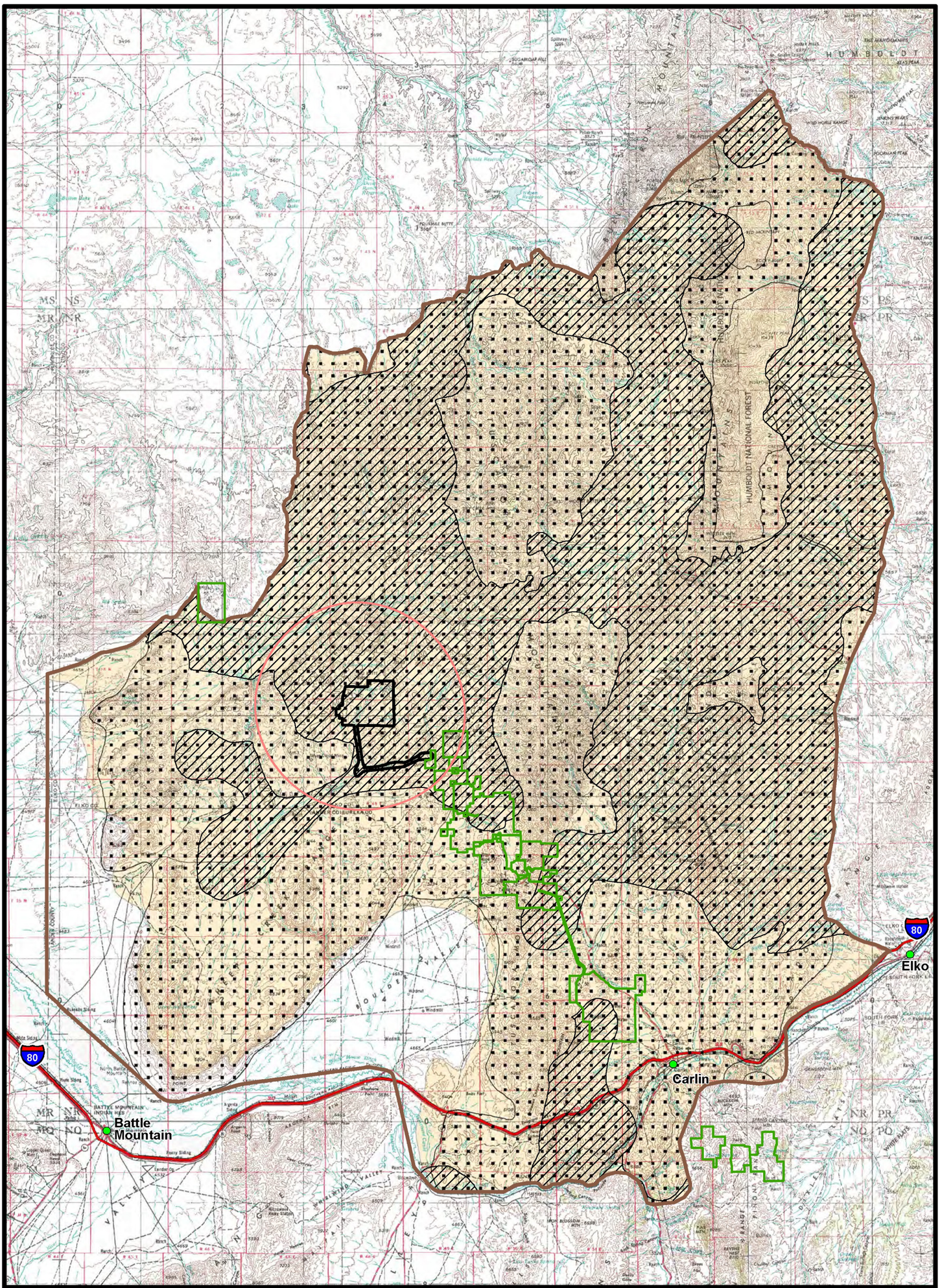
The Townsend's big-eared bat is a year-round resident found throughout Nevada from low desert to high elevation mountain habitats (690 to 11,400 feet amsl). The Townsend's big-eared bat primarily occurs in piñon-juniper, mountain mahogany, white fir, blackbrush, sagebrush, salt desert scrub, agricultural lands, and urban habitats (Bradley et al. 2006). This species prefers caves, mines, and buildings that maintain stable temperatures and airflow for nursery colonies, bachelor roosts, and hibernacula. It does not make major migrations and appears to be relatively sedentary, not traveling far from summer foraging grounds to winter hibernation sites. Its distribution seems to be determined by suitable roost and hibernation sites, primarily caves and mines (Harvey et al. 1999). This bat is believed to feed entirely on moths, which are gleaned moths from foliage and other surfaces (Bradley et al. 2006; Harvey et al. 1999). This species has been documented southwest of the study area along Rock Creek and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Big Brown Bat

The big brown bat is a year-round resident in Nevada. This species is found from low to high elevations (980 to 9,800 feet amsl) and occupies a variety of habitats including piñon-juniper, blackbrush, cresote, sagebrush, and salt desert scrub. This species gleans insects over water and open landscapes, as well as in both forested and edge settings. The big brown bat is a colonial species, roosting in groups up to several hundred. Roost sites include caves, mines, buildings, bridges, and trees. This species is known to be more tolerant of human habitation than other bat species (Bradley et al. 2006). This species has been documented southeast of the study area in the Santa Renia Mountains and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Silver-haired Bat

The silver-haired bat summers and reproduces in northern Nevada and typically occupies low to mid elevations (1,500 to 8,200 feet amsl). This species inhabits coniferous and mixed deciduous/ coniferous forests of piñon-juniper, subalpine fir, white fir, limber pine, aspen, cottonwood, willow, and riparian areas. This species gleans insects and moths in or near wooded areas and along edges of roads, streams, or waterbodies. This species roosts both singly or in small groups in hollow trees, rock crevices, mines, caves, and houses (Bradley et al. 2006). This species has not been documented in the study area. Based on occurrence records in Nevada and marginal foraging habitat within the study area, the potential for this species to occur within the study area is considered low.



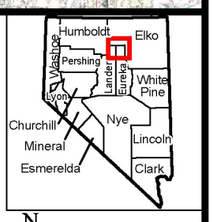
Greater Sage-grouse Habitat in the Study Area and Cumulative Effects Study Area

Figure 3.14-1

Hollister Underground Mine Project EIS

Legend

- Project Area Boundary
- Mine Plan Boundaries
- Cumulative Effects Study Area (PMU)
- Maximum Extent of the 10-foot Groundwater Drawdown Contour (Study Area)
- Nesting and Early Brood Habitat
- Winter Habitat
- Late Summer Habitat



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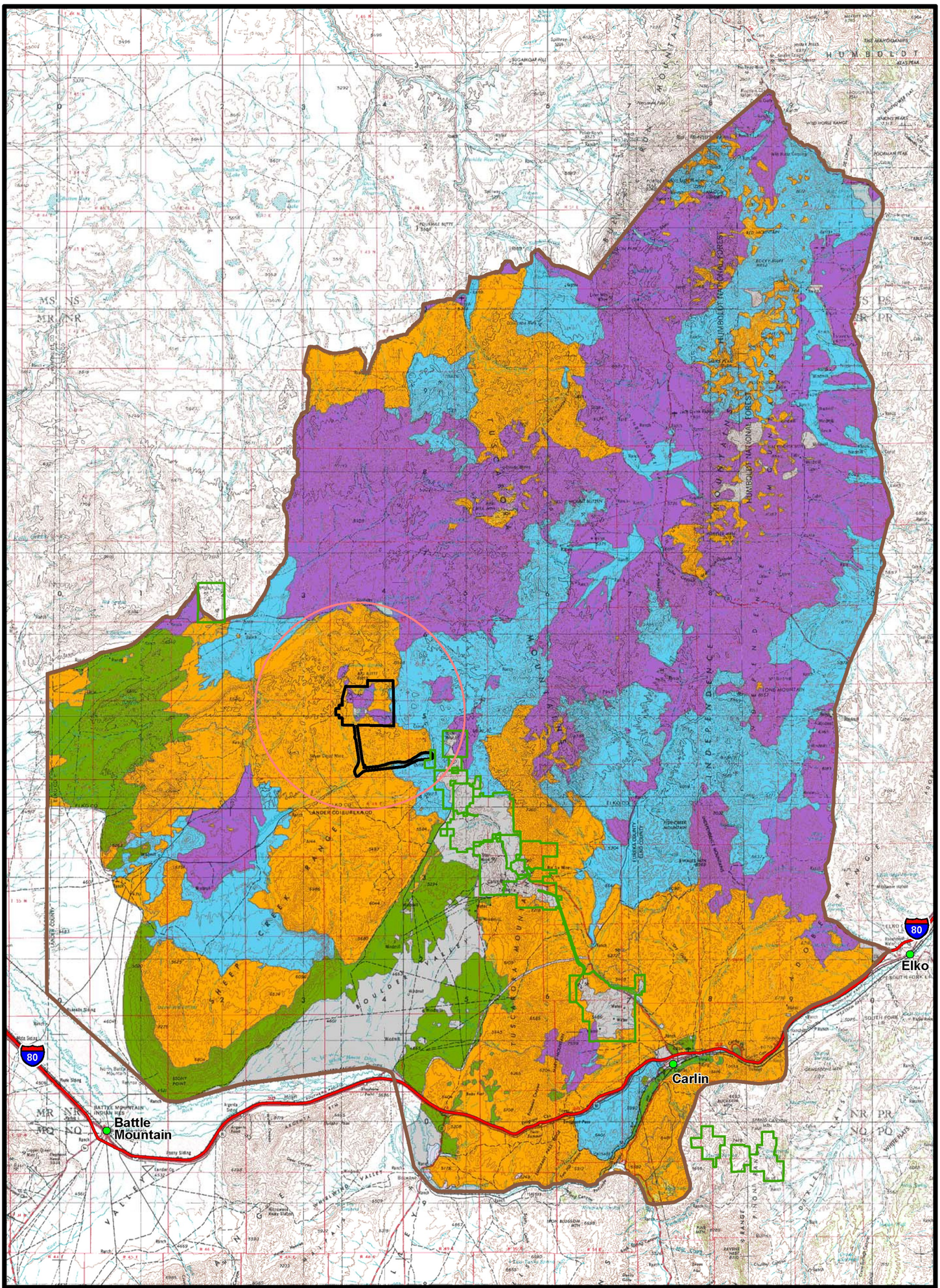
Miles

Source: NDOW 2009a.

3.14-3

3/8/2012



Source: NDOW 2012.

Hollister Underground Mine Project EIS

Figure 3.14-2

Greater Sage-grouse PPH and PGH in the Study Area and Cumulative Effects Study Area

3.14-4

4/19/2012

Hoary Bat

The hoary bat is a summer resident in Nevada found at low to mid elevations (1,870 to 8,200 feet amsl) in forest habitats including riparian areas. This species also is found in valley basins containing pure stands of Rocky Mountain juniper as well as agricultural areas. The hoary bat forages primarily at high altitudes over the tree canopy and would follow watercourses for foraging and drinking. This species roosts in trees within foliage but may roost in caves and beneath rock ledges (Bradley et al. 2006). This species has not been documented in the study area. Based on occurrence records in Nevada and marginal roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered low.

California Myotis

The California myotis is a year-round resident found throughout Nevada at low and mid elevations (689 to 8,957 feet amsl). This species occurs in a variety of habitats from Lower Sonoran desert scrub to higher elevation forests. The California myotis gleans insects above open habitat. This species typically roosts singly or in small groups, although some mines are known to shelter colonies of over 100 individuals. Roost sites include mines, caves, buildings, rock crevices, hollow trees, and under exfoliating bark. This species is known to forage throughout the winter (Bradley et al. 2006). This species has not been documented within the study area. However, based on the presence of marginal roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered moderate.

Small-footed Myotis

The small-footed myotis is found throughout Nevada from approximately 3,500 to 5,900 feet amsl. This species inhabits a variety of habitats including desert scrub, grassland, sagebrush steppe, blackbrush, greasewood, piñon-juniper woodlands, pine-fir forests, agricultural lands, and urban areas. Day and maternity roosts have been found in crevices in cliffs, boulders, and on talus slopes (Bradley et al. 2006). Summer roosts are highly variable and include buildings, mines, under the bark on trees, and crevices in cliffs and boulders (AGFD 1993; Harvey et al. 1999). This species prefers small protected dry crevices. Night and hibernation roosts are located in small caves and abandoned mine adits. Buildings also are used as temporary night roosts between flights. This species forages for insects over the edge of rocky bluffs, in clearings, near rocks, and over forests (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). This species has been documented southeast of the study area in the Santa Renia Mountains and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Long-eared Myotis

The long-eared myotis is found throughout Nevada from approximately 2,260 to 6,790 feet amsl but primarily is found at higher elevations. The long-eared myotis primarily is associated with coniferous forests, including piñon-juniper woodlands, but the species also utilizes sagebrush and desert scrub habitats. Day roosts include hollow trees; under loose tree bark; crevices in rock cliffs and fissures in the ground; and occasionally in caves, abandoned mines, and buildings. Night roosts primarily occur in caves, mines, and abandoned buildings (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). This species is known to roost singly or in small groups. This species gleans insects (primarily small moths) over vegetation and open water (e.g., rivers, streams, and ponds) (Bradley et al. 2006). This species has been documented southeast of the study area in the Santa Renia Mountains and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Little Brown Myotis

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

Long-legged Myotis

The long-legged myotis occupies sagebrush shrublands and piñon-juniper and montane coniferous forest habitats from approximately 3,050 to 11,220 feet amsl in Nevada. Individuals typically day roost singly or in small groups in buildings, rock crevices, caves, abandoned mines, or in hollow trees, particularly large diameter snags or live trees within lightning scars (AGFD 1993; Bradley et al. 2006; Harvey et al. 1999). Night roosts and hibernacula are often in caves and mines. Foraging typically occurs in open areas, often at canopy height (Bradley et al. 2006). This species has been documented southeast of the study area in the Santa Renia Mountains and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Yuma Myotis

The Yuma myotis is a year-round resident found primarily in the southern and western half of Nevada at low to middle elevations (1,476 to 7,677 feet amsl). This species occurs in a wide variety of habitats, including sagebrush, salt desert scrub, agriculture, playa, and riparian habitats. This species gleans aquatic insects over open water and above vegetation. Roost sites include buildings, trees, mines, caves, bridges, and rock crevices. Night roosts are usually associated with buildings, bridges, or other man-made structures (Bradley et al. 2006). This species has been documented northeast of the study area in the Tuscarora Mountains and is likely to occur within the study area (Bradley et al. 2006; NDOW 2010a). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Western Pipistrelle Bat

The western pipistrelle is a year-round resident in Nevada, occupying low and mid elevations (680 to 8,200 feet amsl) in desert habitats of blackbrush, creosote, salt desert scrub, and sagebrush, with occasional occurrence in ponderosa pine and piñon-juniper, usually in association with rock features such as granite boulders and canyons. This species gleans insects over open habitats. This species roosts both singly or in small groups in mines, caves, or occasionally in buildings and vegetation. This species has been documented south of the study area along Rock Creek and is likely to occur within the study area (BLM 2004a; Bradley et al. 2006). Based on its known range and the presence of suitable roosting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Brazilian Free-tailed Bat

The Brazilian free-tailed bat is found throughout Nevada in a wide variety of habitats ranging from desert scrub to high elevation mountain habitats (680 to 8,200 feet amsl). This species roosts in a variety of structures including cliff faces, caves, mines, buildings, bridges, and hollow trees. Some caves are used as long-term transient stopover roosts during migration. The Brazilian free-tailed bat is known to travel long distances to foraging areas and often forages at high altitudes. This species has not been documented within the study area. The nearest record is approximately 35 miles southeast of the study area along the Humboldt River near Elko, Nevada (Bradley et al. 2006). Based on the

presence of suitable foraging habitat within the study area, the potential for this species to occur within the study area is considered moderate.

Preble's Shrew

The Preble's shrew is found in a wide variety of habitats in Nevada including arid grasslands and shrublands, wetland and forest edges, and alpine tundra. This species is active year-round and may be active at any time throughout the day or night, but is probably most active during morning and evening hours (Wildlife Action Plan Team 2006). Most likely resembles other shrews, feeding primarily on insects and other small invertebrates such as worms, mollusks, and centipedes (Wildlife Action Plan Team 2006). The Preble's shrew has been documented approximately 35 miles northeast of the study area near Sheep Creek and suitable habitat occurs within the study area (Ports and George 1990). The potential for this species to occur within the study area is considered high.

Fletcher Dark Kangaroo Mouse

This species is found throughout Nevada in a wide variety of habitats including intermountain desert scrub, sagebrush grasslands, badlands, desert playas, and ephemeral pools. This species primary food source is seeds but also may eat insects. It does not appear to utilize free water and is believed to store food in seed caches within burrow systems. Activity for this species has been observed March through October with peak nocturnal activity occurring in the first two hours after sunset (Wildlife Action Plan Team 2006). This species has been recorded near Halleck, Nevada, in Elko County (O'Farrell and Blaustein 1974). Based on the presence of suitable habitat within the study area, the potential for this species to occur within the study area is considered high.

Pygmy Rabbit

The pygmy rabbit is distributed throughout the northern Great Basin, primarily in habitats dominated by dense stands of big sagebrush and rabbitbrush. This species is most abundant in areas with suitable soils (e.g., high clay content) for burrowing. Pygmy rabbits usually remain near dense cover, where rabbits excavate burrows and create trail systems in the understory. Sagebrush is important forage for this rabbit and is consumed year-round (BLM 2004b). This species has been recorded along the Mud Springs Road and suitable sagebrush habitat occurs throughout the study area based on results of field surveys conducted in 2010 (AECOM 2010b; NDOW 2010a; USFWS 2010). The potential for this species to occur within the study area is considered high.

3.14.1.2 Birds

Bald Eagle

The bald eagle is found throughout Nevada but mainly as a migrant and winter resident (Floyd et al. 2007; Herron et al. 1985). This species generally roosts in close proximity to large water bodies including rivers, lakes, and reservoirs (Johnsgard 1990; Wildlife Action Plan Team 2006). Nests are typically very large stick nests located in large trees such as cottonwoods. Bald eagles typically begin nesting in February and young fledge by July (Herron et al. 1985). This species has been documented within the special status species' CESA. This species has been documented during winter surveys within Squaw Valley and the sub-basins of Rock, Boulder, and Maggie Creek (BLM 2008b, 2004a). However, due to the lack of suitable habitat (i.e., large trees near waterbodies) within the study area, occurrences would be limited to migrating and foraging individuals. Therefore, the potential for this species to occur within the study area is considered moderate.

Swainson's Hawk

The Swainson's hawk is a summer resident of Nevada and, like the golden eagle, is most abundant in the northern third of the state (Floyd et al. 2007; Herron et al. 1985). The majority of documented breeding territories in Nevada have been located in agricultural valleys. This species nests in a wide variety of vegetative communities from 4,000 to 6,500 feet in elevation. Nest sites primarily are found

in deciduous trees; however, nests also have been documented in other vegetation types such as buffaloberry, serviceberry, and sagebrush. Swainson's hawks begin nesting in April and young typically fledge by July (Herron et al. 1985; Johnsgard 1990). This species is known to nest south of the study area along the Humboldt River (Herron et al. 1985). No nest sites have been documented within the study area (NDOW 2010a). Based on the presence of suitable nesting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Ferruginous Hawk

The ferruginous hawk is a common breeder in many areas of Nevada, particularly the central and east-central portions of the state (Floyd et al. 2007; Herron et al. 1985). This species often nests in trees, on promontory points, rocky outcrops, cut banks, or on the ground. Preferred breeding habitat in most of the state is scattered juniper forests at the interface between piñon-juniper and desert shrub communities that overlook broad valleys used for foraging. However, this species also is common in sagebrush shrublands. Ferruginous hawks begin nesting in March and young fledge by July (Herron et al. 1985; Johnsgard 1990). One active nest site was documented within the study area during biological surveys (AECOM 2010c). Based on the presence of an active nest site and suitable nesting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Golden Eagle

The golden eagle is a year-long resident and is considered to be a common breeder throughout Nevada; however, eagle densities and nesting activity are greatest in the northern third of Nevada (Floyd et al. 2007; Herron et al. 1985). Nesting golden eagles prefer suitable cliffs that overlook sagebrush flats, piñon-juniper forests, salt desert shrub, or other habitat capable of supporting a suitable prey base. Highest densities of nesting eagles typically are found along river systems where cliffs border the entire length of the river, and lower densities are found in piñon-juniper habitat and salt desert shrub communities. Golden eagles begin nesting March and young fledge by July. Wintering golden eagles tend to congregate in broad valleys interspersed with agricultural croplands or sagebrush and desert shrub communities (Herron et al. 1985; Johnsgard 1990). Suitable nesting habitat exists approximately 20 miles south of the study area (BLM 2008b). This species also has been observed foraging within the study area (AECOM 2010c). Based on the presence of suitable foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Prairie Falcon

Prairie falcons range throughout the Great Basin and are permanent residents of Nevada. Habitat requirements include steep cliff ledges and outcrops for nesting that border semi-arid valleys. The highest nesting densities in Nevada occur in northern counties, particularly located in or near the mouth of narrow canyons, overlooking riparian vegetation and agricultural lands. Prairie falcons begin nesting in March and young typically fledge by July (Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990). Suitable nesting habitat occurs approximately 25 miles south of the study area in the Sheep Creek Range (BLM 2008b; Floyd et al. 2007). The nearest known prairie falcon nest occurs approximately 2 miles northeast of the Hollister Site (NDOW 2010a). This species also has been observed foraging in the study area (AECOM 2010c; BLM 2004a). Therefore, the potential for this species to occur within the study area is considered high.

Greater Sage-grouse

The greater sage-grouse is found throughout Nevada in sagebrush dominated habitats (Floyd et al. 2007). The greater sage-grouse CESA is based on the Population Management Unit (PMU), and is presented in **Figures 3.14-1** and **3.14-2**. Sagebrush is a key component of greater sage-grouse habitat on a year-long basis. Sagebrush provides forage and nesting, security, and thermal cover for this species. Moist areas that provide succulent herbaceous vegetation during the summer months are

used extensively as brood rearing habitat. Open, often elevated areas within sagebrush habitats usually serve as breeding areas (strutting grounds or lek sites). In Nevada, greater sage-grouse males begin displaying on leks in March and hens typically begin nesting in April and May. During winter, greater sage-grouse often occupy wind exposed areas where sagebrush is available (e.g., drainages, southern or western slopes, or exposed ridges) (Connelly et al. 2000; Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). **Table 3.14-1** presents data on the three active leks that occur within the study area (NDOW 2010a; NNHP 2010a).

Table 3.14-1 Greater Sage-grouse Leks within the Project Vicinity

Name	Status	Distance from Existing Disturbance (miles)	Number of Birds			
			2007	2008	2009	2010
East Velvet	Active	1.00	4	0	-	6
East Clementine	Active	1.10	-	0	2	10
Big Butte	Active	3.48	5	7	-	*

"-" indicates the lek was not surveyed.

* Ground surveys did not observe birds but found sign (i.e., feathers, droppings).

Note: Greater sage-grouse lek data for 2011 is not available.

Source: Burton 2011; Miller 2010b.

Greater sage-grouse nesting, summer, and winter habitat is found within the study area (**Figure 3.14-3**). Approximately 15,958 acres of undisturbed (i.e., unburned) nesting habitat and approximately 16,609 acres of undisturbed summer and winter habitat occurs within the study area. Over the last 10 years wildfires have burned thousands of acres of sagebrush habitat in and around the study area. The remaining patches of unburned sagebrush habitat are very important to area's greater sage-grouse, particularly sagebrush patches which provide high quality nesting habitat. These areas are limited within the study area and are mainly found along Little Antelope Creek, Antelope Creek, and the Mud Springs Road. Field surveys conducted within the study area documented greater sage-grouse sign (e.g., droppings) within the study area, although no birds were observed. Based on the presence of suitable habitat and the close proximity of active leks to the Hollister Site, the potential for this species to occur within the study area is considered high.

In addition to the NDOW designated habitat categories described above, the BLM has recently issued additional guidance on greater sage-grouse management. According to BLM IM 2012-043, two habitat categories have been developed by the BLM and NDOW to help apply management guidelines designed to protect greater sage-grouse habitat. These habitat types are referred to as Preliminary Priority Habitat (PPH) and Preliminary General Habitat (PGH). PPH includes areas that have been identified as having the highest conservation value to maintaining sustainable greater sage-grouse populations. PPH comprises essential/irreplaceable habitat and important habitat (NDOW Categories 1 and 2) (note: these characterizations are preliminary and subject to change). PPH includes breeding, late-brood rearing, and winter concentration areas. Approximately 46,110 acres of PPH (16,720 acres of essential/irreplaceable habitat and 29,390 acres of important habitat) occurs within the study area (**Figure 3.14-4**). PGH comprises habitat of moderate importance, low value habitat, or transitional habitat outside of priority habitat (NDOW Categories 3 and 4) (note: these characterizations are preliminary and subject to change). Approximately 125,390 acres of PGH occurs within the study area (**Figure 3.14-4**).

Sandhill Crane

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

Long-billed Curlew

The long-billed curlew is known to breed at Sheldon National Wildlife Refuge (NWR) in northern Washoe County (approximately 300 miles northwest of the study area), Ruby Lake NWR in Elko County (approximately 90 miles southeast of the study area), Izzenhood area (approximately 25 miles southwest of the study area), Lahontan Valley in Churchill County, and Fish Creek Ranch in Eureka County. This species prefers short grasslands, wet meadows, wetlands, and marshes (Floyd et al. 2007; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. The potential for this species to occur within the study area is considered high.

Black Tern

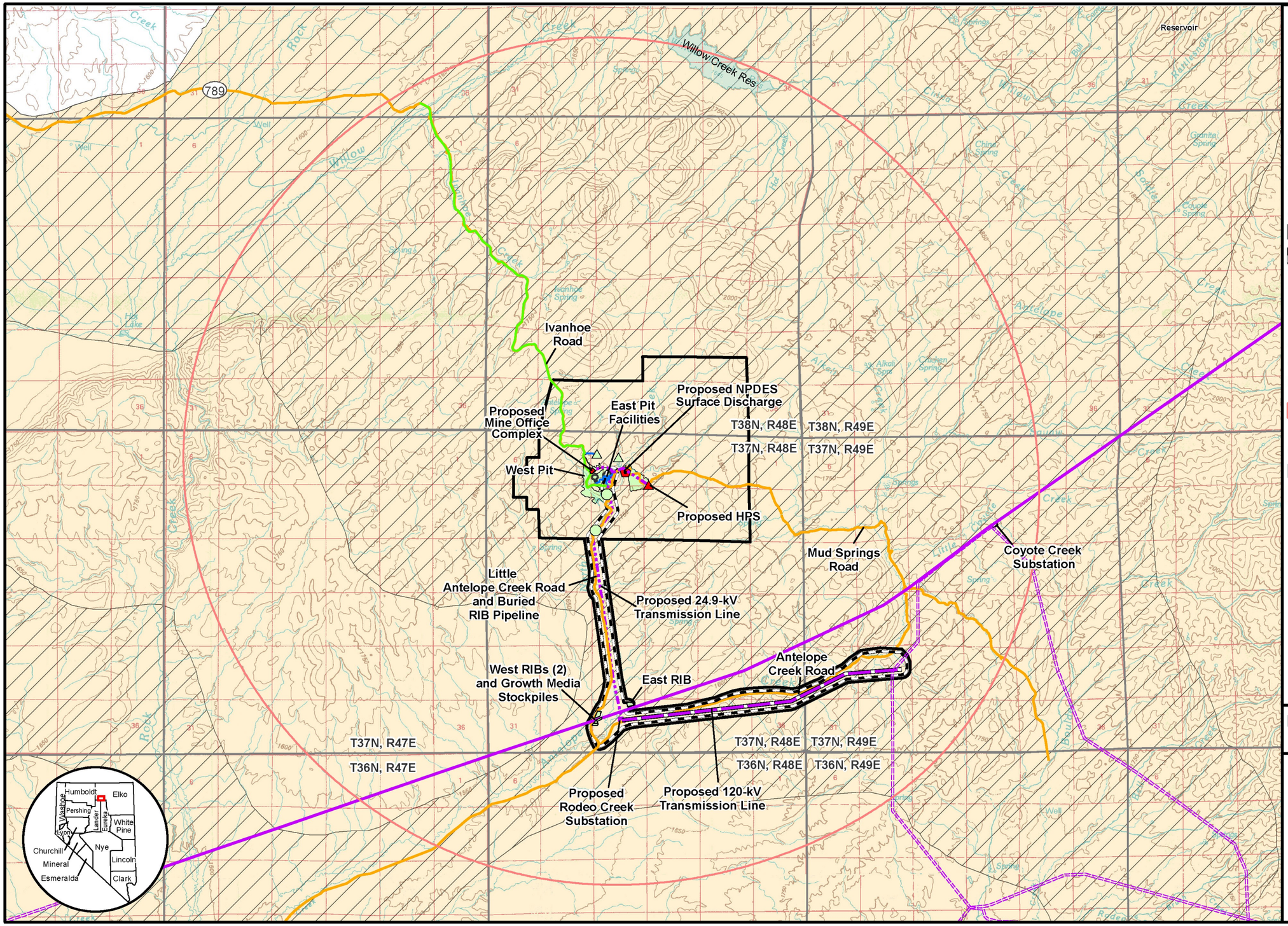
The black tern is found at only a few locations in Nevada including shallow lakes and wetlands from Sheldon NWR to Ruby Lakes NWR south to Mason Valley Wildlife Management Area in western Nevada (Floyd et al. 2007). This species prefers marshes in very fresh water, typically characterized by cattail and/or spikerush but may be found along riparian areas. Nesting usually occurs semi-colonially with other terns in shallow freshwater marshes with emergent vegetation (Floyd et al. 2007; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. Due to marginal habitat occurring within the study area, the potential for this species to occur within the study area is considered low.

Western Yellow-billed Cuckoo

The western yellow-billed cuckoo is known from only a few locations in Nevada. This species has undergone dramatic population declines throughout western North America due to a loss of native riparian habitats. The yellow-billed cuckoo preferred habitat is old-growth riparian woodlands with a dense understory component (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. Occurrence records are limited for Nevada and are mainly concentrated in the southern portion of the state in the Pahranagat Valley and along the Virgin River (Floyd et al. 2007). Due to marginal habitat occurring within the study area, the potential for this species to occur within the study area is considered low.

Western Burrowing Owl

The burrowing owl is known to breed throughout Nevada. The majority of the breeding population is known to migrate from northern Nevada to southern California and Mexico during the winter months. However, observations of this owl have been recorded in Nevada during all months of the year (Floyd et al. 2007; Herron et al. 1985). Breeding by burrowing owls is strongly dependent on the presence of burrows constructed by prairie dogs, ground squirrels, or badgers. Prime burrowing owl habitat must be open, have short vegetation, and contain an abundance of burrows. Burrowing owls begin nesting in April and young typically fledge by August (Floyd et al. 2007; Herron et al. 1985;



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Greater Sage-grouse Habitats

- Nesting and Early Brood Rearing Area
- Late Summer and Winter

Source: NDOW 2009a.

N

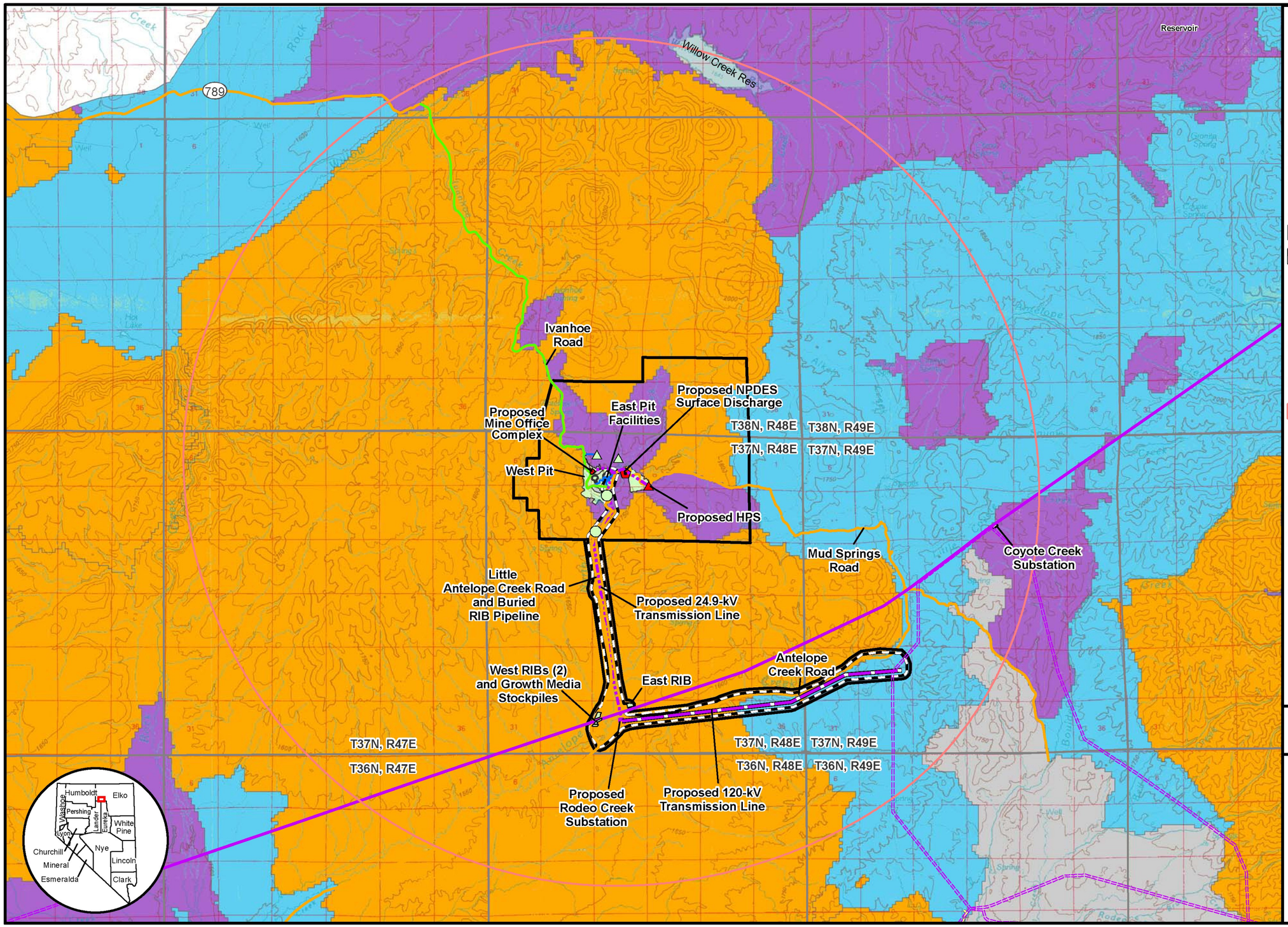
0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.14-3

Greater Sage-grouse Habitat in the Study Area

3/13/2012



Legend

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- 120-kV Transmission Line
- Buried Pipeline
- Maximum Extent of the 10-foot Groundwater Drawdown Contour

Greater Sage-grouse Habitats

- PPH - Essential/Irreplaceable Habitat (NDOW Category 1)
- PPH - Important Habitat (NDOW Category 2)
- PGH - General Habitat (NDOW Categories 3 and 4)
- Non-habitat

Source: NDOW 2012.

N

0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.14-4

Greater Sage-grouse PPH and PGH in the Study Area

4/19/2012

Neel 1999). This species has been observed nesting approximately 10 miles southeast of the study area along Boulder Creek (BLM 2008b) and suitable nesting habitat occurs along the Little Antelope Creek Road (BLM 2004a). Based on the presence of suitable nesting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Long-eared Owl

Long-eared owls occur within piñon-juniper woodlands, coniferous forests, and riparian areas at higher elevations. The majority of Nevada's population of long-eared owls is considered non-migratory, although individuals occurring outside of Nevada have been known to winter in Nevada. Long-eared owls begin nesting in February and young typically fledge by July (Floyd et al. 2007; Herron et al. 1985; Neel 1999). This species has been documented southeast of the study area in Boulder Valley (BLM 2008b). Suitable foraging habitat occurs within the study area. Due to a lack of roosting and nesting habitat, the potential for this species to occur within the study area is considered low.

Short-eared Owl

Short-eared owls are year-round residents of Nevada, although few nest sites have been identified (Floyd et al. 2007; Herron et al. 1985). The species tend to nest in meadow and wetland habitats. Short-eared owls forage in open areas and are known to nest and roost on the ground. This species begins nesting in February and young typically fledge by July (Herron et al. 1985). This species has been documented nesting within the study area in the south bank of Antelope Creek (AECOM 2010c). Based on the presence of suitable nesting and foraging habitat occurs within the study area, the potential for this species to occur within the study area is considered high.

Lewis's Woodpecker

The Lewis's woodpecker breeds in isolated pockets in the northern half of Nevada. This species is found in open forest habitats such as ponderosa pine forests, burned over Douglas fir forests, piñon-juniper woodlands, oak woodlands, and riparian areas. No forest exists in or near the project area. Nesting habitat consists of these habitats with a grassy or brushy understory (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. Based on the presence of suitable foraging and breeding habitat within the study area along Little Antelope Creek and Antelope Creek, the potential for this species to occur within the study area is considered moderate.

Pinyon Jay

The pinyon jay occurs throughout the western U.S. and is a permanent resident of Nevada. This species is strongly associated with piñon-juniper forest habitats and can be found along the piñon-juniper belt extending from the Humboldt River south to the Mojave Desert. Pinyon jays are semi colonial nesters and occur in large groups where food is abundant (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). No piñon-juniper forests exist within or near the project area. The breeding season for this species is April 15 through July 15. Based on the presence of suitable foraging habitat within the study area along the Little Antelope Creek and Antelope Creek, the potential for this species to occur within the study area is considered low.

Juniper Titmouse

The juniper titmouse is a year-round resident that is strongly associated with piñon-juniper woodlands and to a lesser extent, sagebrush shrublands. This species occurs primarily along the piñon-juniper belt through Nevada, ranging from 4,500 to 7,500 feet amsl. Dense foliage and closed canopies are preferred, while thin understory and ground cover are preferred for some feeding activities. This species often nests in cavities in riparian vegetation juxtaposed to piñon-juniper. As a result, the juniper titmouse tends to frequent the interface between piñon-juniper and riparian habitats (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). No piñon-juniper forests exist within or

near the project area. The breeding season for this species is April 15 through July 15. Based on the presence of suitable foraging and breeding habitat within the study area, the potential for this species to occur within the study area is considered moderate.

Loggerhead Shrike

The loggerhead shrike is a common resident throughout Nevada. This species is found in open grasslands along valley floors and foothills of the Great Basin. In Nevada, it is commonly found in scrub habitat types such as sagebrush and greasewood. Loggerhead shrikes prefer shrubs or small trees for nesting, but nesting also can occur in piñon-juniper woodlands. This species can be found perching on wire, fences, or poles (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. This species has been observed within the study area (AECOM 2010c). Based on the presence of suitable nesting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

Yellow-breasted Chat

The yellow-breasted chat is found throughout Nevada, although it is more common in the eastern portion of the state. This species is found in cottonwood, willow, riparian and other woodland habitats with dense understories (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. Due to marginal habitat occurring within the study area along Little Antelope and Antelope creeks, the potential for this species to occur within the study area is considered low.

Vesper Sparrow

The vesper sparrow is a summer resident that occurs in various open shrub habitats from high elevation valleys to higher mountain slopes and basins. This species occurs from approximately 5,500 feet amsl in the foothills of northern Nevada to approximately 9,000 feet in elevation in surrounding mountain ranges. Open areas with a scattered canopy of big sagebrush and a minimum ground cover of 20 percent grasses, forbs, and young shrubs appear to be the preferred nesting habitat for this species. Nests are typically placed on the ground under or near shrubs (Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006). The breeding season for this species is April 15 through July 15. Based on the presence of suitable nesting and foraging habitat within the study area, the potential for this species to occur within the study area is considered high.

3.14.1.3 Amphibians

Columbia Spotted Frog

Isolated populations of the Columbia spotted frog are known to occur in portions of central and northern Nevada including Elko County as part of the Great Basin subpopulation. This species is highly aquatic and is rarely found far from permanent, quiet waterbodies such as wetland habitats, streams, or springs at elevations ranging from about 5,600 to 8,700 feet (Toiyabe Spotted Frog Technical Team 2003; Wildlife Action Plan Team 2006). Frogs are associated with the grassy/sedgy margins of these waterbodies. Females begin laying eggs in late April and May, with tadpoles emerging in August. The Columbia spotted frog may travel to upland areas during wet weather. Overwintering sites in the Great Basin include undercut stream banks and stream heads. The closest known populations are in the Maggie Creek subbasin, which is located outside and east of the aquatic biology CESA (**Figure 3-13-1**) at a distance of approximately 15 miles.

This species has not been recorded within the study area (AECOM 2010d; NDOW 2010a); however, marginal habitat does occur within the study area along Little Antelope Creek and Antelope Creek (AECOM 2010d). Based on the presence of marginal habitat along Little Antelope Creek and Antelope Creek and the lack of occurrence records for this species, the potential for this species to occur within the study area is considered low.

Northern Leopard Frog

The northern leopard frog is broadly distributed in limited and isolated habitats from eastern Nevada to northern and western Nevada. Most Nevada populations are highly localized and isolated from one another (NatureServe 2010a; Wildlife Action Plan Team 2006). This species inhabits permanent water with rooted aquatic vegetation such as springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes. In summer, it commonly inhabits wet meadows and fields. Takes cover underwater, in damp niches, or in caves when inactive. Eggs are laid and larvae develop in shallow, still, permanent water (typically), generally in areas well exposed to sunlight. Eggs are typically attached to vegetation just below the surface of the water. Females begin laying eggs in late April and May and tadpoles emerge by August (NatureServe 2010a; Wildlife Action Plan Team 2006). This species has not been recorded within the study area (AECOM 2010d); however, marginal habitat does occur within the study area along Little Antelope Creek and Antelope Creek (AECOM 2010d). Based on the presence of marginal habitat along Little Antelope Creek and Antelope Creek and the lack of occurrence records for this species, the potential for this species to occur within the study area is considered low.

3.14.1.4 Mollusks

Springsnails, a group of mollusks that are found in perennial springs and seeps, are considered important invertebrates because of their restricted and native origin. The BLM considers springsnails to be a sensitive group of invertebrates and manages the public lands in the Great Basin to protect springsnails and their habitat (U.S. Geological Survey [USGS] et al. 1998). Springsnails usually inhabit spring sources or outflow areas located immediately downstream of the spring outlet. Perennial springs are considered potential habitat for this group of mollusks. Springsnails have been documented at eight spring locations in the Upper Antelope Creek, and one location in each of the Squaw Creek, Hot Creek, and Willow Creek drainages (Sada 2007; McGuire 1996, 1995) (**Figure 3.13-2**). Snails in the Willow Creek and Hot Creek springs were identified as Vinyards pyrg (*Pyrgalopsis vinyardi*). Surprise Valley pyrg (*Pyrgulopsis gibba*) occurs in the Antelope Creek springs and a spring near Squaw Creek. Vinyards pyrg is a BLM sensitive species. Surprise Valley pyrg has no special status.

3.14.2 Environmental Consequences

Primary issues related to special status species would include the loss or alteration of native habitats, increased habitat fragmentation, animal displacement, direct loss of animals, and impacts associated with water management. Potential impacts for 37 special status species identified as potentially occurring within the study area are discussed in the following sections.

3.14.2.1 Proposed Action

Surface Disturbance

Similar to impacts discussed in Section 3.12, Wildlife Resources, potential impacts to special status species include the temporary (short-term and long-term) reduction or loss of habitat. Short-term impacts arise from habitat removal and disturbance as well as from activities associated with mine operation. These impacts would cease upon mine closure and successful reclamation. Long-term impacts consist of changes to habitats and the wildlife populations that depend on those habitats, irrespective of reclamation success. Habitat loss or alteration would result in direct losses of smaller, less mobile species of wildlife, such as small mammals, and the displacement of more mobile species into adjacent habitats. In areas where habitats are at, or near, carrying capacity, animal displacement could result in some unquantifiable reductions in local wildlife populations. Mine and exploration surface disturbance also would result in an incremental increase in habitat fragmentation at the Hollister Site until vegetation has been re-established. It is anticipated that the potential mine-related displacement and habitat fragmentation effects would be highest for special status species that may

use the riparian corridors along Little Antelope Creek and Antelope Creek, particularly during construction of the proposed electric power transmission line (transmission line).

The Proposed Action would result in the long-term loss of approximately 117 acres of wildlife habitat from mining, of which a total of up to 25 acres is associated with surface exploration activities and 34.7 acres would be associated with the transmission line. The Proposed Action disturbance would be in addition to the previously authorized approximately 105 acres of disturbance for a total of approximately 222 acres for the project. The disturbance associated with the Proposed Action would be reclaimed following completion of mining activities.

Mammals

Bats

Of the 13 bat species that could occur in the study area, 8 species (i.e., pallid bat, Townsend's big-eared bat, big brown bat, small-footed myotis, long-eared myotis, long-legged myotis, Yuma myotis, and western pipistrelle bat) have been documented within the special status species CESA (BLM 2004a; Bradley et al. 2006; NDOW 2010a). Potentially suitable habitat for the remaining five species (i.e., hoary bat, little brown myotis, silver-haired bat, California myotis, and Brazilian free-tailed bat) occurs within the study area. Implementation of the proposed project could result in direct and indirect impacts to local bat species and their habitat. Direct impacts would include the long-term loss of foraging habitat, including approximately 117 acres of potentially suitable habitat from the development of the proposed project. Discharge into Little Antelope Creek would increase riparian habitat. No forests exist within or near the project area.

Preble's Shrew

Implementation of the proposed project would result in the long-term loss of approximately 117 acres of potentially suitable habitat for this species, until reclamation has been completed and vegetation has been re-established. This impact would be considered negligible considering the large amount of suitable habitat located within the study area. Indirect impacts associated with mine and mineral exploration noise and human presence currently occurs at the site and would continue under the proposed project. However, project construction likely would result in the direct mortalities of individual shrews, if present. The loss of individual Preble's shrews would not result in population-level effects.

Fletcher Dark Kangaroo Mouse

Implementation of the proposed project would result in the long-term loss of approximately 117 acres of potentially suitable habitat for this species, until reclamation has been completed and vegetation has been re-established. This impact would be considered low, considering the large amount of suitable habitat located within the study area. Indirect impacts associated with mine and mineral exploration noise and human presence currently occurs at the site and would continue under the proposed project. However, project construction likely would result in the direct mortalities of individual mice, if present. The loss of individual Fletcher dark kangaroo mice would not result in population-level effects.

Pygmy Rabbit

Implementation of the proposed project would result in the long-term loss of approximately 43.8 acres of potentially suitable sagebrush habitat (big sagebrush-dominated habitats) for this species, until reclamation has been completed and vegetation has been re-established. Indirect impacts associated with mine and mineral exploration noise and human presence currently occurs at the site and would continue under the proposed project. These impacts would be considered moderate, considering the extent of potentially suitable habitat (mature sagebrush) located within the study area. However,

project construction likely would result in the direct mortalities of individual rabbits, if present. The loss of individual pygmy rabbits (a game species in Nevada) would not result in population-level effects.

Birds

No adverse effects to sensitive raptors and migratory bird species have been identified in association with the construction and operation of the proposed project. Other potential species-specific impacts are discussed in the following sections.

Bald Eagle

No bald eagle nests occur within the study area. Occurrence by this species would be limited to migrating and dispersing individuals. Direct impacts would include the long-term loss of approximately 117 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established. Indirect impacts associated with mine and mineral exploration noise and human presence currently occurs at the Hollister Site and would continue under the proposed project. Based on the lack of existing nest sites within the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Swainson's Hawk

Swainson's hawk nests have not been identified in the study area. In addition, no suitable nesting habitat occurs within the study area. Direct impacts would include the long-term loss of approximately 117 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established. However, this impact would be considered negligible based on the overall availability of suitable foraging habitat within the study area. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. the lack of existing nest sites within the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Ferruginous Hawk

One active ferruginous hawk nest has been identified approximately 885 feet south of the Antelope Creek within the study area. Direct impacts would include the long-term loss of approximately 117 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established. However, this impact would be considered negligible based on the overall availability of suitable foraging habitat in the study area. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the distance of the active nest site from the proposed mining activities, potential impacts to this species as a result of the proposed project would be considered negligible.

Golden Eagle

No active golden eagle nest sites occur within the study area. However, several large stick nests were located on a rock outcrop north of Antelope Creek during field surveys. These nests were inactive at the time of the field surveys. Direct impacts would include the long-term loss of approximately 117 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established. Indirect impacts associated with mine and mineral exploration noise and human presence currently occurs at the site and would continue under the proposed project. Based on the lack of active nest sites within the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Prairie Falcon

The nearest documented prairie falcon nest is approximately 2 miles northeast of the Hollister Site. However, suitable nesting habitat occurs within the study area north of Antelope creek. Direct impacts to prairie falcons would include the long-term of approximately 117 acres of potential foraging habitat, until reclamation has been completed and vegetation has been re-established. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the lack of active nest sites within the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Greater Sage-grouse

Three greater sage-grouse lek sites (three active, one inactive) have been identified in the study area. As discussed in Section 3.12, Wildlife Resources, the nearest active lek site occurs approximately 1 mile north of the Hollister Site. As a result, no direct impacts to breeding greater sage-grouse (or leks) would be anticipated from project activities. Indirect impacts to breeding greater sage-grouse as a result of noise from project activities at the Hollister Site is not expected to occur based on the distance of the active leks from the Hollister Site. For the proposed project, noise surveys were conducted at the three active greater sage-grouse leks (see Section 3.23, Noise) and the results showed that noise from the current Hollister Site was not discernible given the distance of the active leks from the Hollister Site. However, impacts are anticipated to occur as a result of disturbance to sagebrush habitat from project construction activities and the potential loss of brooding habitat (e.g., riparian and wetland habitats) associated with groundwater pumping within the study area.

To prevent disruption of greater sage-grouse breeding activities, appropriate BMPs would be implemented, as described in *A Report on National Greater Sage-grouse Conservation Measures*, Appendix E (Sage-grouse National Technical Team 2011). These BMPs include the applicant-committed measures described in Section 2.4.9. For example, disturbance to breeding greater sage-grouse would be minimized by reducing human presence and noise within 3 miles of an active lek between 1 hour before sunrise to 10:00 a.m.

Potential impacts may still occur to greater sage-grouse habitat. Potential direct impacts would include the incremental long-term loss of approximately 117 acres of nesting and early brood habitat, late summer habitat, and winter habitat. Based on a total of 15,958 acres of nesting habitat and 16,609 acres of summer and winter habitat within the study area, impacts from the Proposed Action would account for less than 1 percent of the available greater sage-grouse habitat found within the study area.

In addition to the impacts to NDOW designated habitat described above, direct impacts also would include the incremental long-term loss of approximately 62 acres of PPH (47 acres of essential/irreplaceable habitat and 15 acres of important habitat), and approximately 55 acres of PGH habitat (**Figure 3.14-4**). Notwithstanding these impacts, adverse impacts to the greater sage-grouse in the area are not expected to increase substantially. The majority of the disturbance in the PPH habitat already exists, and most new disturbance would be in PGH habitat. All of the four spring complexes potentially impacted by groundwater drawdown from the proposed project are located within PPH important habitat.

Sandhill Crane, Long-billed Curlew, Black Tern, Western Yellow-billed Cuckoo, and Yellow-breasted Chat

These species have not been documented within the study area and limited marginal habitat occurs along Little Antelope Creek and Antelope Creek. No direct impacts are anticipated for these species based on limited habitat within the study area, and the existing level of human activity at the Hollister Site. However, impacts to these species may result from the potential loss of 12 acres of wetland

habitat and some riparian habitat within the maximum extent of the 10-foot groundwater drawdown contour (**Figure 3.9-2**) as a result of groundwater pumping associated with the Proposed Action. These impacts would include loss of available surface water and associated wetland and riparian vegetation.

Western Burrowing Owl

Although no burrowing owl nest sites have been documented within the study area, sagebrush shrubland vegetation that would be disturbed as a result of the proposed project would be suitable habitat for foraging birds within the study area. Direct impacts to this species would include the long-term loss of approximately 117 acres sagebrush shrubland breeding and foraging habitat, until reclamation has been completed and vegetation has been re-established. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the lack of documented nest sites within the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Long-eared Owl

This species has not been documented breeding within the study area and breeding habitat is limited within the study area. Direct impacts to this species would result from the long-term loss of approximately 117 acres of potential foraging habitat until reclamation has been completed and vegetation has been re-established. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the limited breeding habitat in the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Short-eared Owl

This species has been documented nesting along Antelope Creek and suitable nesting habitat is present throughout the study area. Direct impacts to this species would result from the long-term loss of approximately 117 acres of potential foraging habitat until reclamation has been completed and vegetation has been re-established. These impacts would be considered negligible based on the overall availability of suitable habitat in the vicinity of the study area. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the overall availability of suitable habitat in the study area and the existing level of activity at the Hollister Site, potential impacts to this species as a result of the proposed project would be considered low.

Lewis's Woodpecker, Pinyon Jay, Juniper Titmouse

Based on the presence of marginal habitat (e.g., sage-brush shrubland) in the study area, direct impacts to these species would result from the long-term loss of approximately 117 acres of sagebrush shrubland habitat. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the implementation of Rodeo Creek Gold Inc's (RCG's) committed environmental protection measures, the overall availability of suitable habitat in the study area, and the existing level of activity at the Hollister Site, potential impacts to these species as a result of the proposed project would be considered low.

Loggerhead Shrike, Vesper Sparrow

Based on the presence of potentially suitable breeding habitat within the study area, direct impacts to this species would include the long-term loss of approximately 117 acres of potential breeding and foraging habitat, until reclamation has been completed and vegetation has re-established. Indirect impacts would continue to result from mine and mineral exploration noise and human presence. Based on the overall availability of suitable habitat in the study area and the existing level of activity at the

Hollister Site, potential impacts to these species as a result of the proposed project would be considered low.

Amphibians

The Columbia spotted frog and northern leopard frog have not been recorded in the study area. Based on marginal habitat and the lack of occurrence records for these species, the potential for occurrence is considered to be low. Potential habitat exists in wetlands located within the study area. Project construction would not impact these wetland areas. However, groundwater pumping could reduce flows in 4 spring complexes and 12 acres of associated wetlands and some riparian areas within the study area. A potential reduction in flow in the affected springs also could reduce natural flows in Antelope Creek as described in Section 3.6, Surface Water Resources and Watersheds. These streams represent potential habitat for special status amphibians. A majority of these springs, wetland, and stream habitats have not been surveyed for amphibians including these two species. If present, habitat for these species could be adversely affected by reduced flows and water levels. However, discharge to Little Antelope Creek would create riparian habitat for the life of the mine.

Mollusks

As discussed in Section 3.5, Groundwater Resources and Geochemistry and Section 3.13, Aquatic Biological Resources, groundwater pumping could reduce flows in 4 spring complexes within the study area. Groundwater pumping could reduce flows in eight springsnail springs along Antelope Creek and one springsnail spring near Squaw Creek. Low potential adverse impacts are predicted for seven of the Antelope Creek springs. High potential impacts are predicted for one Antelope Creek spring and the Squaw Creek spring. Impacts on habitat could include no reductions, moderate reductions in spring water levels, or a total loss of wetted area depending on the volume of flow reduction. The impacts of reduced flow would be more pronounced in small springs where changes in habitat conditions could represent a substantial portion of the habitat. Typically, these mollusk species are restricted to spring sources and a limited distance of the spring outsource (usually less than 600 feet) (Sada and Deacon 1994). Potential flow reductions could alter the preferred habitat conditions for these species. If flows are significantly reduced, springsnails may be eliminated from a site.

Human Presence and Noise

Impacts to special status species from increased human presence and noise from construction activities would be the same as those discussed in Section 3.12, Wildlife Resources. Details on human presence and noise impacts for greater sage-grouse is presented below.

Recent studies on greater sage-grouse have shown that development activities can negatively impact populations as a result of increased noise and increased human disturbance (Holloran 2005; Walker et al. 2007). Greater sage-grouse have been observed to abandon lek sites in areas with increased road development (Braun 1986; Holloran 2005; Walker et al. 2007). Compared to hens near undisturbed leks, greater sage-grouse hens that used leks within approximately 2 miles of development activities moved further away from leks to nesting areas and had lower nest initiation rates (Lyon and Anderson 2003). Furthermore, greater sage-grouse hens that utilized nesting habitats further from roads had greater brood survivorship than those hens utilizing habitat near roads (Lyon and Anderson 2003). Research also has shown that, as a result of increased food sources associated within development activities (e.g., road kill, litter, etc.), population levels of predators, especially corvids, generally increases over time unless deterrents are used on tall structures (Andren 1992; Avery and Genchi 2004).

However, based on the results of the noise measurements described in Section 3.23, Noise, impacts from increased human presence and noise at and near the Hollister Site on greater sage-grouse is anticipated to be low. This is primarily due to the distance of the active leks in relation to the current

Hollister Site, topographic shielding of the leks from the Hollister Site and Ivanhoe Road, and the existing level of human activity at the Hollister Site.

Water Management Activities

Impacts to special status species would be the same as described in Section 3.12, Wildlife Resources.

Hazardous Materials Spill

The possibility of a transportation-related spill of process chemicals along the transportation route is discussed in Section 3.24, Hazardous Materials and Solid Waste. The potential for special status wildlife species exposure to toxic chemicals as a result of a transportation-related spill would be greatest if an accident were to occur near aquatic habitats. Spills in dryland habitat would pose only minimal risk to most special status wildlife species since these spills would be adjacent to highways and could be rapidly contained and cleaned up. In general, the materials of greatest concern would be sulfuric acid and diesel fuel. The effects of a sulfuric acid release would be highly variable and would depend on the quantity released, the location of the release (e.g., dry upland area, wet meadow area, or flowing stream area), the species exposed, and the chemical conditions at the release location. The most likely effect of a potential release of sulfuric acid would be the poisoning of terrestrial or aquatic species. Animal species that drink contaminated water could suffer severe effects or death depending on the concentration of sulfuric acid and the volume of the water consumed.

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

Hazardous chemicals would be transported via U.S. Department of Transportation-certified containers and transporters, and transportation of sulfuric acid and other chemical reagents would be in accordance with all applicable rules and regulations. In addition, as discussed in Section 3.24, Hazardous Materials and Solid Waste, RCG would implement their Spill Prevention, Control, and Countermeasures Plan that establishes procedures for responding to accidental spills or releases of hazardous materials to minimize environmental risks.

3.14.2.2 Mud Springs Road Transmission Line Alternative

Impacts to special status species would be the same as described for the Proposed Action except the transmission line route under this alternative would be approximately 9.5 and 15.2 (50 percent sagebrush shrubland and 50 percent grassland) fewer acres of vegetation during construction of the North and South Options, respectively. This would reduce the extent of impacts associated with habitat disturbance, habitat fragmentation, and bird/bat collisions with the transmission line.

3.14.2.3 Mud Springs Waste Rock Storage Facility Alternative

Impacts to special status species would be the same as described for the Proposed Action except for an additional 18.9 acres of disturbance to grassland habitat as a result of the Mud Springs Waste Rock Storage Facility (WRSF) and Mud Springs Road diversion. This alternative has the potential to increase habitat fragmentation; however, 30 percent of the 18.9 acres of grassland habitat disturbance occurs in previously burned (2005) habitat. Consequently, this area has already experienced habitat loss and fragmentation as a result of wildfires and any additional impacts to special status species as a result of this alternative are expected to be low. Developing a stable land form design for the Mud Springs WRSF that complements the surrounding topography may reduce impacts to wildlife (including sensitive species) associated with human presence and noise. In the event that this alternative is selected, a reclamation land form plan would be developed that would take into consideration sage-grouse conservation measures as dictated by BLM IM-2012-043, and other applicable regulations or guidance.

3.14.2.4 Backfill Alternative

Impacts to special status species would be the same as described for the Proposed Action except for an additional 10.6 acres of surface disturbance to primarily grassland habitat would be lost temporarily until reclamation activities are completed. This alternative would result in surface disturbance to an area further away from the core mining area and would likely have incrementally more impacts to wildlife from noise and habitat fragmentation than the Proposed Action. After closure and reclamation, noise and activity associated with the Backfill Alternative would be eliminated. Areas would be returned to habitat once re-seeded and successfully reclaimed.

3.14.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed, and the associated potential impacts to special status species, would not occur. The Hollister Development Block Project would continue to operate under existing authorizations.

3.14.3 Cumulative Impacts

Past, present, and reasonably foreseeable future actions (RFFAs) are described in Section 3.2. The CESA for special-status species is the same as the wildlife CESA (**Figure 3.12-1**) except for greater sage-grouse, which is presented in **Figure 3.14-1** and **Figure 3.14-2**. **Table 3.14-2** presents the disturbance of special status species habitat by the Proposed Action, wildfire, and mining operations. The CESA for greater sage-grouse encompasses areas that are utilized by greater sage-grouse in relation to past and present actions and RFFAs. **Table 3.14-2** presents the disturbance of greater sage-grouse habitat by wildfire and mining operations. Several thousand acres of cultivated alfalfa in Boulder Valley and the Humboldt River Valley (area north of Battle Mountain) may potentially provide late summer/brood-rearing habitat for greater sage-grouse (BLM 2008b). These areas provide succulent forbs sought by greater sage-grouse including alfalfa and other annual or perennial forbs. The current extent of potential use of these cultivated areas by greater sage-grouse is unknown since cover provided by sagebrush habitats adjacent to these fields have been impacted by wildfires in many areas over the last 20 to 30 years (BLM 2008b).

Studies have shown that development can negatively impact sage-grouse populations as a result of habitat loss and increased human disturbance (Holloran 2005; Walker et al. 2007). Greater sage-grouse have been observed to abandon lek sites in areas with increased road development (Braun 1986; Holloran 2005; Walker et al. 2007). Compared to hens in undisturbed leks, sage-grouse hens that used breeding leks within approximately 2 miles from development moved further away from breeding leks to nesting areas and had lower nest initiation rates (Lyon and Anderson 2003). Furthermore, sage-grouse hens that utilized habitats farthest from roads had greater brood survivorship than those hens utilizing habitat near roads (Lyon and Anderson 2003). Connelly et al. (2000) recommends that facilities be located more than 2 miles (3.2 kilometers [km]) from active lek sites under ideal habitat conditions, 3 miles (5 km) when habitat conditions are not ideal, and 11 miles (18 km) when greater sage-grouse populations are migratory. The Proposed Action also would result in cumulative impacts to PPH and PGH habitat within the CESA (**Figure 3.14-2**). It is assumed that habitat conditions within the study area are not ideal, based on fire history, and the current level of human disturbance and noise levels at the Hollister Site. In addition, mine groundwater pumping activities within the greater sage-grouse CESA could result in a reduction or loss of flows in springs and seeps that support brooding habitat for greater sage-grouse. Reductions or elimination of flows in springs and seeps could impact greater sage-grouse dependent on these sites and may impact the distribution and use of habitat during the spring, summer, and early fall.

Table 3.14-2 Cumulative Special Status Species and Greater Sage-grouse Habitat Disturbance

CESA	Habitat Classification	Total Acres of Habitat	Acres of Habitat Disturbed by Fire[1]	Acres of Habitat Disturbed by Proposed Action	Acres of Habitat Disturbed by Mining Operations (Past, Present, RFFAs[2])	Total Acres of Habitat Disturbed
Special Status Species[3]	NA	2,389,947	1,131,690 (47%)	129[5] (<1%)	38,622 (2%)	1,170,036 (49%)
Greater Sage-grouse (habitat type)[4]	NA	2,272,791	1,051,007 (46%)	129[5] (<1%)	37,142 (2%)	1,088,278 (48%)
Greater Sage-grouse (habitat classification)[6]	PPH – essential/ irreplaceable	686,320	155,891 (23%)	47 (<1%)	600 (<1%)	156,538 (23%)
	PPH – important	492,240	257,541 (52%)	27[5] (<1%)	122 (<1%)	257,690 (52%)
Greater Sage-grouse (habitat classification)[6]	PGH	735,877	601,798 (82%)	55 (<1%)	4,106 (<1%)	605,959 (82%)

[1] Fire data used for this analysis has been further refined and modified since the Betze Pit Expansion Supplemental Environmental Impact Statement (BLM 2008b).

[2] See **Table 3.2-1** for a breakdown of mining projects.

[3] The special status CESA is identical to the wildlife CESA, excluding greater sage-grouse.

[4] Includes nesting, early brood, late summer, and winter habitat.

[5] Includes 12 acres of potentially impacted wetland habitat within the maximum extent of the 10-foot groundwater drawdown contour as a result of groundwater pumping. Some riparian habitat also may be impacted, but is not quantified.

[6] Preliminary Priority Habitat (PPH) and Preliminary General Habitat (PGH) are as described in BLM IM 2012-043.

Source: NDOW 2012, 2009a; USGS 2004.

Groundwater pumping associated with Hollister mining could reduce flow in nine springs that contain springsnails within the Antelope and Squaw creek drainages. These nine springs occur in two of four identified spring complexes (**Figure 3.9-3**). These four spring complexes overlap with the groundwater drawdown contour for Barrick's Betze/Post Project dewatering. The Proposed Action and the Betze/Post Project have groundwater drawdown in separate aquifers. However, Proposed Action's potential effects on these two spring complexes would contribute to overall cumulative impact to springsnails in the CESA.

Potential cumulative impacts to other special status species would parallel those described in Section 3.12, Wildlife Resources.

Cumulative impacts to special status species for the Mud Springs Road Transmission Line Alternative would be the same as described for the Proposed Action, with the exception of an incremental decrease in habitat loss of 9.5 acres and 15.2 acres for the North and South options, respectively.

Cumulative impacts to special status species under the Mud Springs Road WRSF and Backfill alternatives would be the same as the Proposed Action, with the exception of an incremental increase in habitat loss of 18.9 and 10.6 acres, respectively.

3.14.4 Potential Monitoring and Mitigation Measures

SSS-1

Issue: Northeastern Nevada has more greater sage-grouse leks than personnel to survey them annually. As such, many leks have inconsistent survey data. Due to the remoteness of the East Velvet, East Clementine, and Big Butte leks, NDOW only has sporadic data on attendance.

Monitoring/Mitigation Measure: RCG would hire an appropriate contractor to conduct lek surveys according to NDOW protocols for the East Velvet, East Clementine, and Big Butte greater sage-grouse leks each year during the breeding season (March 15 to June 15) and report the results of the lek surveys to NDOW and the BLM.

Effectiveness: By implementing SSS-1, accurate yearly lek counts would be obtained for the East Velvet, East Clementine, and Big Butte greater sage-grouse leks. Based on trend data for these three leks, BLM and NDOW would be able to monitor the status of the leks and determine whether additional mitigation would be necessary to protect greater sage-grouse in the project region.

3.14.5 Residual Impacts

Residual impacts to special status species under the Proposed Action would include the long-term loss of 43.8 acres of sagebrush shrubland. The loss of shrub-dominated communities would represent a long-term change in wildlife habitat composition (i.e., shrub-dominated communities to grass/forb dominated communities) under the Proposed Action because it may take up to approximately 25 years for mature shrubs to become established in these communities. In addition, 12 acres of wetland habitat and some riparian habitat would be impacted in the long-term under the Proposed Action due to the impacts associated with groundwater pumping within the maximum extent of the 10-foot groundwater drawdown contour.

3.15 Paleontological Resources

3.15.1 Affected Environment

3.15.1.1 Study Area

The direct and indirect effects study area for paleontological resources consists of the project area as shown in **Figure 3.15-1**. The Cumulative Effects Study Area (CESA) for paleontological resources is shown on **Figure 3.15-1** and is essentially the Carlin Trend north of Interstate 80. The CESA extends from Newmont's Gold Quarry/South Operations Area Project in the south to the Midas Mine in the north and includes mining and mineral exploration activity in most of the Carlin Trend. Past, present, and reasonably foreseeable future actions (RFFAs) associated with mining and mineral exploration in the CESA are described in Section 3.2 and shown in **Figures 3.2-1** and **3.2-2**. The CESA chosen provides an adequate area of analysis in which to compare the relative effects of the Proposed Action with overall mining activity in the Carlin Trend. Within the CESAs there also are projects and activities that may impact paleontological resources and that are not related to mining, including community development, gas and geothermal lease sales, and wildfire management programs, as described in Sections 3.2.1, Past and Present Actions, and 3.2.2, Reasonably Foreseeable Future Actions.

3.15.1.2 Regulatory Structure

Federal legislative protection for paleontological resources stems from the Antiquities Act of 1906 (PL-59-209; 16 United States Code 431 et seq; 34 Stat. 225), which calls for protection of historic and prehistoric structures, and other objects of historic or scientific interests on federally administered lands. Federal protection for scientifically important paleontological resources would apply to construction or other related project impacts that would occur on federally owned or managed lands.

The Bureau of Land Management (BLM) manages paleontological resources (fossils) on public lands under the following statutes and regulations (BLM 2010i):

- Federal Land Policy and Management Act of 1976 (P.L. 94-579);
- National Environmental Policy Act of 1969 (P.L. 91-190);
- Various sections of BLM's regulations found in Title 43 Code of Federal Regulations that address the collection of vertebrate, invertebrate, and plant fossils; and
- Paleontological Resources Preservation Act (P.L. 111-011).

In addition to the statutes and regulations previously listed, fossils on public lands are managed through the use of internal BLM guidance and manuals. Included among these are the BLM Manual 8270 and the BLM Handbook H-8270-1. Various internal instructional memoranda have been issued to provide guidance to the BLM in implementing management and protection to fossil resources.

3.15.1.3 Potential Fossil Yield Classification

Recently, the BLM has adopted the Potential Fossil Yield Classification (PFYC) system to identify and classify fossil resources on federal lands (BLM 2007c). Paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

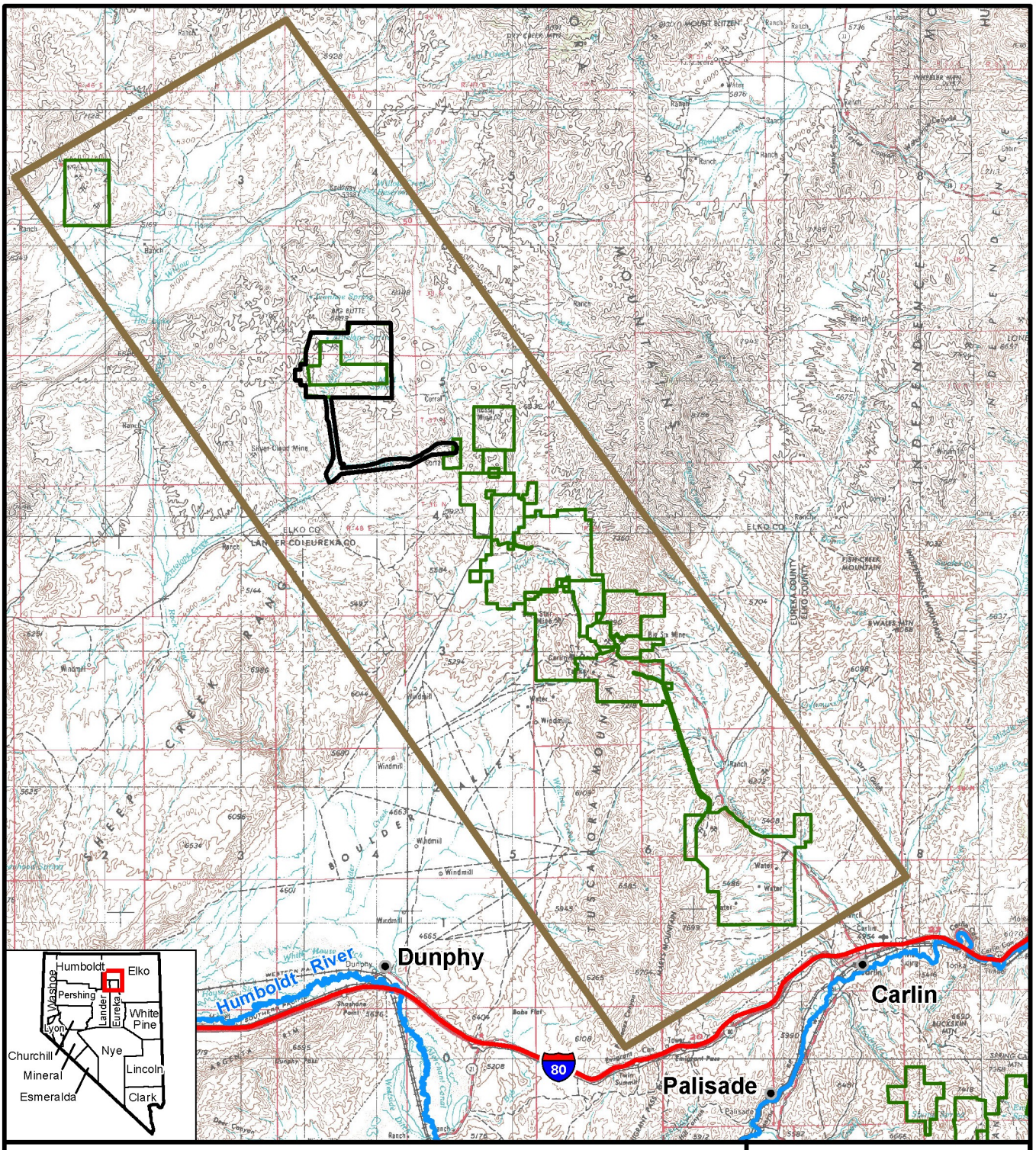

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Figure 3.15-1

Paleontological Resources Direct/Indirect Study Area and Cumulative Effects Study Area

1/18/2012

The PFYC system is a way of classifying geologic units based on the relative abundance of vertebrate fossils or scientifically significant fossils (plants, vertebrates, and invertebrates) and their sensitivity to adverse impacts. A higher class number indicates higher potential for presence. The PFYC is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class. Instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment.

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis, and should be used to assist in determining the need for further mitigation assessment or actions. The BLM intends for the PFYC System to be used as a guideline as opposed to rigorous definitions. Descriptions of the potential fossil yield classes are summarized in **Table 3.15-1**.

Table 3.15-1 Potential Fossil Yield Classification

Class	Description	Basis	Comments
1	Igneous and metamorphic (tuffs are excluded from this category) geologic units or units representing heavily disturbed preservation environments that are not likely to contain recognizable fossil remains.	• Fossils of any kind known not to occur except in the rarest of circumstances • Igneous or metamorphic origin • Landslides and glacial deposits	The land manager's concern for paleontological resources on Class 1 acres is negligible. Ground disturbing activities would not require mitigation except in rare circumstances.
2	Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically significant invertebrate fossils.	• Vertebrate fossils known to occur very rarely or not at all • Age greater than Devonian • Age younger than 10,000 years before present • Deep marine origin • Aeolian origin • Diagenetic alteration	The land manager's concern for paleontological resources on Class 2 acres is low. Ground disturbing activities are not likely to require mitigation.
3	Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Also, sedimentary units of unknown fossil potential.	• Units with sporadic known occurrences of vertebrate fossils • Vertebrate fossils and significant invertebrate fossils known to occur inconsistently; predictability known to be low • Poorly studied and/or poorly documented; potential yield cannot be assigned without ground reconnaissance	The land manager's concern for paleontological resources on Class 3 acres may extend across the entire range of management. Ground disturbing activities would require sufficient mitigation to determine whether significant paleontological resources occur in the area of a Proposed Action. Mitigation beyond initial findings would range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.

Table 3.15-1 Potential Fossil Yield Classification

Class	Description	Basis	Comments
4	Class 4 geologic units are Class 5 units (see below) that have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation.	• Significant soil/vegetative cover; outcrop is not likely to be impacted • Areas of any exposed outcrop are smaller than 2 contiguous acres • Outcrop forms cliffs of sufficient height and slope that most is out of reach by normal means • Other characteristics that lower the vulnerability of both known and unidentified fossil localities	The land manager's concern for paleontological resources on Class 4 acres is toward management and away from unregulated access. Proposed ground disturbing activities would require assessment to determine whether significant paleontological resources occur in the area of a proposed action and whether the action would impact the paleontological resources. Mitigation beyond initial findings would range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.
5	Highly fossiliferous geologic units that regularly and predictably produce vertebrate fossils and/or scientifically significant invertebrate fossils, and that are at risk of natural degradation and/or human-caused adverse impacts.	• Vertebrate fossils and/or scientifically significant invertebrate fossils are known and documented to occur consistently, predictably, and/or abundantly • Unit is exposed; little or no soil/vegetative cover • Outcrop areas are extensive; discontinuous areas are larger than 2 contiguous acres • Outcrop erodes readily; may form badlands • Easy access to extensive outcrop in remote areas • Other characteristics that increase the sensitivity of both known and unidentified fossil localities	The land manager's highest concern for paleontological resources should focus on Class 5 acres. Mitigation of ground disturbing activities would be required and may be intense. Areas of special interest and concern should be designated and intensely managed.

Sources: BLM 2008c, 2007c.

3.15.1.4 Paleontological Resources in the Project Area

The paleontological resources in the project area have a high potential of occurring in the tuffaceous materials in the Carlin Formation (Hockett 2010). The deposits consist of a combination of water laid volcanic tuff, tuffaceous sediment, and non-volcanic detritus (**Figure 3.15-2**). The depositional environment likely helped preserve the bone material of dead animals as well as the high amount of silica contained in the volcanic ash. According to Hockett (2010), the volcanic tuffs are the highly fossiliferous rocks in the Carlin Formation, but the tuffs are not the predominant rock-type in the formation. The proposed type-section southwest of Carlin, Nevada described by Regnier (1960) indicates a high degree of variability of deposits within the formation. Descriptions of the Carlin Formation in the project area also are indicative of the variability of the Carlin Formation (Theodore et al. 2006; Wallace 2003a,b).

The fossils that have been found in the Carlin Formation in the project vicinity are vertebrates and can include varieties of extinct camel, antelope, and ancestors of the horse. A locality within a few miles of the Hollister Site near the Mud Springs Road consisted of vertebrate fossils that had been weathered out of the rock (Stadelman 2010). Specimens from localities in the Willow Creek area have been placed on display at the Northeastern Nevada Museum in Elko (Hockett 2010). The Carlin Formation would rate 4 or 5 in the PFYC system for high potential for scientifically valuable fossils.

A field survey of the proposed electric power transmission line (transmission line) corridors was performed in June 2010 (Erathem-Vanir Geological Consultants 2010). Although the survey resulted in the collection of a few recognizable vertebrate fossils and the identification of four localities, most of the fossil material consisted of fragments of fossilized bone of limited scientific value due to the fragmented nature of the material and the material has been eroded from its original place of deposition. However, it is possible that important fossils may be unearthed during ground-disturbing activities.

The other geological units in the project vicinity are alluvium, lava flows, Slaven Chert and Vinini Formation (see Section 3.4, Geology and Minerals, for more detail). Alluvium and lava flows would be considered as having low potential for significant fossils. In various places in northern Nevada, the Vinini Formation has invertebrate fossils (Coates 1986), but the potential for preservation in the Hollister project area is low because of the deformation to which it has been subjected. The Slaven Chert also is reported to contain invertebrate fossils (Theodore et al. 2006). The fossils are potentially useful in determining the age and depositional environment except that the mode of deposition of the strata may have displaced the fossils from areas where they originally occurred (Theodore et al. 2006). The Vinini Formation and Slaven Chert would probably rate 2 in the PFYC system because of their age, lack of vertebrate fossils, marine deposition, and extreme deformation (in the case of the Vinini Formation).

3.15.2 Environmental Consequences

Issues associated with paleontological resources include the historically known fossil beds in the project vicinity that could be damaged as a result of the Proposed Action.

3.15.2.1 Proposed Action

Direct adverse impacts (destruction or damage) to fossils could potentially occur from transmission line construction activities conducted on the tuffaceous portions of the Carlin Formation, which has a high potential to contain scientifically important fossils, especially vertebrates. Indirect impacts during construction would include erosion of fossil beds due to slope regrading and vegetation clearing or the unauthorized collection of scientifically important fossils by construction workers or the public due to increased access to fossil localities. There is a very low risk of impacts to fossils on previously authorized disturbed lands. Also, underground mining is not likely to affect paleontological resources because the Vinini Formation host rock has a low potential to have scientifically important fossils.

Impacts to paleontological resources associated with surface exploration would be minimal because pre-exploration surveys would be conducted as part of the cultural resources inventory prior to surface disturbance activities.

Although the Carlin Formation has a high potential to contain fossils, impacts to paleontological resources associated with transmission line construction would be minimal due to the previous surveys confirming that the fossils on the surface within the proposed transmission line corridor were of minimal scientific value.

There would be no impacts to paleontological resources associated with Ivanhoe or Little Antelope Creek roads maintenance in the study area because the road would not be widened and there would be no additional disturbance.

3.15.2.2 Mud Springs Road Transmission Line Alternative

Portions of this alternative transmission line route cross the Carlin Formation. Therefore, the risk of direct and indirect impacts to fossil resources would be the same as those described for the Proposed Action. North and South options of this alternative would result in 9.5 and 15.2 fewer acres of disturbance, respectively, than the Proposed Action.

3.15.2.3 Mud Springs Waste Rock Storage Facility Alternative

Impacts to paleontological resources under the Mud Springs Waste Rock Storage Facility (WRSF) Alternative would be the same as described for the Proposed Action. The Mud Springs WRSF would cover approximately 14.3 acres of previously undisturbed Carlin Formation.

3.15.2.4 Backfill Alternative

The Backfill Alternative would potentially disturb less than 1.0 acre of previously undisturbed Carlin Formation. Impacts to paleontological resources would be the same as the Proposed Action.

3.15.2.5 No Action Alternative

The No Action Alternative would not impact paleontological resources because current activities occur on previously disturbed areas.

3.15.3 Cumulative Impacts

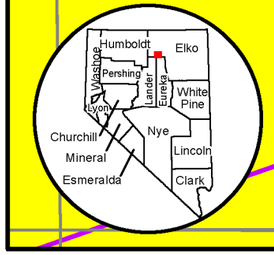
The CESA for paleontological resources is shown on **Figure 3.15-1**. The past, present, and RFFAs in the CESA are described in Section 3.2. The various mines and developments in the CESA are located on a variety of bedrock formations with widely varying fossil potential and not all disturbances would pose a risk to fossil resources. RFFAs occurring in non-fossil-bearing geologic formations would not impact or affect paleontological resources. Future actions such as roads or surface disturbing activities in fossil-bearing formations (i.e., Carlin Formation) could impact, expose, damage, or destroy paleontological resources. Incremental adverse effects to paleontological resources in the Carlin Trend as a result of the Proposed Action would be minimal because the disturbance resulting from the Proposed Action would be very small compared to the disturbance already caused by other mining, management, and development activities in the Carlin Trend (Moore 2002; Norby 2002; Theodore et al. 2006).

X:\0Projects\60137_424_Rodeo_Creek_Gold_Hollister\Figures_DEIS\Figure_3-15_2_Paleo_Map.mxd

Ivanhoe Road
Proposed Mine Office Complex
Proposed NPDES Surface Discharge
West Pit
East Pit Facilities
Proposed HPS
Transmission Line Analysis Corridor
Little Antelope Creek Road and Buried RIB Pipeline
Proposed 24.9-kV Transmission Line
East RIB
West RIBs (2)
Proposed Rodeo Creek Substation
Proposed 120-kV Transmission Line
Antelope Creek Road
Mud Springs Road
Coyote Creek Substation
T38N, R48E
T38N, R49E
T37N, R48E
T37N, R49E

Geologic Units

- Qu - Alluvium, undivided
- QTgc - Gravel terraces and poorly exposed Carlin Formation
- Tvu - Tertiary volcanics, undivided
- Tcr - Craig Rhyolite (Miocene)
- Trp - Rhyolite Porphyry (Miocene)
- Tri - Rhyolite intrusions (Miocene)
- Trv - Rhyolite Velvet Area (Miocene)
- Tdh - Dacite (Eocene)
- Ttsm - Tuffs and tuffaceous sedimentary rocks
- Tcu - Carlin Formation, sedimentary and volcanic rocks, undivided
- Dsc - Slaven Chert (Ordovician)
- Du - Devonian rocks, undivided
- Ov - Vinini Formation (Ordovician)
- PIPs - Pensylvanian-Permian Strathearn Formation
- dmr - Mining disturbance
- Water



Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- Ivanhoe Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line

Geologic Information

- Areas Designated for Paleontology Surveys
- Geologic Fault

Source: Theodore et al. 2006; Wallace 2003a,b.

N

0 0.5 1 Miles

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Figure 3.15-2

Paleontological Resources in the Study Area and Vicinity

3/2/2012

Limited discoveries of fossils have been found in the Carlin Trend. Prehistoric camel and horse fossils were found in the Carlin Formation at the Gold Quarry Mine (BLM 2002b, 1993b).

Cumulative impacts to paleontological resources from the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives, combined with past and present actions and RFFAs, would be the same as described for the Proposed Action.

3.15.4 Potential Monitoring and Mitigation Measures

PR-1

Issue: Potential impacts to unique or site-specific invertebrate, vertebrate, or plant fossils, if present, requires protection under BLM regulation and policy.

Monitoring/Mitigation Measure: During construction, installation, and reclamation of the proposed transmission line, the BLM may require Rodeo Creek Gold Inc (RCG) to have a qualified specialist to monitor the areas with high potential for paleontological resources to occur. If vertebrate fossils or unique or site-specific invertebrate or plant fossils are found, the 43 CFR 3809 regulations would be implemented (§3809.420(b)(8)). Work on the transmission line by NVEnergy or RCG would stop immediately and BLM would be notified. BLM would assess the situation and determine any necessary mitigation, which may necessitate RCG hiring a qualified specialist to evaluate the site and report on the findings.

Effectiveness: This measure would allow for the evaluation of any vertebrate, invertebrate, or plant fossils that may be discovered and provide adequate time for their preservation or data recovery.

3.15.5 Residual Impacts

There would be no residual impacts to paleontological resources with the implementation of the mitigation measure.

3.16 Cultural Resources

3.16.1 Affected Environment

As defined in the Bureau of Land Management (BLM) Manual 8100, "cultural resources are definite locations of human activity, occupation, or use identifiable through field inventory (survey), historical documentation, or oral evidence. The term includes archaeological, historic, or architectural sites, structures, or places with important public and scientific uses, and may include definite locations (sites or places) of traditional, cultural, or religious importance to specified social and/or cultural groups. Cultural resources are concrete, material places and things that are located, classified, ranked, and managed through the system of identifying, protecting, and utilizing for public benefit."

Cultural resources also include Traditional Cultural Properties (TCPs) and properties of traditional religious and cultural importance to contemporary Native American groups. Due to the importance of TCPs and properties of traditional religious and cultural importance to area tribes and bands, these resources are discussed in Section 3.17, Native American Traditional Values.

3.16.1.1 Regulatory Framework

Federal historic preservation laws provide a legal environment for documentation, evaluation, and protection of cultural resources that may be affected by federal undertakings, or by private undertakings operating under federal license, or on federally managed lands. The National Environmental Policy Act (NEPA) states that federal agencies shall take into consideration impacts to the natural environment with respect to an array of resources, and that alternatives must be considered. The courts have made clear that cultural resources are regarded as part of the natural environment. The National Historic Preservation Act (NHPA) of 1966, as amended, established the Advisory Council on Historic Preservation (ACHP) and the National Register of Historic Places (NRHP). The NHPA mandates that federal agencies consider an undertaking's effects on cultural resources that are listed or eligible for listing on the NRHP, and Section 106 of the NHPA establishes a review process by which these resources are given consideration during the conduct of federal undertakings. Cultural resources listed or eligible for listing on the NRHP are referred to as historic properties.

Regulations in 36 Code of Federal Regulations (CFR) 800 outline the process through which historic preservation legislation under the NHPA is administered. Regulations in 36 CFR 800.14 allow federal agencies to adopt program alternatives to 36 CFR 800 and to tailor the Section 106 process to better fit agency procedures. The most common program alternative is a Programmatic Agreement (PA) negotiated between the agency, State Historic Preservation Office (SHPO), and ACHP. The National Programmatic Agreement (NPA) among the BLM, ACHP, and the National Conference of State Historic Preservation Officers was adopted as the program alternative for the BLM. The NPA is thus the national BLM authority for meeting requirements of the NHPA. Day-to-day Section 106 compliance is guided by statewide protocols developed by state BLM offices and SHPOs. In Nevada, the State Protocol Agreement (signed in 1999 and amended in 2009) between the BLM and the Nevada SHPO defines how the BLM and SHPO interact and cooperate under the NPA, and provides direction for implementing Section 106 of the NHPA. Additionally, the BLM Handbook H-8120 provides direction to the BLM for conducting Section 106 reviews, and for mitigation of adverse effects of proposed undertakings on historic properties.

Under the NPA, the Nevada Protocol, and 36 CFR 800, project-specific programmatic agreements are recommended for multiple undertakings or complex projects. A PA for a complex project lays out the steps that the agency and consulting parties agree would be taken to consider the effects of the project on historic properties and to resolve any adverse effects. A PA among the BLM, Nevada SHPO, ACHP, and Rodeo Creek Gold Inc (RCG) currently is being prepared for the proposed project. Federally recognized Native American tribes with cultural ties to the study area have been invited to

participate in development of the PA as concurring parties. The PA defines general and specific measures that would be undertaken by the BLM, SHPO, and RCG to ensure that the BLM's objectives and responsibilities regarding the protection of historic properties under the NHPA would be fulfilled.

3.16.1.2 Eligibility Criteria for Listing Properties on the NRHP

The NRHP, maintained by the National Park Service (NPS) on behalf of the Secretary of the Interior, is the nation's inventory of historic properties. The NPS has established three main standards that a property must meet to qualify for listing on the NRHP: age, integrity, and significance. To meet the age criteria, a property generally must be at least 50 years old. To meet the integrity criteria, a property must "possess integrity of location, design, setting, materials, workmanship, feeling, and association" (36 CFR 60.4). Finally, a property must be significant according to one or more of the following criteria:

- Criterion A – Be associated with events that have made a significant contribution to the broad patterns of our history; or
- Criterion B – Be associated with the lives of persons significant in our history; or
- Criterion C – Embody the distinctive characteristics of a type, period, or method of construction, or represent the work of a master, or possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
- Criterion D – Have yielded, or may be likely to yield, information important in prehistory or history.

3.16.1.3 Area of Potential Effect

An Area of Potential Effect (APE) was established by the BLM, in consultation with the SHPO to include all lands that may be directly or indirectly affected by the proposed Hollister Underground Mine Project. As a result of the consultation, the BLM and SHPO have designated two APEs for the proposed project. The "Mining APE" is defined as the lands for which the project proposes surface disturbance for mining and ancillary facilities associated with the transition of the Hollister Development Block Project to the Hollister Underground Mine Project (**Figure 3.16-1**). The "Exploration APE" includes areas within which RCG may propose surface exploration activities. Within the Exploration APE, the BLM would designate exploration-specific APEs in response to RCG exploration proposals. The BLM, in consultation with the SHPO, the tribes, consulting parties and RCG, may amend the APE as needed through an amendment to the PA.

The cumulative effects study area (CESA) for cultural resources encompasses an area extending 7.7 miles north, 6.2 miles south, 8.6 miles east, and 4.3 miles west of the East Pit (**Figure 3.16-2**). The boundary of the CESA was determined based on the distribution of Tosawihi material, and includes places where Tosawihi material was procured and used by the Western Shoshone. Past and present actions and reasonably foreseeable future action (RFFAs) are summarized in Section 3.2.

3.16.1.4 Cultural Context

The proposed project area encompasses the Tosawihi Quarries Archaeological District (Tosawihi Quarries), which is approximately 3,722 acres in size and considered the largest opalite (chert) quarry in the Great Basin. The occurrence of Tosawihi-like toolstone has been observed as far as 93 miles from the source. Previous research conducted at the quarries indicates that the quarries have been utilized for at least 10,000 years. Much of the research has focused on identifying the type and distribution of sites within the Tosawihi Quarries, which has been accomplished mainly through survey and archaeological excavation.

Midas-Tuscarora Road

APE along Ivanhoe Road extends to intersection with Midas-Tuscarora Road

78-foot-wide buffer along road

Ivanhoe Road

Proposed Mine Office Complex

Proposed NPDES Surface Discharge

West Pit

East Pit Facilities

Proposed HPS

Mud Springs Road

Coyote Creek Substation

Silver Cloud Mine Road

Little Antelope Creek Road and Buried RIB Pipeline

Proposed 24.9-kV Transmission Line

Existing 345-kV Transmission Line

328-foot-wide buffer along transmission lines

Existing 120-kV Transmission Line

West RIBs (2) and Growth Media Stockpiles

East RIB

Antelope Creek Road

Proposed 120-kV Transmission Line

Proposed Rodeo Creek Substation

Humboldt
Elko
Washoe
Pershing
Lander
Eureka
White Pine
Lyon
Churchill
Nye
Lincoln
Mineral
Esmeralda
Clark

Legend

Existing/Authorized Surface Disturbance or Facilities

- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- 345-kV Transmission Line
- 120-kV Transmission Line

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- APE for Mining Activities and Facilities
- APE for Exploration Activities
- Storm Water Diversion Channel

Land Ownership

- Bureau of Land Management
- Private

Sources: BLM 2010c; RCG 2009a.

N

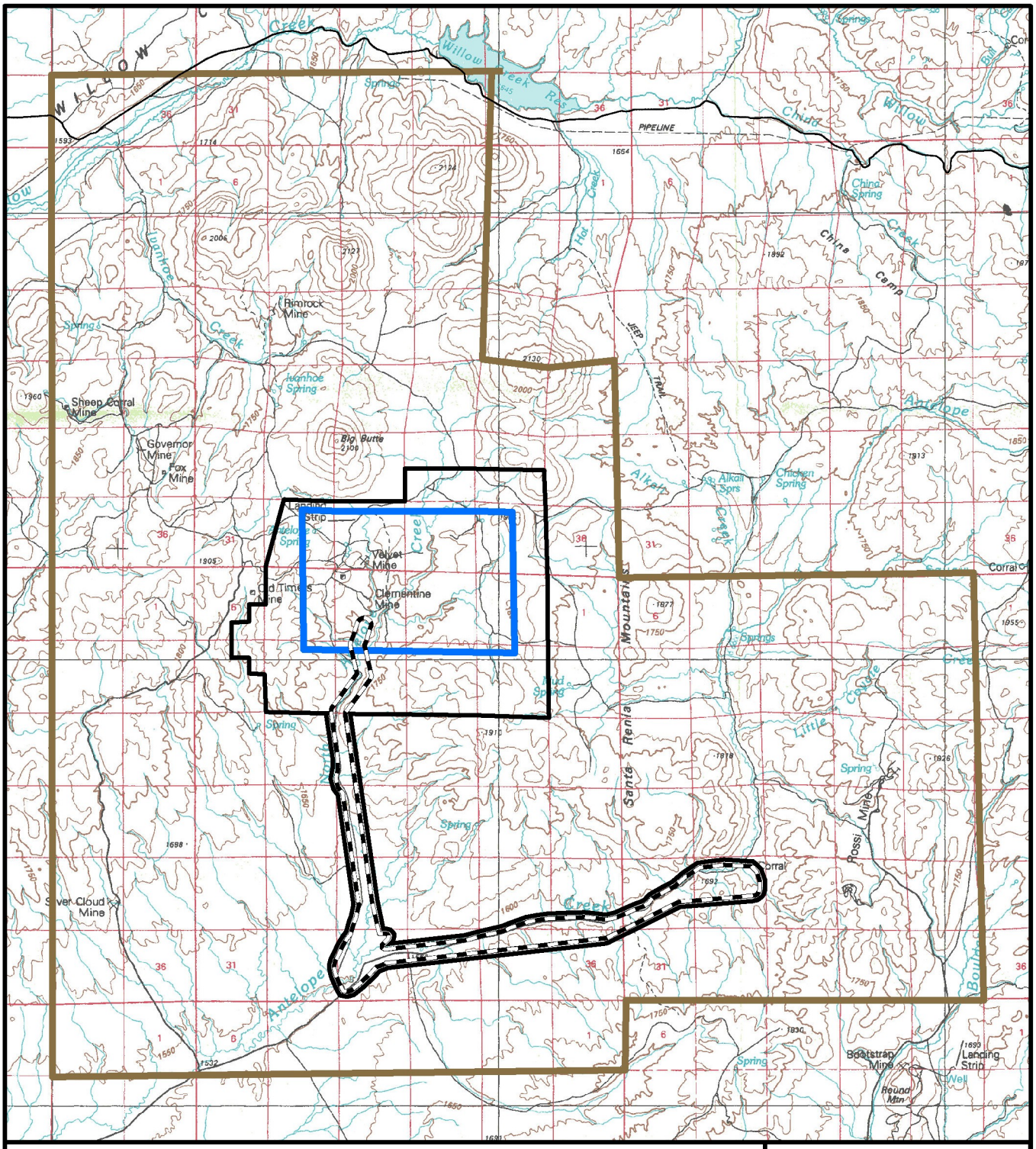
0 1 2 Miles

Hollister Underground Mine Project EIS

Figure 3.16-1

Cultural Resources
Area of Potential Effect
and
Proposed Action
Facilities Overview

3/20/2012



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Tosawihi Quarries Archaeological District
- Transmission Line Analysis Corridor

N

0 1 2 Miles

Source: Fawcett 2010.

Hollister Underground Mine Project EIS

Figure 3.16-2

Cultural Resources and Native American Traditional Values Cumulative Effects Study Area

3/20/2012

Great Basin prehistory is defined as a series of phases based on archaeological excavations at James Creek, Pie Creek, and Tule Shelters. These phases include Izzenhood, Dry Gulch, Pie Creek, South Fork, James Creek, Maggie Creek, and Eagle Rock. The following brief summaries provide a general overview of the prehistory and history of the region encompassing the Tosawihi Quarries. Information included in the summaries was extrapolated from Clemmer (1990), Elston (2006), Elston et al. (1987), Fawcett and Hockett (2006), Grayson (1993), Hockett (2006), Leach and Botkin (1992), Rusco and Raven (1992), Schroedl (1995), and SWCA Environmental Consultants (2010).

3.16.1.5 Prehistoric Overview

Paleoarchaic Period: Izzenhood and Dry Gulch Phases

Recently discovered evidence suggests humans were present in the Great Basin prior to 12,000 B.P.; evidence of human occupation in the Great Basin becomes more common after 11,000 B.P. This period is marked by cool, moist conditions. Paleoarchaic sites typically are situated in places that would have been adjacent to pluvial lakes or near other wetland settings. Population density was low and groups were highly mobile. Paleoarchaic people were broad spectrum hunter-gatherers who hunted small animals such as waterfowl and sage grouse, and gathered wetlands plants (e.g., cattail pollen, shoots, seeds). Diagnostic tools associated with the Paleoarchaic include stemmed and fluted projectile points.

Early Archaic

The shift from the Paleoarchaic to the Early Archaic period corresponds approximately to the beginning of the middle Holocene period (7,500 B.P) and is characterized by a transition to a warmer, drier environment that resulted in the drying out of lakes, streams, and springs. There is a limited amount of well-dated sites or artifact assemblages from this period, which may suggest a sparse population living in the area at that time. Artifact assemblages dated to this period indicate that Early Archaic people practiced a forager-type subsistence/settlement pattern in small groups; while other assemblages indicate that the Early Archaic practiced large game hunting. Diagnostic tools associated with the Early Archaic were Pinto series projectile points.

Middle Archaic: Pie Creek, South Fork, and James Creek Phases

This period is marked by a shift to cooler, moister conditions in which streams and springs began to flow again and marshes were re-established in some places. The Middle Archaic falls within the transition period from the middle to the late Holocene (ca. 4,500 B.P.). Middle Archaic populations exploited a wide range of habitats and re-occupied residential sites and seasonal camps. Overall settlement patterns were relatively mobile, with movements timed to take advantage of resources maturing at different times in different elevation zones. Diagnostic tools of the Middle Archaic period include Gatecliff Series projectile points, as well as the Humboldt and Elko Series projectile points.

Late Archaic: Maggie Creek Phase

The Late Archaic period (ca. 1,450 B.P.) is associated with the appearance of the bow and arrow. During this period, the climate became warmer and drier, similar to the current climate. Subsistence and settlement patterns varied and ranged from nomadic groups that used a variety of ecological zones to more sedentary groups that primarily used cultivated and locally procured wild resources. Characteristics of Fremont assemblages, such as Fremont-like ceramics, Fremont-style side-notched projectile points, and corn remains are present in sites or components that date to the Maggie Creek phase. Arrow point types, such as Eastgate Expanding Stem, Rose Spring Corner-notched, and Rye Patch Miniature are diagnostic tools of this period.

Late Prehistoric: Eagle Rock Phase

During this period, the overall pattern appears to represent significant intensification of the use of small game and plant resources relative to earlier periods. The introduction of brownware pottery at about

900 B.P. and better groundstone technologies led to the consumption of pine nuts and an increase in other plant foods (e.g., tubers, bunch grasses) throughout the Great Basin. Larger sites are located on the valley floors, with seasonal pine nut gathering and temporary hunting camps located in higher altitudes. The earlier Late Archaic points were replaced by Desert Side-notched and Cottonwood Series points.

3.16.1.6 Class I (files search) Inventory

In January 2010, a Class I files and records search was completed to identify all previously conducted archaeological investigations and previously recorded cultural resources within the project area and CESA (Summit 2010a). The files search was conducted through the online Nevada Cultural Resources Information System database and by reviewing the files at the BLM.

Project Area

A total of 50 cultural resources inventories (including Class II and III) have been previously conducted within the project area (see **Appendix F, Table F-1** for a list of the inventories). As a result of the inventories, a total of 202 sites have been previously documented in the project area. This total includes 192 prehistoric sites, 3 historic sites, and 7 multi-component sites. Of the 202 sites, 28 are eligible for the NRHP, 153 are not eligible, and 21 are unevaluated. Included in the total of eligible sites is the Tosawihi Quarries, which consists of 172 loci, of which 157 contribute to the overall eligibility of the quarries. Contributing loci include rockshelters, quarry pits and outcrops, and large deposits composed of solid layers of millions of flakes, cores, bifaces, and other artifacts often several meters thick in the vicinity of pits and outcrops. It should be noted that unevaluated sites are treated as if eligible until an evaluation of eligibility can be made for each site. By definition, isolated finds are not eligible for the NRHP.

The following provides a breakdown of the 202 sites previously recorded in the project area by project component:

- Mining Facilities (part of Mining APE) – In sum, 54 sites have been previously recorded within the area of the mining facilities. All of the 54 were recorded as prehistoric sites. Of these, only two were eligible for the NRHP and were mitigated as part of the Ivanhoe Project.
- Mud Springs Road/Hatter Production Shaft (part of Mining APE) – Locus 86, which is a contributing locus of the Tosawihi Quarries, was previously recorded in the proposed location of the Hatter production shaft, ramp, or raise (HPS). During the recent field inventories, the locus was discovered 450 feet away from the road, but within the exploration area. Therefore, the locus is included in the site totals for the exploration area.
- Ivanhoe Road (part of Mining APE) – A total of 17 sites have been previously recorded along the Ivanhoe Road. Of these, 15 are prehistoric sites, 1 is a historic site, and 1 is a multi-component site. In total, 2 of the sites are eligible for the NRHP and the remaining 15 sites are not eligible.
- Electric Power Transmission Line (Transmission Line) Corridor (part of Mining APE) – In sum, 20 sites have been previously recorded within the transmission line corridor. These include 17 prehistoric sites and 3 multi-component sites. Of the 20 sites, 11 are eligible for the NRHP and 9 are not eligible.
- Little Antelope Creek Road (part of Mining APE) – A total of 13 sites have been previously recorded along Little Antelope Road. Of these 13 sites, 11 are prehistoric and 2 are multi-component containing both a prehistoric and historic component. Included in the total are 8 NRHP-eligible sites and 5 ineligible sites.

- Surface Exploration (Exploration APE) – A total of 98 sites has been previously recorded in this area, which includes the Tosawihi Quarries. Of these, 95 are prehistoric, 2 are historic, and 1 is multi-component containing both a prehistoric and historic component. Included in the site total are 5 NRHP-eligible sites (including the Tosawihi Quarries), 72 ineligible sites, and 21 unevaluated sites. One of the historic sites is the remains of four workings of the Butte Quicksilver Mine (Butte No. 1, Butte No. 2, Clementine, and Velvet); the site is not eligible for the NRHP.

Cumulative Effects Study Area

A total of 64 cultural resources inventories (including Class II and III) have been conducted within the CESA (excluding the project area) (**Appendix F, Table F-1**). The majority of these inventories have occurred as a result of mining and mineral exploration and expansion. Other inventories consist of linear areas surveyed for utility lines and road improvements. As a result of the inventories, 344 have been previously documented within the CESA. These include 328 prehistoric sites, 6 historic sites, and 10 multi-component sites containing both a prehistoric and historic component. Of these, 72 are eligible for the NRHP, 236 are not eligible, and 36 are unevaluated.

The CESA for cultural resources includes approximately 76,203 acres. Approximately 9,488 acres (12.5 percent) of the 76,203 acres have been inventoried for cultural resources. Total acreage of the 344 sites is 1,668.2 acres; total acreage for the 108 NRHP-eligible sites (including unevaluated sites) is 1,375.7 acres. Based on eligible site totals and acreage, site density is approximately one eligible site for every 87.9 acres. For the remaining approximately 75,255 acres, there is a potential for 2,942 sites.

3.16.1.7 Class III Field Inventory

A Class III intensive field inventory to locate and record cultural resources was completed for the transmission line analysis corridor, which was the only proposed disturbance area that had not been previously inventoried to Class III standards (Summit 2010b). In addition, 16 previously recorded historic properties were revisited to better define their boundaries relative to proposed disturbance areas, and 2 previously recorded unevaluated sites were revisited to assess their NRHP eligibility.

Transmission Line Analysis Corridor Survey

A total of 20 archaeological sites were located during the transmission line analysis corridor survey (**Table 3.16-1**). The survey corridor measured 11.6 miles long and extended 150 feet either side of the proposed transmission line centerline. With the exception of two small areas totaling 33 acres, the entire transmission line corridor (416 acres) was surveyed to Class III standards. The 33 acres were not inventoried because 14 acres had been previously surveyed in 2007, and 19 acres had been previously disturbed by mining activities.

Of the 20 sites located during the inventory, 7 are previously recorded and 13 are newly recorded (**Table 3.16-1**). Included in the 20 sites are 11 historic properties, of which 7 have been previously determined as eligible for the NRHP under Criterion D, and 4 are recommended as eligible for the NRHP under Criterion D. The 7 previously recorded sites include 5 large, complex lithic scatters and 2 small lithic debitage and tool scatters; 2 of the previously recorded sites also have historic components consisting of debris scatters. The 13 newly recorded sites all consist of prehistoric lithic scatters. Of these, 9 are small flake scatters with no tools and 4 are lithic scatters with a greater quantity and diversity of artifacts. The total area of eligible sites within the transmission line analysis corridor is 27 acres.

Table 3.16-1 Archaeological Sites Documented During the Class III Inventory of the Transmission Line Analysis Corridor

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area (m^2)
CrNV-12-16233	Prehistoric	Newly recorded lithic scatter with three concentrations and several tools.	Eligible	Yes	1,217
CrNV-12-8229*	Prehistoric	Previously recorded lithic scatter consisting of seven concentrations and several tools. Survey relocated several artifacts and lithic concentrations; recorded 16 new prehistoric artifacts and a historic artifact.	Eligible	Yes	13,818
CrNV-12-8242*	Prehistoric	Previously recorded lithic scatter consisting of two concentrations and several tools. Survey relocated 2 artifacts and lithic concentrations; recorded 13 new artifacts.	Eligible	Yes	33,274
CrNV-12-8243*	Prehistoric	Previously recorded lithic scatter consisting of two concentrations and several tools. Survey relocated 1 artifact and 2 lithic concentrations; recorded 2 new lithic concentrations and 8 new artifacts.	Eligible	Yes	1,619
CrNV-12-8244*	Prehistoric/Historic	Previously recorded lithic scatter consisting of four concentrations and several tools; historic debris from the 1950s. Survey relocated several artifacts and lithic concentrations, plus historic component; recorded 15 new artifacts.	Prehistoric – Eligible; Historic – Not Eligible	Yes	13,078
CrNV-12-12929*	Prehistoric	Previously recorded small lithic scatter consisting of a dense area of flakes and several tools. Survey relocated the lithic scatter; recorded one new artifact.	Eligible	Yes	1,635

Table 3.16-1 Archaeological Sites Documented During the Class III Inventory of the Transmission Line Analysis Corridor

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area (m^2)
CrNV-12-16234	Prehistoric	Newly recorded very small lithic scatter with no tools.	Not Eligible	No	32
CrNV-12-16235	Prehistoric	Newly recorded small lithic scatter with no tools.	Not Eligible	No	159
CrNV-12-16236	Prehistoric	Newly recorded small lithic scatter with no tools.	Not Eligible	No	73
CrNV-12-16237	Prehistoric	Newly recorded small lithic scatter with no tools.	Not Eligible	No	26
CrNV-12-16238	Prehistoric	Newly recorded very small lithic scatter with no tools.	Not Eligible	No	31
CrNV-12-16239	Prehistoric	Newly recorded very small lithic scatter with no tools.	Not Eligible	No	29
CrNV-12-16240	Prehistoric	Newly recorded small lithic scatter with a few tools.	Eligible	Yes	310
CrNV-12-16241	Prehistoric	Newly recorded small lithic scatter with one tool.	Not Eligible	No	55
CrNV-12-16242	Prehistoric	Newly recorded very small lithic scatter with no tools.	Not Eligible	No	26
CrNV-12-16243	Prehistoric	Newly recorded small lithic scatter with no tools.	Not Eligible	No	155
CrNV-12-16244	Prehistoric	Newly recorded lithic scatter with several tools.	Eligible	Yes	689
CrNV-12-16245	Prehistoric	Newly recorded lithic scatter with several tools.	Eligible	Yes	1,672
CrNV-12-14239	Prehistoric/Historic	Previously recorded large lithic scatter consisting of four concentrations and several tools and historic debris. Survey relocated artifacts and concentrations; recorded eight new artifacts.	Prehistoric – Eligible; Historic – Not Eligible	Yes	26,346

Table 3.16-1 Archaeological Sites Documented During the Class III Inventory of the Transmission Line Analysis Corridor

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area (m^2)
CrNV-12-14241	Prehistoric/Historic	Previously recorded large lithic scatter consisting of two concentrations and several tools and historic debris. Survey relocated several artifacts and two concentrations; recorded ten new artifacts.	Prehistoric – Eligible; Historic – Not Eligible	Yes	15,418

*Site extends into Little Antelope Creek Road.

Source: Summit 2011

Revisit of NRHP-eligible Sites

A total of 18 previously recorded sites were revisited during the course of the archaeological investigations (**Table 3.16-2**). Of these, 4 are located along the Ivanhoe Road, 1 is located along Mud Springs Road near the location of the proposed HPS, and 13 are located along Little Antelope Creek Road.

Table 3.16-2 Previously Recorded Sites Within the Project APE Revisited During Archaeological Investigations

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area m^2
Ivanhoe Road					
CrNV-12-6820	Prehistoric/ Historic	Previously recorded as a large lithic scatter consisting of several concentrations and tools, and dozer cuts and debris dating from 1935 to 1945. Site has undergone previous data recovery. Revisit found four new prehistoric artifacts.	Prehistoric – Eligible; Historic – Not Eligible	Yes	65,418
CrNV-12-6829	Prehistoric/Historic	Previously recorded as a lithic scatter consisting of flakes and a few assayed cobbles. Revisit found no cultural material.	Not Eligible	No	900
CrNV-12-6840	Prehistoric/ Historic	Previously recorded as a small lithic scatter consisting of flakes and a few assayed cobbles; possible historic pit. Revisit found few traces of the site; however, two tools and a feature were identified.	Not Eligible	No	2,452

Table 3.16-2 Previously Recorded Sites Within the Project APE Revisited During Archaeological Investigations

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area m^2
CrNV-12-6844	Prehistoric	Previously recorded as a lithic scatter consisting of several concentrations and tools. Site has undergone previous data recovery. Revisit found debitage and two tools.	Eligible	Yes	18,246
HPS					
CrNV-12-10319, Locus 86	Prehistoric	Previously recorded as a rock shelter with lithic scatter and burned bone fragment. Revisit located the site across a steep drainage and 450 feet away from the road.	Eligible	No	27
Little Antelope Creek Road					
CrNV-12-8843	Prehistoric	Previously recorded as a small lithic scatter consisting of two concentrations and several tools. Revisit relocated lithic concentrations; recorded one new historic artifact.	Eligible	No	4,094
CrNV-12-12799	Prehistoric	Previously recorded as a very small lithic scatter consisting of a dense area of flakes with no tools. Revisit relocated the lithic scatter; recorded no new artifacts.	Eligible	No	2
CrNV-12-12931	Prehistoric	Previously recorded as a very small lithic scatter consisting of a dense area of flakes and a few tools. Revisit found the site but no tools; artifact density has decreased.	Eligible	Yes	18
CrNV-12-12932	Prehistoric	Previously recorded as a large lithic scatter consisting of 17 concentrations and several tools. Revisit relocated several artifacts and lithic concentrations; recorded 31 new artifacts.	Eligible	Yes	49,746
CrNV-12-12933	Prehistoric	Previously recorded as a lithic scatter consisting of three concentrations and a few tools. Revisit relocated two loci and three artifacts; recorded five new artifacts.	Eligible	No	2,368

Table 3.16-2 Previously Recorded Sites Within the Project APE Revisited During Archaeological Investigations

Site Number	Type	Description	NRHP Eligibility	Potential Impacts	Site Area m^2
CrNV-12-12965	Prehistoric	Previously recorded as a lithic scatter consisting of 19 concentrations and several tools. Revisit relocated 11 loci; recorded 1 new locus and 9 new artifacts.	Eligible	Yes	39,630
CrNV-12-13977	Prehistoric/Potentially Ethnohistoric	Previously recorded as wooden structural remains with two lithic concentrations. Revisit relocated wooden structure and lithic concentrations; recorded new lithic concentration and two new artifacts.	Eligible	No	1,517
CrNV-12-14235	Prehistoric	Previously as a large lithic scatter consisting of three concentrations and several tools. Revisit relocated several artifacts and 2 lithic concentrations; recorded 12 new artifacts.	Eligible	No	30,944

*Site extends into transmission line analysis corridor.

Source: Summit 2011.

Ivanhoe Road

Of the four previously recorded sites revisited along the Ivanhoe Road, two had been previously determined eligible for the NRHP under Criterion D, and two had not been previously evaluated for the NRHP (**Table 3.16-2**). The two previously recorded eligible sites included a prehistoric lithic scatter and a multi-component site consisting of a prehistoric lithic scatter and historic debris scatter. Both sites have undergone data recovery (archaeological excavation) twice, once to test for NRHP eligibility and once to mitigate effects associated with the Ivanhoe Project. Although these sites were previously excavated, they are still eligible for the NRHP. Total area of the two eligible sites is 20.7 acres. The two unevaluated sites included a prehistoric lithic scatter and multi-component site consisting of a prehistoric lithic scatter and possible historic pit feature. Following the site revisit, both sites were evaluated as not eligible for the NRHP by the field archaeologist.

Mud Springs Road (near HPS)

A previously recorded NRHP-eligible rock shelter with a lithic scatter and burned bone fragment was revisited along Mud Springs Road between the existing mine and proposed location of the HPS (**Table 3.16-2**). The rock shelter is Locus 86 of the Tosawihi Quarries, which is eligible for the NRHP under Criteria A and D. As a result of the revisit, the location of the rock shelter was confirmed as being across a steep drainage and over 450 feet from Mud Springs Road. No other loci were identified in the area of the proposed HPS.

Little Antelope Creek Road

A total of eight previously recorded historic properties were revisited along Little Antelope Creek Road (**Table 3.16-2**). The eight sites include seven prehistoric lithic scatters and the remains of a historic wooden structure with two lithic scatters (potentially ethnohistoric). Of the eight sites, three are either bisected by Little Antelope Creek Road or within 65 feet of the road. Total area of the three historic properties either bisected or within 65 feet of the road is 22.1 acres.

Surface Exploration (Exploration APE)

A total of 98 sites have been previously recorded in the Exploration APE. (Note: The 98 "sites" include 97 cultural sites and the Tosawihi Quarries, which includes 172 loci.). Of the 98 sites, 95 are prehistoric, 2 are historic, and 1 is multi-component containing both a prehistoric and historic component. Included in the site total are 4 historic properties, 72 ineligible sites, 21 unevaluated sites, and the Tosawihi Quarries. One of the historic sites includes the remains of four workings of the Butte Quicksilver Mine (Butte No. 1, Butte No. 2, Clementine, and Velvet); the site is not eligible for the NRHP. Total area of the four historic properties is 55.8 acres.

3.16.2 Environmental Consequences

Potential impacts to historic properties are assessed using the "criteria of adverse effect" (36 CFR 800.5[a][1]): "An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association." There are five broad categories of effect:

1. Physical destruction or alteration of a property or relocation from its historic location;
2. Isolation or restriction of access;
3. Change in the character of the property's use or of physical features within the property's setting, or the introduction of visible, audible, or atmospheric elements that are out of character with the significant historic features of the property;
4. Neglect that leads to deterioration or vandalism; and
5. Transfer, sale, or lease from federal to non-federal control, without adequate and legally enforceable restrictions or conditions to ensure the preservation of the historic significance of the property.

Under NEPA, effects to historic properties can be direct or indirect. Direct effects are caused by an undertaking and occur at the same time and place (40 CFR 1508.8[a]). These types of effects to historic properties include physical damage resulting from surface-disturbing activities and can occur to both known sites and subsurface sites. Indirect effects are caused by an undertaking and are later in time or farther removed in distance, but are still reasonably foreseeable (40 CFR 1508.8[b]). These types of effects often are not quantifiable and can occur both within and outside of the APE. Indirect effects to historic properties include, but are not limited to, changes in erosion patterns due to construction activities, inadvertent damage due to off-road maintenance traffic, and illegal artifact collection due to increased access to an area.

3.16.2.1 Proposed Action

<u>Potential Effects</u>

The Proposed Action would result in approximately 117 acres of surface disturbance that includes 49.6 acres for mining, water management, and ancillary facilities; 34.7 acres for the transmission line; 7.7 acres for roads; and 25 acres for surface exploration. The Proposed Action surface disturbance would be in addition to the previously authorized disturbance of approximately 105 acres for a total

disturbance of approximately 222 acres. Brief impact summaries of each proposed component of the Proposed Action are provided below.

Facilities (Mining, Water Management, and Ancillary)

Approximately 49.6 acres of disturbance associated with the mining facilities, water management facilities, and ancillary facilities would occur under the Proposed Action. Ground disturbance associated with construction of these facilities could directly impact both known historic properties and unknown subsurface sites that could be discovered during ground-disturbing activities. Only two historic properties are located within the proposed areas of the mining facilities; both sites were mitigated as part of the Ivanhoe Project.

Indirect effects to historic properties often are not quantifiable and can occur both within and outside of the APE. Potential indirect effects could include changes in erosion patterns caused by runoff and/or water discharge, as well as vandalism, inadvertent damage, and illegal artifact collection associated with an increase in disturbance and numbers of people in the APE.

Visual impacts were determined by comparing visual contrast ratings for the proposed project facilities with the Visual Resource Management (VRM) class objective for the project vicinity. All of the area proposed for disturbance is rated VRM Class IV. The objective for VRM Class IV states, "…the level of change to the characteristic landscape can be high." The proposed facilities would have visual characteristics during active mining similar to the existing facilities. As a result, the proposed facilities would have similar, but expanded, visual effects to those already occurring from the existing facilities. However, conformance with VRM standards does not mean that no visual impacts would occur that might alter the eligibility of historic properties and what makes them eligible (in particular, the Tosawihi Quarries).

Surface Exploration (Exploration APE)

The exploration APE includes approximately 8,181 acres (including the Tosawihi Quarries). Approximately 1,953 acres (24 percent) of the exploration APE have been inventoried for cultural resources. Total site acreage (which includes 97 sites and 172 loci) within the exploration APE is 907 acres. Site density is one site for every 7.26 acres.

The Tosawihi Quarries, which is located within the exploration APE, is approximately 3,722 acres. Of the 3,722 acres, approximately 1,385 acres (37.2 percent) have been inventoried for cultural resources. Within the Tosawihi Quarries are 157 loci that contribute to the overall eligibility of the quarries. Total acreage of the 157 contributing loci is 801.6 acres. Site density for the contributing loci is one locus for every 8.82 acres. For the remaining 2,337 acres, there is a potential for an additional 265 loci within the Tosawihi Quarries that may all be contributing elements of the quarries.

Prior to surface exploration, Class III inventories would be required for those areas not previously inventoried to Class III standards. Ground disturbance associated with surface exploration could directly and cumulatively affect historic properties and contributing loci identified in the exploration APE.

Access Roads

Ivanhoe Road. Impacts to the two historic properties could occur as a result of continued maintenance along Ivanhoe Road. Total area of the two historic properties is 20.7 acres.

Little Antelope Creek Road. Impacts to three historic properties along Little Antelope Creek Road could occur as a result of minimal maintenance activities. Total area of the three historic properties is 22.1 acres.

East Pit Spur Road. No cultural resources are located within the area proposed for the new East Pit Spur Road.

Mud Springs Road. A short portion of Mud Springs Road would be upgraded within the previously authorized mining disturbance area in order to accommodate haul trucks to and from the HPS.

Surface Exploration Access. Surface exploration access would utilize existing roads, two-track roads, and overland travel. The use of existing roads and other access routes within and around the Tosawihi Quarries can cause adverse effects to historic properties. BLM would be consulted with and approve any maintenance to these roads or routes, and their use for mineral exploration and mining-related activities. In addition, to minimize impacts to cultural and other resources, the BLM discourages the use of roads when deep rutting (3 inches or more) would occur.

Transmission Line

A total of 11 historic properties are located within the transmission line analysis corridor and could be affected by ground-disturbing activities associated with construction of the transmission line. Total area of the 11 historic properties is 27.0 acres. Visual impacts to the 11 historic properties are not expected to occur as site setting is not a contributing factor to the significance of these sites.

With respect to visual impacts to Tosawihi Quarries, the moderate color and line contrasts of the transmission line and substation would achieve the Class IV objective during the project's active life. However, as stated previously, conformance with VRM standards does not mean that no visual impacts would occur that could affect the eligibility of the Tosawihi Quarries and the criteria that make it eligible.

Resolution of Effects

The PA currently being developed outlines the steps to be taken to: 1) identify cultural resources; 2) evaluate them for eligibility for listing on the NRHP; 3) identify potential adverse effects; 4) develop measures to avoid, reduce, or mitigate adverse effects; and 5) address inadvertent discoveries. Additionally, the PA assigns roles and responsibilities for its implementation, which ensures that all interested parties are given an opportunity to comment on the effects of an undertaking on historic properties and any mitigation for such effects.

In consultation with the Nevada SHPO, the Tribes, and consulting parties, the BLM would determine whether construction and operation of the proposed project would have an adverse effect on any properties listed or eligible for listing on the NRHP. If the BLM determines that a property would be adversely affected, then mitigation would be proposed in accordance with the PA. Mitigation may include, but would not be limited to, one or more of the following measures: 1) avoidance through changes in the construction or operational design; 2) data recovery, which might include the systematic professional archaeological excavation of a historic property; 3) the use of landscaping or other techniques that would minimize or eliminate effects on a property's setting; or 4) the development of interpretive materials.

In accordance with the PA, when avoidance is not reasonably practicable, the BLM, in consultation with the SHPO, RCG, the tribes, and consulting parties (as appropriate) would review and approve a treatment plan developed and implemented by RCG's archaeological contractor(s). The treatment plan would be designed to minimize and/or mitigate project-related effects to historic properties. For historic properties eligible to the NRHP under Criteria (A) through (C), mitigation, other than data recovery, would be considered (e.g., further documentation, oral history, historic markers, exhibits, interpretive materials, etc.). Mitigation of historic properties eligible under Criterion (D) may involve archaeological excavation utilizing a treatment plan that has been reviewed and approved by the BLM and SHPO. Where appropriate, efforts would be made to involve the public or make interpretive information available to the public. Input from consulting parties would be used by the BLM to reach decisions on

other mitigation measures. The BLM would require as a condition of approval or authorization that RCG completes the fieldwork portions of any treatment plan prior to initiating any activities that may affect historic properties.

As stipulated in the PA, for historic properties located inside or outside of the Tosawihi Quarries, a buffer zone of at least 100 feet around the historic property would be established to protect the property from inadvertent damage. The BLM may, on a case-by-case basis, agree to a smaller buffer zone. Project facilities would not encroach into the established buffer without further review and approval by the BLM, which may require further mitigation.

To minimize the potential for illegal collection, vandalism, and inadvertent damage, RCG would ensure that all its project personnel and contractors are instructed on cultural resources avoidance and protection measures, including the statutes protecting cultural resources as part of its environmental training program prior to being authorized to work in the study area. In addition, RCG's project personnel would continue to be educated about their responsibilities to protect cultural resources, and RCG's policy against off-road travel and removal of artifacts would be enforced (see Section 2.4.9, Applicant-committed Environmental Protection Measures).

Per the PA, if any previously unknown archaeological sites are discovered during construction on BLM-administered lands, all construction activities would cease within 100 feet of the discovery, and the BLM manager would be notified of the find. Steps would be taken to protect the site from vandalism or further damage until the BLM Authorized Officer could evaluate the nature of the discovery, as outlined in the PA. Construction would not resume in the area of the discovery until the BLM manager has issued a notice to proceed.

In accordance with the PA, if human remains, remains thought to be human, associated or unassociated funerary objects, or objects of cultural patrimony are discovered on federal lands, work within 100 feet of the discovery would stop immediately. RCG or its contractors would immediately notify the BLM and SHPO of the discovery, followed by written notification. Upon notification, the BLM would notify the appropriate law enforcement authorities, county coroner, appropriate tribes, and potentially interested parties. Assessment, treatment, and protection of the remains would be in accordance with the PA. Work in the immediate vicinity of the human remains would not resume until after disposition of the human remains has been determined. The BLM would issue a notice to proceed after notification to the SHPO and consultation with appropriate tribal representatives.

Per the PA, treatment of any discovered human remains and associated artifacts found on non-federal land would be handled in accordance with the provisions of Nevada state law (Nevada Revised Statute 383). RCG would notify the relevant county coroner or sheriff, the landowner, SHPO and BLM of the discovery.

3.16.2.2 Mud Springs Road Transmission Line Alternative

The majority of proposed disturbance associated with the Mud Springs Road Transmission Line Alternative would be on previously undisturbed land. At this time, portions of this alternative have not been inventoried for cultural resources. For those portions previously inventoried, the inventory data indicate no known historic properties along the segment of the alternative terminating at the existing Coyote Creek Substation (North Option), and one historic property along the segment terminating at a new substation (South Option). The historic property is identified as a prehistoric lithic scatter. Total site area for the one historic property is 6.5 acres.

If this alternative were chosen, a Class III inventory would be required along previously unsurveyed portions of the road. It is unknown at this time as to how many historic properties may be located along these previously unsurveyed portions. If historic properties were located during the inventory, unavoidable adverse effects would be mitigated as described for the Proposed Action.

3.16.2.3 Mud Springs Road Waste Rock Storage Facility Alternative

The construction of the Mud Springs Waste Rock Storage Facility (WRSF) would disturb approximately 21 acres, 90 percent of which would be new surface disturbance. Three loci, which contribute to the overall eligibility of the Tosawihi Quarries, fall within the proposed location of the Mud Springs Road WRSF; however, the locations of these loci have not been field verified as of this date. The three loci are Locus 88, Locus 93, and Locus 94. All of the loci are eligible under Criteria A and D. Locus 88 consists of four quarry pits and one quarry outcrop with debitage and bifaces. Loci 93 and 94 are diffuse lithic scatters with cores, bifaces, and debitage. Total site area for the three loci is 11.4 acres. If this alternative were chosen, unavoidable adverse effects to these loci would be mitigated as described for the Proposed Action.

3.16.2.4 Backfill Alternative

Previous inventories recorded five loci (27, 31, 34, 75, and 145) along the existing two-track roads to the site raises; however, the locations of these loci have not been field verified as of this date. The existing two-track roads to the raises would require upgrades to accommodate trucks transporting rock material to be used in the raise backfilling. No loci are located within other proposed disturbance areas associated with this alternative. All of the five loci contribute to the overall eligibility of the Tosawihi Quarries under Criteria A and D. Loci 27, 31, and 145 consist of several quarry pits, cores, hammerstones, bifaces, and flakes. Locus 34 consists of the same artifacts as Loci 27, 31, and 145, but with the addition of a “rare” tabular ground stone piece; loci 75 is a single quarry pit. Total site area for the five loci is 22.7 acres. If this alternative were chose, unavoidable adverse effects to the loci would be mitigated as described for the Proposed Action.

3.16.2.5 No Action Alternative

Under the No Action Alternative, the proposed facilities that would comprise the proposed project would not be developed. No additional ground-disturbing activities beyond surface exploration, which is currently authorized, would occur. The bulk sampling and exploration activities would continue as currently permitted. Therefore, no effects to historic properties are anticipated under the No Action Alternative.

3.16.3 Cumulative Impacts

As directed by law, cultural resources inventories are conducted for any actions involving federal actions, and adverse effects to historic properties avoided or mitigated as appropriate. Avoidance through project redesign is the preferred method of mitigation; however, when avoidance is not feasible, data recovery (archaeological excavation) or other forms of mitigation are implemented prior to ground-disturbing activities.

For the proposed project, unavoidable adverse effects to historic properties would be mitigated in accordance with the PA and a treatment plan developed in consultation with the Nevada SHPO, RCG, the tribes, and consulting parties. In addition, any previously unknown historic properties potentially discovered during construction activities would be mitigated as stipulated in the PA. If data recovery is necessary to mitigate unavoidable adverse effects to historic properties, the process would recover a substantial amount of data but ultimately the site would be destroyed by the undertaking preventing future opportunities for scientific research, preservation, or public appreciation. Data recovery mitigates the potential damage, but the effects are still adverse. Over time, this represents a cumulative loss.

The number of artifacts at documented historic properties located in the vicinity of existing mines and exploration areas has decreased since the properties were first documented, suggesting that indirect effects, such as illegal collecting of artifacts, have occurred and most likely would continue to occur in

the CESA through increased access, development, and increased human presence, as a result of past, present, and RFFAs.

Cultural landscapes and especially historic properties have been cumulatively affected by past and present mining activities, as well as by road construction, livestock grazing, recreational use of the area, range improvements, and wildfires. Soil compaction, altered surface water drainage, and erosion associated with road construction are all negative impacts to the landscape and, by extension, to cultural resources. Livestock congregation and trailing at or across historic properties damage artifacts and the contexts in which they occur. Recreational use of the area, in particular, off-road vehicle travel is increasingly responsible for damage to all types of cultural resources. In addition, off-road vehicle travel takes people into generally unvisited or hard to reach areas, increasingly putting cultural sites at risk of illegal collecting and vandalism. Range improvements benefit cultural resources by restoring cultural landscapes, but certain improvements utilize treatments (e.g., burning, plowing) that impact sites. Wildfires in of themselves are destructive to cultural landscapes and to sites, in particular to standing wooden structures and rock art.

3.16.4 Potential Monitoring and Mitigation Measures

Unavoidable adverse effects to known historic properties identified within the APE would be mitigated in accordance with the PA and Historic Properties Treatment Plan. The BLM, in consultation with SHPO and ACHP, is developing a mitigation and treatment plan that would address identified adverse effects of the project on historic properties. Any subsurface archaeological material discovered during construction activities would be treated in accordance with the PA, Applicant committed Environmental Protection Measures and 3809 Regulations. Per the PA, the BLM, SHPO, Tribes, and Nevada Site Stewards may monitor proposed disturbance and any historic properties that remain untreated within or adjacent to the APE. Monitoring of historic properties around areas of exploration and mining would be effective in ensuring inadvertent damage would not occur to these properties.

3.16.5 Residual Impacts

The Proposed Action would result in the loss of cultural resources not eligible for the NRHP. Although these sites would be recorded to BLM standards and the collected information integrated into local and statewide databases, the sites ultimately would be destroyed or impacted by project construction. For cultural resources eligible for the NRHP and located within the APE, adverse effects would be mitigated in accordance with the PA. Total area of historic properties located within the Mining APE is 69.7 acres. Total area of historic properties located within the Exploration APE is unknown at this time since the entire APE has not been surveyed. Although adverse effects to historic properties would be mitigated through implementation of data recovery or other forms of mitigation, some of the cultural values associated with these sites cannot be fully mitigated; therefore, it is anticipated that residual impacts to these resources would occur.

3.17 Native American Traditional Values

3.17.1 Affected Environment

Ethnographic resources are associated with the cultural practices, beliefs, and traditional history of a community. Examples of ethnographic resources include places in oral histories or traditional places, such as particular rock formations, the confluence of two rivers, or a rock cairn; large areas, such as landscapes and viewscapes; sacred sites and places used for religious practices; social or traditional gathering areas, such as dance areas; natural resources, such as plant materials or clay deposits used for arts, crafts, or ceremonies; and places and natural resources traditionally used for non-ceremonial uses, such as trails or camping locations.

The study area and cumulative effects study area (CESA) for effects to Native American traditional values encompasses an area extending 7.7 miles north, 6.2 miles south, 8.6 miles east, and 4.3 miles west of the East Pit (**Figure 3.16-2**). The boundary of the CESA was determined based on the distribution of Tosawihi material, and includes places where Tosawihi material was procured and used by the Western Shoshone. Past and present actions and reasonably foreseeable future actions (RFFAs) are described in Section 3.2.

3.17.1.1 Regulatory Framework

Federal laws, regulations, and agency guidance require the Bureau of Land Management (BLM) to consult with Native American tribes concerning the identification of cultural values, religious beliefs, and traditional practices of Native American people that may be affected by actions on BLM-administered lands. This consultation includes the identification of places (i.e., physical locations) of traditional cultural importance to Native American tribes. Places that may be of traditional cultural importance to Native American people include, but are not limited to:

- Locations associated with the traditional beliefs concerning tribal origins, cultural history, or the nature of the world;
- Locations where religious practitioners go, either in the past or the present, to perform ceremonial activities based on traditional cultural rules or practice;
- Ancestral habitation sites;
- Trails;
- Burial sites; and
- Places from which plants, animals, minerals, and waters possessing healing powers or used for other subsistence purposes, may be taken.

The 1992 amendments to the National Historic Preservation Act (NHPA) place major emphasis on the role of Native American groups in the Section 106 review process. Subsequent revisions to the regulations of the Advisory Council on Historic Preservation published in May 18, 1999, incorporate specific provisions for federal agencies to involve Native American groups in land or resource management decisions and for consulting with these groups throughout the process. Before making decisions or approving actions that could result in changes in land use, physical changes to lands or resources, changes in access, or alienation of lands, federal agencies must determine whether Native American interests would be affected, observe pertinent consultation requirements, and document how this was done. Tribal participation in the Section 106 process, including the use of tribal monitors, is designed to identify properties of cultural or religious significance, as well as to offer solutions to eliminate or reduce potential adverse effects.

The NHPA also was amended to explicitly allow that "properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization may be determined to be eligible for inclusion on the NRHP." If a resource has been identified as having importance in traditional cultural practices and the continuing cultural identity of a community, it may be considered a traditional cultural property (TCP). The term "traditional cultural property" first came into use within the federal legal framework for historic preservation and cultural resource management in an attempt to categorize historic properties containing traditional cultural significance. To qualify for eligibility to the National Register of Historic Places (NRHP), a TCP must:

- Be more than 50 years old;
- Be a place with definable boundaries;
- Retain integrity; and
- Meet certain eligibility criteria as outlined for cultural resources in the NHPA (see Section 3.16, Cultural Resources).

In addition to NRHP eligibility, some places of traditional religious and cultural importance also must be evaluated to determine if they should be considered under other federal laws, regulations, directives, or policies. These include, but are not limited to, the Native American Graves Protection and Repatriation Act (NAGPRA) of 1990, American Indian Religious Freedom Act (AIRFA) of 1978, Archaeological Resources Protection Act (ARPA) of 1979, and Executive Order (EO) 13007 (Sacred Sites) of 1996.

NAGPRA established a means for Native Americans, including Indian tribes, to request the return of human remains and other sensitive cultural items held by federal agencies or federally assisted museums or institutions. NAGPRA also contains provisions regarding the intentional excavation and removal of, inadvertent discovery of, and illegal trafficking in Native American human remains and sensitive cultural items located on federal lands.

AIRFA established a federal policy of protecting and preserving the inherent right of individual Native Americans to believe, express, and exercise their traditional religions including, but not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites.

ARPA requires notification of the appropriate Indian tribe before approving a cultural resource use permit for the excavation (testing and data recovery) of archaeological resources, if the responsible federal land manager determines that a location having cultural or religious importance to the tribe may be harmed or destroyed. In Nevada, ARPA permits issued by the Nevada BLM State Office required tribal consultation.

EO 13007 requires federal agencies to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, to accommodate access to and ceremonial use of sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of these sites. To implement these requirements, federal agencies must where practicable and appropriate implement procedures to ensure reasonable notice is provided for proposed actions or land management policies that may restrict future access to, or ceremonial use of, or adversely affect the physical integrity of sacred sites.

3.17.1.2 Tosawihi Quarries Archaeological District

The study area encompasses the Tosawihi Quarries Archaeological District (Tosawihi Quarries), which is a culturally and religiously significant area in the traditional homeland of the Western Shoshone people. The region encompassing the study area primarily was used by the *Tosawihi*

(meaning “White Knife”), a subgroup of the Western Shoshone who derived their name from the use of the white chert commonly found at the Tosawihi Quarries. *Tosawihi* Shoshone traditionally occupied the Humboldt River Valley around Battle Mountain, the lands drained by Rock Creek and other northern tributaries of the Humboldt River from as far west as Golconda or Winnemucca and east to the Independence Mountains (Rusco and Raven 1992).

Ethnographic sources and recent interviews and meetings with contemporary Western Shoshone identify the past and present importance of the Tosawihi Quarries as:

- A sacred place regarded by many Western Shoshone as a source of medicine traditionally used for power in healing, and for the protection and success in warfare;
- The location of special power spots used traditionally for vision or power quests;
- A place remembered in the oral tradition of Western Shoshone as an economically important place visited regularly on seasonal treks between the Humboldt and Snake River valleys;
- The location used to procure a highly knappable chert, as well as a large variety of both large and small game and edible plants;
- A place where numerous open camps sites and rockshelters have been documented attesting to it seasonal occupation throughout the use of the quarries;
- An area used both as a source of religiously important materials and of power that continues to be a major part of the religious practices of many Western Shoshone, particularly by those who identify themselves as descendants of the *Tosawihi*;
- The location of Tosawihi chert, which when made into a knife or other implement by a gifted healer, is known to be used in contemporary traditional religious healing rituals throughout the western United States; and
- An area that is central to the ethnic identity of the Western Shoshone; those who still visit the area to hunt or collect the medicine continually renew their ties to the area.

In 1991, several interviews and meetings with tribal groups and individuals who retain traditional, religious, and cultural ties to the Tosawihi Quarries were conducted as part of a Native American study program. The purpose of the program was to provide background information for an environmental impact statement (EIS) on proposed mining activities in the Tosawihi Quarries (Rusco and Raven 1992). At that time, the Tosawihi Quarries were recommended as eligible for inclusion on the NRHP as a TCP because of their significance to the ongoing lifeways of Western Shoshone.

In the late 1990s, the BLM initiated new consultation with the Western Shoshone regarding the potential impacts of mine groundwater pumping to seeps, springs, and streams that may hold special cultural importance to Western Shoshone traditional life ways. As a result of these efforts, two TCPs were defined, one at Rock Creek and one at Tosawihi Quarries (Hockett 1999). The Tosawihi Quarries TCP encompasses several springs, a vision quest locale, and a chert collecting area. The Tosawihi Quarries TCP also was determined eligible for the NRHP under criteria “a” and “d” (as described in Section 3.16.1.2). The Nevada State Historic Preservation Officer (SHPO) subsequently concurred with this determination. Since that time, the BLM has been in continuous contact with tribal groups and individuals, conducting formal consultation, information-sharing meetings, and field trips to the quarries.

3.17.1.3 Native American Consultation

In compliance with the NHPA, the BLM initiated government-to-government consultation for the Hollister Underground Mine Project EIS on July 30, 2009, by sending letters to the following federally recognized tribes and bands: Te-Moak Tribe of Western Shoshone, Duckwater Shoshone Tribe, Ely

Shoshone Tribe, Yomba Shoshone Tribe, Confederated Tribes of the Goshute Reservation, Battle Mountain Band Council, Wells Band Council, South Fork Band Council, Elko Band Council, and Shoshone-Paiutes Tribes of the Duck Valley Indian Reservation. Letters were sent to inform the tribes and bands of the proposed project and solicit any concerns the tribes and bands may have regarding places of cultural and religious importance or TCPs. In addition, the BLM sent letters to the Western Shoshone Defense Project, Western Shoshone Descendants of Big Smokey, and Western Shoshone Committee of Duck Valley to inform them of the project. **Table 3.17-1** lists the contacted tribes/bands and tribal organizations, and any concerns/comments regarding the proposed project.

Table 3.17-1 Summary of Native American Consultation and Communication

Name of Tribe/Band	Date of Initial Contact	Follow-up Letters/Meetings/ Field Visits	Comments/Concerns
Battle Mountain Band Council	July 30, 2009	August 31, 2009 May 20, 2010 June 15, 2010 July 11, 2011 March 16, 2012	Tribal members attending the May 20, 2010, meeting and June 15, 2010, field trip discussed protection of the Tosawihi Quarries afforded by its status as a TCP; expressed concerns with possible looting by mine employees and impacts to potential burials.
Shoshone-Paiute Tribes of the Duck Valley Indian Reservation	July 30, 2009	August 31, 2009 January 29, 2010 May 13, 2010 June 3, 2010 June 15, 2010 September 28, 2010 August 28, 2010 August 31, 2010 July 11, 2011 March 16, 2012	BLM attended Tribal Council meetings and provided details of the proposed project; previous National Environmental Policy Act (NEPA) analyses in the project vicinity; and, biological survey data for the proposed project. Tribal Council requested all mining and other activities to stop in Tosawihi Quarries. Also requested copies of final archaeological reports for the proposed project. During meetings and field visits, tribal participants discussed the importance of Tosawihi as a cultural site; expressed concerned with looting of chert deposits. Several meetings were canceled.
Elko Band Council	July 30, 2009	August 31, 2009 September 16, 2009 May 27, 2010 June 15, 2010 July 11, 2011 March 16, 2012	During the June 15, 2010, field trip, tribal participants discussed the sacredness of the Tosawihi Quarries.
Duckwater Shoshone Tribe	July 30, 2009	August 31, 2009 July 11, 2011 March 16, 2012	No comment to date.
Ely Shoshone Tribe	July 30, 2009	August 31, 2009 July 11, 2011 March 16, 2012	No comment to date.

Table 3.17-1 Summary of Native American Consultation and Communication

Name of Tribe/Band	Date of Initial Contact	Follow-up Letters/Meetings/ Field Visits	Comments/Concerns
Confederated Tribes of Goshute Reservation	July 30, 2009	August 31, 2009	No comment to date.
South Fork Band Council	July 30, 2009	August 31, 2009 July 11, 2011 March 16, 2012	No comment to date.
Te-Moak Tribe of Western Shoshone	July 30, 2009	August 31, 2009 January 6, 2010 May 27, 2010 June 15, 2010 July 11, 2011 March 16, 2012	BLM attended Tribal Council meetings and provided details of the EIS process and schedule. During May 27, 2010, meeting and June 15, 2010, field visit, tribal participants expressed concerns with possible looting by mine employees and impacts to potential burials.
Wells Band Council	July 30, 2009	August 31, 2009 May 27, 2010 July 11, 2011 March 16, 2012	During the May 27, 2010, meeting, concerns focused on potential impacts to subsurface chert deposits.
Yomba Shoshone Tribe	July 30, 2009	August 31, 2009 July 11, 2011 March 16, 2012	No comment to date.
Tribal Organizations			
Western Shoshone Defense Project	July 30, 2009	August 31, 2009 May 27, 2010 July 11, 2011 March 16, 2012	During the May 27, 2010, meeting, concerns focused on potential impacts to subsurface chert deposits.
Western Shoshone Descendants of Big Smokey	July 30, 2009	August 31, 2009 August 28, 2010 July 11, 2011 March 16, 2012	During August 28, 2009, field visit, descendants expressed concern with looting of chert deposits.
Western Shoshone Committee of Duck Valley	July 30, 2009	August 31, 2009 July 11, 2011 March 16, 2012	No comment to date.

Source: BLM 2012; Fawcett 2011; Tiley 2010.

After a tribal council meeting held on January 6, 2010, the Te-Moak Tribe of Western Shoshone submitted a resolution to the BLM on January 15, 2010, in which the tribe "demands no further activities are pursued around or near the Tosawihi Quarries to ensure preservation of Native American cultural values and promote the health, safety, and welfare of the Native American people" (Cassadore 2010).

The BLM has held five public scoping meetings to allow the public an opportunity to learn about the proposed project and its components, and to ask questions and provide comments. Meetings were

held on May 10, 11, 12, 13, and 20, 2010, in Winnemucca, Battle Mountain, Elko, Mountain City, and Owyhee, Nevada, respectively. Although several Western Shoshone individuals attended the meetings in Mountain City and Owyhee, these meetings were not government-to-government consultation. During the meetings in Mountain City and Owyhee, tribal individuals expressed the following concerns relative to the proposed project and its location within the Tosawihi Quarries:

- Damage to chert locations;
- Disturbance to cultural resources;
- Cumulative effects of groundwater pumping and potential impacts to the springs;
- Increased access to the Tosawihi Quarries; and
- Installation of the electric power transmission line (transmission line) and its potential to increased development in the area.

In addition to the public scoping meetings, the BLM held three tribal information meetings. These were held in Battle Mountain (May 20, 2010); Elko (May 27, 2010); and Owyhee (June 3, 2010). The purpose of the meetings was to provide additional information about the proposed project and allow tribal individuals an opportunity to express their concerns and ask questions relative to the proposed project. Of greatest concern to the tribal individuals were potential subsurface impacts to chert deposits due to the underground mining.

On June 15, 2010, the BLM and nine Tosawihi descendents from Owyhee, Battle Mountain, and Elko visited the project area to get an overview of the current operations and view the aboveground footprint. During the field visit, the descendents expressed concerns about possible looting by mine employees and impacts to potential burials.

On August 28, 2010, the BLM and members of the Shoshone-Paiute Tribes of the Duck Valley Indian Reservation and Western Shoshone Descendants of Big Smokey visited the project area. Discussions during the field trip focused on plant and chert sources available in the area, and accessibility to collection areas by local tribal members. Concerns expressed by the tribal participants centered on possible looting of chert deposits, and inaccessibility to Velvet Canyon due to the road being washed out by previous rains.

The BLM sent a second letter to the tribal groups and organizations on July 11, 2011. In the letter, the BLM requested input, recommendations, concerns, and advice regarding the proposed Hollister Underground Project, and offered to meet with the tribal groups as part of the government-to-government consultation efforts. Attached to the letter were a project map, description of the proposed project, and response form for use in responding to the letter.

On March 16, 2012, the BLM sent a third letter to the tribal groups and organizations regarding government-to-government consultation. In the letter, the BLM describes the proposed action, and informs the tribal groups and organizations of the Backfill Alternative and its analysis in the EIS.

As part of the tribal consultation efforts, an ethnographic report was prepared for the Hollister Underground Mine Project (Tiley 2010). The purpose of the ethnographic report was to summarize Native American concerns regarding the proposed project and to update existing ethnographic information on Western Shoshone traditional use of the project area. Previous ethnographic documentation available online, at the BLM, and at state repositories was reviewed to develop the ethnographic overview of the area. Additionally, previous consultation between tribal governments and the BLM that has been conducted over the last 20 years for previous mining activities in and near the proposed project area was examined to provide a reference point for current tribal concerns. In order to update previous ethnographic documentation and to solicit concerns relative to

the currently proposed project, the report author met with tribal individuals, attended tribal meetings, and participated in the two field visits to the project area. The results of these data gathering efforts were summarized in the report, which was submitted to the BLM in November 2010. A public version of the report was shared with various Western Shoshone tribal governments and interested groups.

The BLM continues to provide opportunities to meet and coordinate with tribal governments and interested tribal members to address their concerns and to work together in developing appropriate measures to protect the quarries and sites of tribal importance or concern. Native American consultation and coordination is ongoing in regards to the proposed project and PA.

3.17.2 Environmental Consequences

The NEPA process does not require a separate analysis of impacts to religion, spirituality, or sacredness. As a result, references in the analysis to such beliefs or practices convey only the terminology used by participants involved in the ethnographic study and tribal consultation and coordination conducted for the proposed project. This terminology does not reflect any BLM evaluation, conclusion, or determination that something is or is not religious, sacred, or spiritual in nature, but conveys only the information that has been gathered through tribal consultation and coordination and the ethnographic study.

The project-specific issues for the effects analysis were identified based on information provided by tribal individuals during conduct of Native American consultation. Impacts to Native American traditional values would be considered significant if the Proposed Action or other alternatives would result in adverse effects to NRHP-eligible properties of traditional religious and cultural importance (including TCPs) to the tribes.

The effects of federal undertakings on properties of traditional religious and cultural importance to contemporary Native Americans are given consideration under the provisions of EO 13007, AIRFA, and recent amendments to the NHPA. As amended, the NHPA now integrates Native American tribes into the Section 106 compliance process.

3.17.2.1 Proposed Action

Potential Impacts

As previously discussed, the Tosawihi Quarries were determined eligible for inclusion on the NRHP. Big Butte and Ivanhoe, Buttercup, and Antelope springs are prominent places where spirits dwell and are recognized as TCPs. Ivanhoe and Buttercup springs and Big Butte are located north of the Tosawihi Quarries. Antelope Springs is located on the northern edge. The traditional importance of the quarries centered around three topics: medicine and power, economic pursuits, and as a focal point for ethnic identity. White chert and red and white volcanic tuff found at the Tosawihi Quarries traditionally were used medicinally by Western Shoshone. The chert was a valuable economic item both for use and for trade, and became widely distributed through trade networks. The Tosawihi Quarries has been described by contemporary Western Shoshone as the center of a larger power area and continues to be an important element of the Western Shoshone culture for medicinal, spiritual, and traditional purposes.

As a result of tribal consultation, public scoping, field tours, site visits, and interviews conducted for the ethnography report, impacts to cultural resources, graves/burials, and subsurface chert deposits, as well as groundwater drawdown impacts to springs, impacts associated with increased access, and the potential for increased development in the area as a result of installation of the transmission line were identified as concerns by tribal governments and individuals. These potential impacts are discussed in the following paragraphs. Visual and noise analyses were conducted from Big Butte because of its

status as a TCP and historically as a place to fast and pray. Details of the noise and visual analyses are described below.

Impacts to Cultural Resources (including TCPs and Properties of Traditional Religious and Cultural Importance)

Western Shoshone individuals expressed concerns about potential impacts to or loss of cultural resources related to Western Shoshone heritage within the Tosawihi Quarries. A Programmatic Agreement (PA) among the BLM, Nevada SHPO, Advisory Council on Historic Preservation, and Rodeo Creek Gold Inc is being developed for an area that encompasses the proposed project. The tribes and bands listed on **Table 3.17-1** were asked to participate in development of the PA as concurring parties. The PA outlines the steps to be taken to: 1) identify cultural resources; 2) evaluate them to determine if they are eligible for listing on the NRHP; 3) identify potential adverse effects; 4) develop measures to avoid, reduce, or mitigate adverse effects; and 5) address inadvertent discoveries. A copy of the PA was mailed to the tribes and bands (except the Confederated Tribes of Goshute Reservation), and to the Western Shoshone Committee of Duck Valley, Western Shoshone Defense Project, Western Shoshone Descendents of Big Smokey, and BIA on September 1, 2011. A copy was not mailed to the Goshute because the tribe requested not to receive information on projects located in the northwestern part of the BLM Elko District.

In consultation with the Nevada SHPO and interested Tribes, the BLM would determine whether construction and operation of the proposed project would have an adverse effect on any NRHP-eligible sites, as well as any sites of tribal concern. If the BLM determines that NRHP-eligible sites or sites of tribal concern would be adversely affected, then mitigation would be proposed in accordance with the PA. Mitigation may include, but would not be limited to, one or more of the following measures: 1) avoidance through changes in the construction or operational design; 2) data recovery, which might include the systematic professional archaeological excavation of an NRHP-eligible site; 3) the use of landscaping or other techniques that would minimize or eliminate effects on the site's setting; and 4) the development of interpretive materials. Tribal representatives would be asked to participate in the development of any data recovery or mitigation plan.

During meetings and other exchanges with the Western Shoshone, the BLM has been told that while tribal members do not like archaeological excavation (data recovery), they prefer excavation to the loss and damage of the sites due to mining or exploration without the opportunity to learn about the sites. The BLM has stressed to tribal members that archaeological treatment does not preclude other treatments to deal with non-archaeological aspects or concerns for cultural resources.

Impacts to Subsurface Chert Deposits

Previous ethnographic studies document the importance of the chert found at the Tosawihi Quarries as a valuable economic item by Western Shoshone ancestors both for use in tool manufacturing and for trade. During the public scoping meetings, tribal individuals expressed concern about potential impacts to subsurface chert deposits as a result of the proposed project. According to project geologists, subsurface chert deposits in the Tosawihi Quarries area extend approximately 10 to 100 feet below the ground surface, whereas the underground exploration and mining activities would be 500 to 2,000 feet or more below the surface. Due to the depth of mining operations versus the depth of the chert deposits, no impacts to subsurface chert deposits are expected to occur as a result of the Proposed Action.

Impacts to Potential Burials

Although burials have not been found during archaeological field investigations conducted in the study area or specified by tribal participants during consultation, members of the Elko Band and Shoshone-Paiute Tribes of the Duck Valley Indian Reservation expressed concern about the possible presence

of burials at residential sites or camps, especially in caves. Their concerns are based on the premise that increased mining activity (i.e., increased numbers of people) would increase the opportunity for looting of cultural sites, including possible burials.

In accordance with the PA, if construction or other project personnel discover what might be human remains, funerary objects, or items of cultural patrimony on federal land, then construction would immediately cease within 100 feet of the discovery, and the BLM manager would be notified of the find. In accordance with BLM policy and applicable regulations, a determination would be made regarding the cultural affiliation of any such remains, funerary objects, or other items. Any discovered Native American human remains, funerary objects, or items of cultural patrimony found on federal land would be handled according to the provisions of the NAGPRA and its implementing regulations (43 Code of Federal Regulations 10) and as stipulated in the PA. Work in the immediate vicinity of the human remains would not resume until after disposition of the human remains has been determined. The BLM would issue a notice to proceed after notification to the SHPO and consultation with appropriate tribal representatives.

If human remains and associated artifacts are discovered on non-federal land during construction activities, construction would immediately cease within the area of the discovery and the county coroner or sheriff would be notified of the find. Treatment of any discovered human remains and associated artifacts found on non-federal land would be handled in accordance with the provisions of Nevada state law.

Looting Impacts to Archaeological Resources

RCG requires site-specific cultural sensitivity training. This training includes education regarding the protection of cultural resources and is provided to all employees, contractors, and visitors to the site. Compliance with RCG's cultural resource protection policies is mandatory.

Per the PA, the BLM, SHPO, and Tribes may monitor proposed disturbance and any historic properties that remain untreated within or adjacent to the APE.

Drawdown Impacts to Springs

According to Western Shoshone beliefs, all living things depend on water, and without it, life would cease. Therefore, the drying up of springs or reduction of flow due to groundwater pumping is of great concern to the Western Shoshone who view water sources as being sacred. Drawdown from mine pumping is not expected to affect Antelope Spring, Ivanhoe Spring, or Buttercup Spring due to differences between the aquifers that support these features and the groundwater zone that seeps into the underground workings. In addition, differences in elevation and separation by geologic structures would eliminate the potential for impacts to these springs from the Proposed Action. Drawdown mainly would affect the deeper Vinni Formation, which is isolated from valley alluvium by the clayey, less permeable nature of overlying volcanic rock. Four spring complexes potentially would be affected by the Proposed Action from groundwater drawdown in the Vinni Formation. For an expanded discussion of drawdown impacts to the springs, the reader is referred to Section 3.6, Surface Water Resources and Watersheds.

Impacts Associated with Road Improvements

Tribal individuals were concerned that Little Antelope Creek Road and the Ivanhoe Road would be improved as part of the Proposed Action, which potentially would increase the numbers of people to the area and the potential for illegal collection of artifacts and inadvertent damage. Under the Proposed Action, the existing access roads, including Little Antelope Creek Road and Ivanhoe Road, would not be improved, but would be maintained.

Increased Development Due to Installation of the Transmission Line

No increased development due to the installation of the transmission line would be anticipated because the transmission line would be removed upon permanent mine closure. Poles would be cut at the base (below ground surface) and disposed of at an approved off-site location. Any two-track spur roads accessing pole sites would be scarified and seeded. Holes would be filled, covered, and reseeded with a BLM-approved seed mix.

Visual and Noise Analyses

During the meetings and field trips, tribal individuals spoke of the sacredness of Big Butte. According to several tribal individuals, Big Butte historically has been a place to fast and pray, and should be protected for the "coming generations. For kids to be somebody important, they need to receive power from places such as Big Butte on a vision quest." Due to its traditional and cultural importance to the tribes, visual and noise analyses were conducted from Big Butte.

For the visual analysis, a key observation point was established on the top of Big Butte. Results of the visual analysis indicate that the majority of the proposed project would not be visible from the top of Big Butte because the land slopes away from the viewers' attention. The most prominent project facility visible from the top of Big Butte would be the Hatter production shaft, which would be slightly over 2 miles away from Big Butte and would rise approximately 120 feet above the natural ground surface. Other project facilities would be entirely screened by the intervening terrain. RCG plans to paint the buildings to blend into the natural terrain. For an expanded discussion of visual impacts, the reader is referred to Section 3.22, Visual Resources.

Noise levels were determined from measurements taken at the base of Big Butte. Measurements ranged from 2 to 10 minutes over a period of 2 hours. In addition to measurements of ambient conditions, noise levels from generators, other mine machinery, and ore truck traffic were measured. There are two primary sources of noise associated with hard rock mining: blasting and operation of stationary and mobile equipment. Under the Proposed Action, blasting would occur underground and would not be audible on the surface. Additional equipment would be in use underground and occasionally would depart from the portal for maintenance, repair, or to haul waste rock and ore to the surface, but would not be a notable contributor to noise levels on the surface. The generators would be replaced during normal operations by the proposed transmission line, thereby reducing mine site noise emissions. Noise effects on top of Big Butte from ore trucks would be just over 40 decibels on the A-weighted scale (dBA) and the average likely would be in the low 30s dBA. For comparison, a noise level of 35 dBA is equivalent to a soft whisper heard at 6 feet away. Truck noise from the top of Big Butte would be discernible under quiet, low wind conditions, but would not be obtrusive. For an expanded discussion of noise impacts, the reader is referred to Section 3.23, Noise.

Surface Exploration

Contributing loci to the overall eligibility of the Tosawihi Quarries could be affected by surface exploration. The area proposed for surface exploration encompasses the Tosawihi Quarries. The Tosawihi Quarries consists of 172 recorded loci. Of the 172 recorded loci, 157 contribute to the overall eligibility of the Tosawihi Quarries. Of these, 156 are contributing elements under criteria A and D, and 1 is a contributing element under Criterion A. In addition to the 25 acres of authorized surface disturbance for exploration, 25 more acres of disturbance for surface exploration would be dispersed throughout the project area over the course of the 20-year mine life. Surface exploration under the Proposed Action would occur on previously approved areas. Although 25 acres is being proposed for surface exploration, for a total of up to 50 acres, disturbance could occur anywhere within the project area.

Currently, only 24 percent of the surface exploration area has been inventoried for cultural resources. As a result of previous inventories, 4 NRHP-eligible sites and the 157 contributing loci were documented within the exploration area. Prior to surface exploration, cultural resources inventories would be required for the remaining 76 percent of the surface exploration area that has not been surveyed. Ground disturbance associated with surface exploration could directly and cumulatively affect any historic properties and contributing loci identified within this area. Adverse effects to historic properties or contributing loci would be avoided or, if avoidance is not feasible, mitigated in accordance with the PA.

3.17.2.2 Mud Springs Road Transmission Line Alternative

The majority of proposed disturbance associated with the Mud Springs Road Transmission Line Alternative would be on previously undisturbed land. At this time, portions of this alternative have not been inventoried for cultural resources. For those portions previously inventoried, the inventory data indicate no known historic properties along the segment of the alternative terminating at the existing Coyote Creek Substation (North Option), and one historic property along the segment terminating at a new substation (South Option). The historic property is identified as a prehistoric lithic scatter. Total site area for the historic property is 6.5 acres. If the Mud Springs Road Transmission Line Alternative were chosen, Class III cultural resource inventories would be required for all proposed disturbance areas not previously inventoried. In addition, tribal consultation would be conducted to identify any sites of tribal concerns that may be located within the alternative transmission line corridor. TCPs would not be impacted by this alternative.

3.17.2.3 Mud Springs Road Waste Rock Storage Facility Alternative

The construction of the Mud Springs Waste Rock Storage Facility (WRSF) would disturb approximately 21 acres, 90 percent of which would be new surface disturbance. Three loci, which are contributing elements of the Tosawihi Quarries, fall within the proposed location of the Mud Springs Road WRSF; however, the locations of these loci have not been field verified as of this date. The three loci are Locus 88, Locus 93, and Locus 94. All of the loci are eligible under criteria A and D. Locus 88 consists of four quarry pits and one quarry outcrop with debitage and bifaces. Loci 93 and 94 are diffuse lithic scatters with cores, bifaces, and debitage. Total site area for the three loci is 11.4 acres. If this alternative were chosen, tribal consultation would be conducted to identify any sites of tribal concerns that may be located within the location of the WRSF. TCPs would not be impacted by this alternative.

3.17.2.4 Backfill Alternative

Previous inventories recorded five loci (27, 31, 34, 75, and 145) along the existing two-track roads to the site raises; however, the locations of these loci have not been field verified as of this date. The existing two-track roads to the raises would require upgrades to accommodate the trucks transporting rock material to be used in the raise backfilling. No loci are located within other proposed disturbance areas associated with this alternative. All of the five loci are contributing elements of the Tosawihi Quarries under criteria A and D. Loci 27, 31, and 145 consist of several quarry pits, cores, hammerstones, bifaces, and flakes. Locus 34 consists of the same artifacts as Loci 27, 31, and 145, but with the addition of a “rare” tabular ground stone piece; loci 75 is a single quarry pit. Total site area for the five loci is 22.7 acres. TCPs would not be impacted by this alternative. However, backfilling the shaft would provide an additional safety measure for individuals in the area because the risks of falling into a shaft would be minimized. The land would be restored to beneficial use.

3.17.2.5 No Action Alternative

Under the No Action Alternative, the proposed facilities that would comprise the proposed project would not be developed. No additional ground-disturbing activities beyond surface exploration, which is currently authorized, would occur. The bulk sampling and exploration activities would continue as

currently permitted. Therefore, no new effects to Native American traditional values are anticipated under the No Action Alternative.

3.17.3 Cumulative Impacts

For cumulative effects, the study area includes an area extending 7.7 miles north, 6.2 miles south, 8.6 miles east, and 4.3 miles west of the East Pit (**Figure 3.16-2**). Section 3.2 describes the past and present actions, and RFFAs. Ethnographic research, cultural resources inventories, Native American consultation efforts, and personal communication and interviews with Western Shoshone individuals have provided documentation that establishes the importance of the Tosawihi Quarries in Western Shoshone history. Archaeological data on file at the BLM supports Western Shoshone historic and prehistoric use of the CESA and is consistent with the traditional/cultural use information provided by contemporary Western Shoshone. Past and present traditional, cultural, and spiritual use information, combined with oral and written histories and the archaeology of the area, support prehistoric, historic, and modern use of the CESA by native practitioners for hundreds if not thousands of years.

Project-specific issues for Native American traditional values were identified based on information provided by tribal governments and individuals through consultation with the BLM, and through public scoping, field visits, site visits, and interviews conducted for the ethnography report. Project-specific issues identified by tribal governments and individuals and analyzed for the Proposed Action include potential effects to cultural resources, subsurface chert deposits, and burials, as well as groundwater drawdown impacts to springs, and impacts associated with road improvements and increased development due to installation of the transmission line. Impacts to subsurface chert deposits as well as impacts associated with road improvements and increased development due to installation of the transmission line would not be anticipated to occur. Therefore, no cumulative impacts would be anticipated. Cumulative impacts to cultural resources and springs are described below.

3.17.3.1 Impacts to Cultural Resources (including TCPs and Properties of Traditional Religious and Cultural Importance)

As a result of previous cultural resources inventories in the CESA, 344 sites have been previously documented within the CESA. These include 328 prehistoric sites, 6 historic sites, and 10 multi-component sites containing both a prehistoric and historic component. Of these, 72 are eligible for the NRHP, 236 are not eligible, and 36 are unevaluated. The sites primarily consist of lithic debitage, tool scatters, and debitage scatters. The lithic debitage and tool scatters contain fragments of stone implements, while debitage scatters contain stone waste flakes, which are a byproduct of tool making. Other cultural sites or resources include (and are not limited to) red and white clay sources, rock shelters, village sites, projectile points, ground stone, and TCPs (e.g., Tosawihi Quarries, Rock Creek). According to the Western Shoshone, cultural sites are associated with the ancestors and considered “physical proof of Shoshone existence” or physical expressions of cultural identity.

The impact analysis of the Proposed Action indicates no adverse impacts to cultural sites (including TCPs and properties of traditional religious and cultural importance) based on compliance with the NHPA, PA, and implementation of mitigating measures involving data recovery (i.e., archaeological excavation), along with collection of all important artifacts with detailed recording of their context. Therefore, under NEPA, no cumulative effects to cultural sites would occur as a result of the Proposed Action. However, if data recovery is necessary to mitigate unavoidable adverse effects to NRHP-eligible sites, the process would recover a substantial amount of data but ultimately the site would be destroyed by the undertaking preventing future opportunities for scientific research, preservation, or public appreciation. Data recovery mitigates the potential damage, but the effects are still adverse. Over time, this represents a cumulative loss.

3.17.3.2 Drawdown Impacts to Springs

The proposed project would result in impacts to springs within the maximum extent of the 10-foot groundwater drawdown contour (Section 3.6.2.1, Proposed Action). These impacts would be in addition to impacts caused by mining development within the Rock Creek Valley and Willow Creek Valley hydrographic areas (Section 3.6.3, Cumulative Impacts). These cumulative impacts would result from ongoing surface disturbance by mining and other land uses, from Carlin Trend mine dewatering and pumping discharges, and from groundwater drawdown. Within the context of Native American traditional values, this represents a cumulative impact to the intrinsic value of water in tribal culture. For an expanded discussion of cumulative impacts to water resources see Section 3.6, Surface Water Resources and Watersheds.

Summary

From a regional perspective, the proposed project would be viewed as adding to the destruction of Western Shoshone aboriginal territory. However, the co-location of proposed utilities with existing roads; the location of most mining facilities within existing or reclaimed mining disturbance; the relatively small amount of proposed ground disturbance; and, the transition from underground exploration and bulk sampling to underground mining operations would reduce the potential for more widespread disruption of minimally altered portions of this territory. In addition, the proposed project's level of disturbance would represent a small amount of change in the regional landscape. For these reasons, cumulative impacts on Native American traditional values from a regional perspective are anticipated to be minor.

3.17.4 Potential Monitoring and Mitigation Measures

The BLM acknowledges that certain impacts cannot be fully mitigated to the satisfaction of the tribes. As stated earlier in Section 3.17.2.1, Proposed Action, and the PA, possible mitigation measures may lessen certain impacts. Adverse effects to religious, spiritual, or sacred values cannot be monitored or mitigated.

Unavoidable adverse effects to known historic properties, as well as sites of tribal importance identified within the APE would be mitigated in accordance with the PA and Historic Properties Treatment Plan. Any subsurface archaeological material, including human remains, discovered during construction activities would be treated in accordance with the PA and NAGPRA, if applicable. Per the PA, the BLM, SHPO, and Tribes may monitor proposed disturbance and any historic properties that remain untreated within or adjacent to the APE. Monitoring of historic properties, including sites of tribal importance, around areas of exploration and mining would be effective in ensuring inadvertent damage would not occur to these properties. No additional mitigation is recommended.

3.17.5 Residual Impacts

Historic properties, TCPs, properties of traditional religious and cultural importance, and contributing loci to the Tosawihi Quarries identified within proposed disturbance areas would be mitigated in accordance with the PA. Although adverse effects to these properties/loci would be mitigated through implementation of data recovery or other forms of mitigation, some of the cultural values associated with these properties/loci cannot be fully mitigated; therefore, it is anticipated that residual impacts to these resources would occur.

3.18 Recreation and Wilderness

3.18.1 Affected Environment

The study area for recreation and wilderness issues is based on the anticipated potential extent of effects from the proposed project. The direct effects study area for recreation and wilderness encompasses an area that includes Elko County, northwestern Eureka County, and northeastern Lander County (**Figure 3.18-1**). The Cumulative Effects Study Area (CESA) for recreation and wilderness includes Elko County, Humboldt County, Lander County, and Eureka County (**Figure 3.18-2**). As discussed in Section 3.20, Social and Economic Values, most employees live in the Winnemucca area with a few people living in Battle Mountain, Elko, and Spring Creek. The project is located in Elko County, Nevada. Therefore, the dispersed nature of wilderness, recreational activities, and past and present actions, and reasonably foreseeable future actions (RFFAs) in the region requires the large four county CESA. The past, present, and RFFAs within the defined CESA are discussed in Section 3.2.

3.18.1.1 Recreation

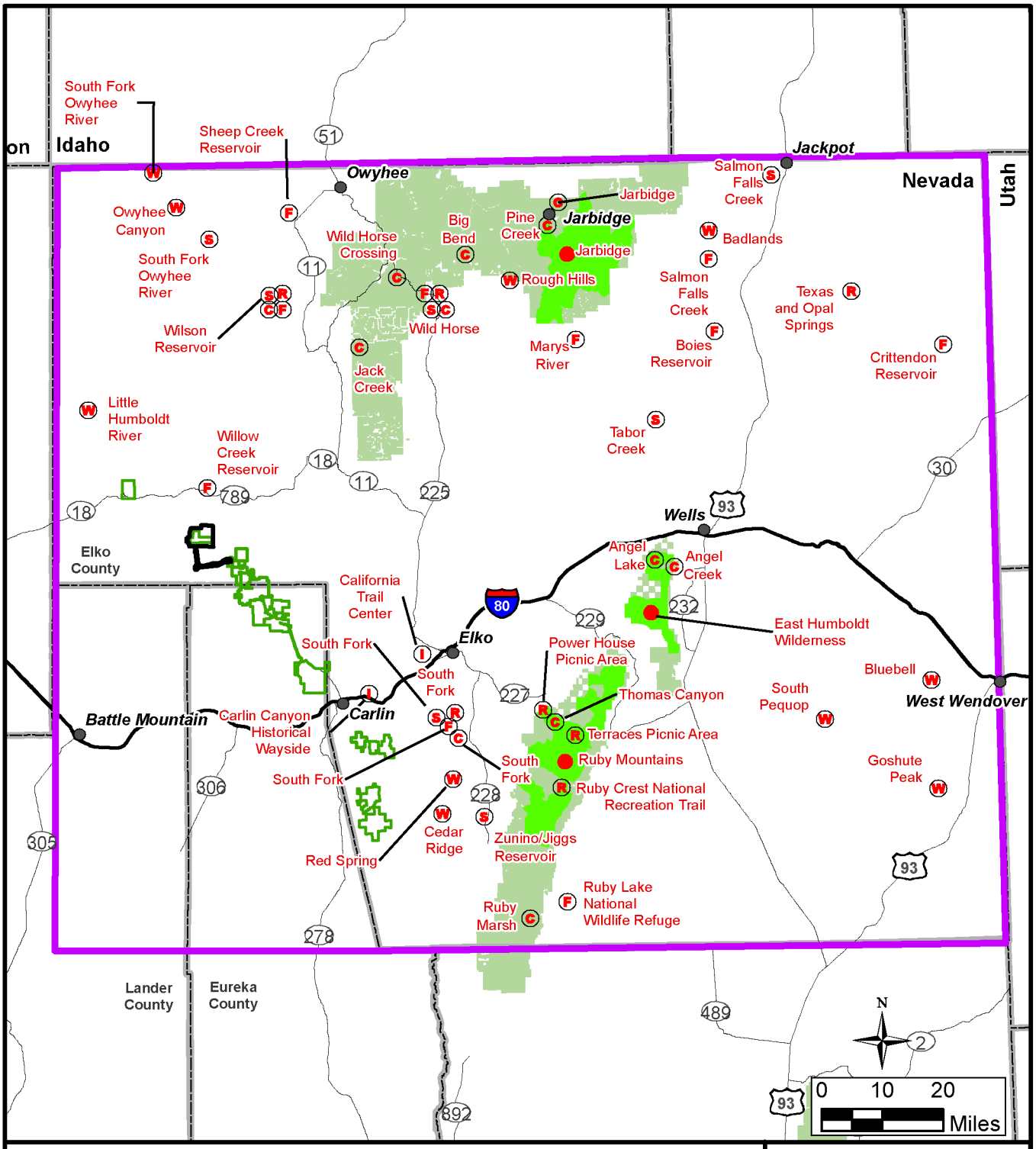
There are no developed recreational facilities in the project area. Willow Creek Reservoir is the closest recreational facility to the project. It is located 6 miles north of the project boundary and is privately owned by Barrick but managed by Nevada Department of Wildlife (NDOW) (Bureau of Land Management [BLM] 2000c). There is open access to the public for fishing, hunting, boating, and camping (BLM 2010d). **Figure 3.18-1** shows all recreation areas, interpretive areas, campgrounds, fishing areas, and special recreation management areas within the direct effects study area. Dispersed recreational opportunities in and near the project vicinity include photography, hiking, camping, off-highway vehicle travel, fishing, and hunting for chukar, greater sage-grouse, and big game, etc. Industrial areas are fenced and off limits to recreation. However, most of the area within the project boundary, including the electric power transmission line (transmission line) corridor and surface exploration areas, are available for recreation.

The proposed project is located within Hunting Unit 68. Hunting Unit 68 is managed by NDOW within a group of units consisting of units 61, 62, 64, 66, and 68. Hunting is allowed for mule deer, pronghorn, and to a lesser extent, elk. **Tables 3.18-1** and **3.18-2** show harvest statistics for mule deer and pronghorn for the entire group of units from 2004 through 2009, respectively.

Large scale fires from 1999 to 2011 have caused a severe reduction in available forage (i.e., shrub browse) and an overall increase of noxious weeds and non-native invasive plant species weeds such as cheatgrass, non-native thistles, and hoary cress (BLM 2011a, 2008b). More information may be found in Section 3.8, Vegetation Resources, and Section 3.10, Noxious Weeds and Non-native Invasive Plant Species. Big game populations and numbers have decreased due to the reduction of available forage after the fires (see Section 3.12, Wildlife Resources).

3.18.1.2 Wilderness

The 10,168-acre project area was evaluated for wilderness characteristics in 1979. The Inventory Unit polygons identified and inventoried in 1979 are: NV-010-122, Willow Creek South; NV-010-123, Bootstrap; NV-010-124, Antelope Creek; NV-010-125, Silver Cloud; and NV-010-210, Checkerboard.



Legend

- Project Area Boundary
- Direct Effects Study Area
- Other Mine Plan Boundaries
- Road
- County Boundary
- Forest Service Lands
- Forest Service Wilderness Lands
- City
- Campground
- Fishing Area
- Interpretive Site
- Recreation Area
- Special Recreation Management Area
- Wilderness Study Area
- Wilderness Area

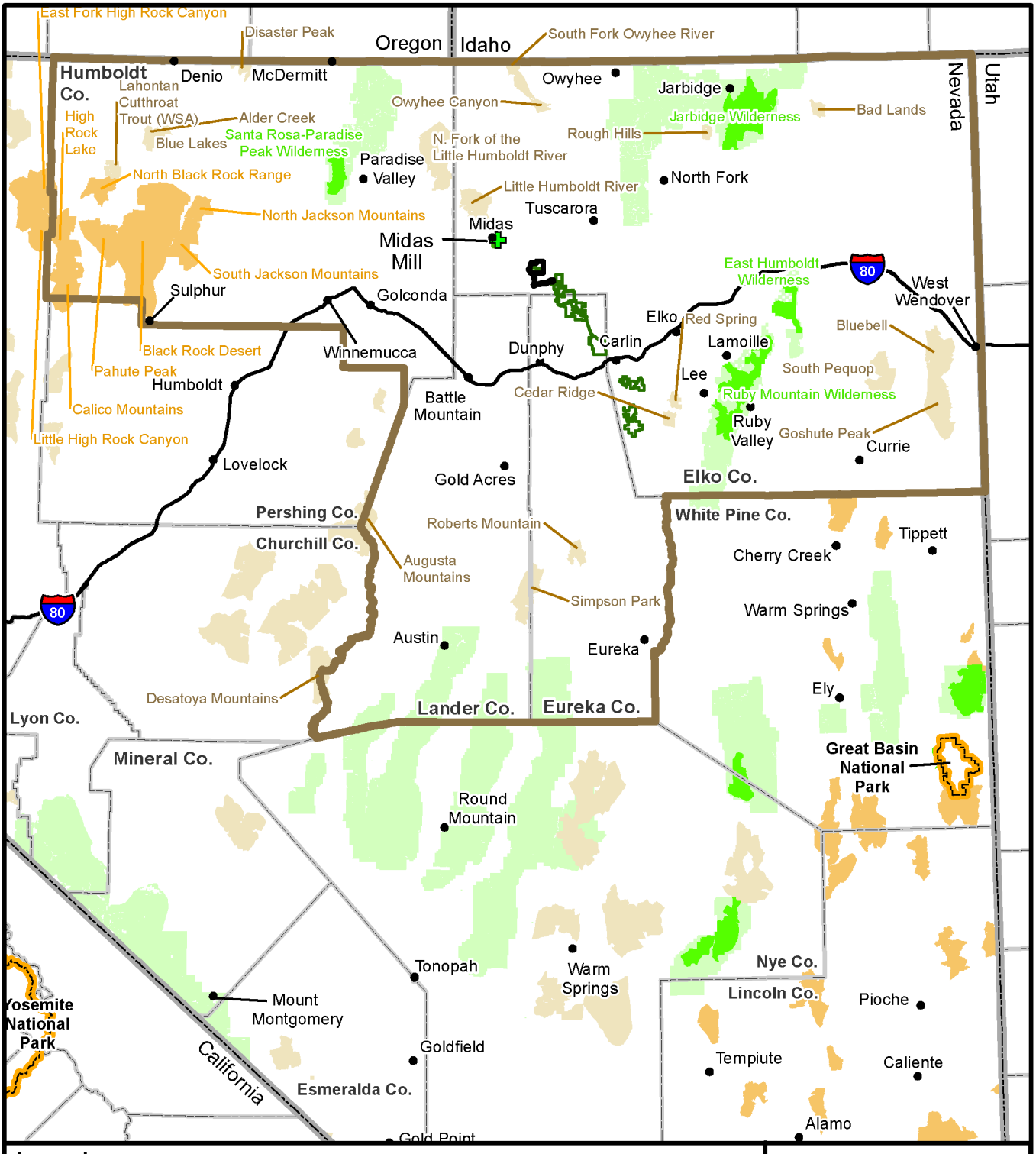
Sources: BLM 2007a,b, 2008b, 2010d,e.

3/20/2012

Hollister Underground Mine Project EIS

Figure 3.18-1

Recreation and Wilderness Direct Effects Study Area



Hollister Underground Mine Project EIS

Figure 3.18-2

Recreation and Wilderness Cumulative Effects Study Area

4/2/2012

Table 3.18-1 Mule Deer Harvest Statistics for Units 61, 62, 64, 66, and 68

Year	Total Harvest	Hunting Licenses Sold
2009	321	759
2008	364	799
2007	538	1,080
2006	475	949
2005	474	872
2004	253	490

Source: NDOW 2009c.

Table 3.18-2 Pronghorn Harvest Statistics for Units 61, 62, 64, 66, and 68

Year	Total Harvest	Hunting Licenses Sold
2009	117	156
2008	95	115
2007	168	184
2006	110	143
2005	83	94
2004	95	116

Source: NDOW 2009d.

In 1979, it was determined that the project area and adjacent surrounding areas did not meet the criteria for wilderness characteristics or designation as wilderness because:

- NV-010-122 Willow Creek South: The public recommended that the area be dropped from further wilderness study. BLM concurred with the recommendation because of the heavy mining active in the area.
- NV-010-123 Bootstrap: The unit does not meet the basic requirements necessary to be carried over to the intensive inventory stage. Due to lack of topographic and vegetative screening, and the relatively small size, it lacked outstanding opportunities for solitude or a primitive and unconfined type of recreation in comparison to others of its kind.
- NV-010-124 Antelope Creek: This area had already been intensively inventoried because of a special project. The intensive inventory found that the area lacked wilderness characteristics and it was dropped from further wilderness consideration.
- NV-010-125 Silver Cloud: This area had already been intensively inventoried because of a special project. The intensive inventory found that the area lacked wilderness characteristics and it was dropped from further wilderness consideration.
- NV-010-210, Checkerboard. None of the public lands, other than a few acres described elsewhere occur in blocks of more than 5,000 acres each. In fact, most are the size of a single section (640 acres). None of these lands are in areas of sufficient size as to make practicable its preservation and use in an unimpaired condition.

After the initial wilderness characteristics inventory was completed, open-pit mining occurred at the Hollister Site creating two open pits, waste rock storage facilities (WRSFs), a heap leach pad, and additional roads. Surface exploration for gold also has created new roads throughout the area. Considering the 1979 inventory and subsequent disturbance, the Elko District management has determined that the area does not contain lands with wilderness characteristics.

Ten BLM wilderness study areas (WSAs) are located within the direct effects study area including the Little Humboldt, Owyhee Canyon, Red Springs, Cedar Ridge, South Fork Owyhee River, Rough Hills, Badlands, South Pequop, Bluebell, and Goshute Peak WSAs (**Figure 3.18-1**, **Table 3.18-3**).

The Little Humboldt River WSA (NV-010-132) is the closest WSA to the project area (approximately 16 miles northwest) and it encompasses 42,213 acres. It has moderate potential for mining precious metals, but development is unlikely due to the rugged terrain and high wilderness values. The current recommendation for the Little Humboldt River WSA is for 29,775 acres to become wilderness lands and to release 12,438 acres as non-wilderness lands (BLM 2000d).

Wilderness areas are presented in **Table 3.18-4**. There are three U.S. Forest Service (USFS)-designated wilderness areas no BLM-designated wilderness areas within the direct effects study area. The Jarbidge Wilderness Area is the closest wilderness area to the project area (approximately 62 miles northeast of the project area and is managed by the USFS (**Figure 3.18-1**). It has a variety of dispersed recreational opportunities that include horseback riding, hiking, cross-country skiing, photography, camping, and hunting. The Jarbidge Wilderness Area encompasses 111,899 acres and is surrounded on all sides by the Jarbidge Ranger District.

3.18.2 Environmental Consequences

The Proposed Action and alternatives potentially could affect recreation and wilderness resources both directly and indirectly. Direct impacts may include elimination or displacement of recreation resources in the project area, or degradation of the recreation experience for users of the resources due to noise, traffic, excessive dust, or other emissions from the proposed project. Indirect impacts may result from changes in demand for limited recreation resources as a result of project-related population growth.

3.18.2.1 Proposed Action

Recreation

The project area encompasses a total of 10,168 acres, 88 percent (9,301 acres), of which are BLM-managed lands and 12 percent (867 acres) are private lands. Under the Proposed Action, total surface disturbance would be minor and would be approximately 117 acres in addition to the previously authorized disturbance of approximately 105 acres for a total disturbance of approximately 222 acres. Of the 117 acres of surface disturbance for the Proposed Action, approximately 106.2 acres (91 percent) of the surface disturbance would be on public land and 10.8 acres (9 percent) on private land. During operations the mine area encompassed by the perimeter fence would continue to be excluded from recreational use (613 acres).

During surface exploration drilling and transmission line construction, it is likely that mule deer would move away from new areas of project activity and noise (see Section 3.12, Wildlife Resources). As a result, hunters would hunt in areas adjacent to the project area and within the project vicinity. There is extensive public land in the immediate surrounding area that would accommodate migration of dispersed recreation activity from the project area. Because potential effects on game species are anticipated to be low, the overall effect on recreational hunting would be minor.

Table 3.18-3 Wilderness Study Areas

BLM Wilderness Study Area	Size (acres)	Distance from Hollister Mine Project (miles)	Recreation Uses	Direct Effects Study Area	Cumulative Effects Study Area
Little Humboldt River	42,213	16	Backpacking, hiking, wildlife viewing, photography, rock climbing, fishing, and horseback riding.	X	X
North Fork of the Little Humboldt River	69,591	34	Backpacking, hiking, wildlife viewing, photography, rock climbing, fishing, and horseback riding.		X
Owyhee Canyon	21,379	44	Backpacking, hiking, wildlife viewing, photography, rock climbing, fishing, and horseback riding.	X	X
Red Springs	7,522	51	Horseback riding and limited hiking.	X	X
Cedar Ridge	9457	54	Hunting, wildlife viewing, and horseback riding.	X	X
South Fork Owyhee River	8,098	55	Hunting, backpacking, river running, sight-seeing, photography, wildlife viewing, botanical studies, and fishing.	X	X
Rough Hills	6,484	60	Backpacking, camping, hiking, horseback riding, upland game bird and mule deer hunting, wildlife viewing, sightseeing, photography, and fishing.	X	X
Roberts Mountain	15,179	76	Backpacking, hiking, rock climbing, nature study, hunting, and photography.		X
Augusta Mountains	88,098	78	Backpacking, hiking, and primitive camping.		X
Simpson Park	49,266	82	Hiking, horseback riding, and hunting.		X
Bad Lands	9,263	91	River running, wildlife viewing, and fishing.	X	X
Disaster Peak	12,736	100	Backpacking, hiking, camping, fishing, sightseeing, photography, and winter sports.		X
South Pequop	40,222	102	Backpacking, hiking, camping, fossil collecting, and Bristle cone pine viewing.	X	X
Bluebell	54,413	114	Backpacking, hiking, wildlife viewing, photography, rock climbing, and fossil collecting.	X	X

Table 3.18-3 Wilderness Study Areas

BLM Wilderness Study Area	Size (acres)	Distance from Hollister Mine Project (miles)	Recreation Uses	Direct Effects Study Area	Cumulative Effects Study Area
Blue Lakes	19,975	114	Backpacking, camping, hunting, fishing, horse-packing, and winter sports.		X
Alder Creek	5,189	118	Backpacking, hiking, hunting, fishing, horse-packing, and nature study.		X
Goshute Peak	70,138	120	Backpacking, hiking, wildlife viewing, photography, rock climbing, and fossil collecting.	X	X
Desatoya Mountains	51,006	124	Hiking, camping, hunting, cross-country skiing, horseback riding, and photography.		X
Lahontan Cutthroat Trout	11,945	124	Backpacking, hunting, horseback riding, cross country skiing, and winter camping.		X

Source: BLM 2000d.

Table 3.18-4 Wilderness Areas

Recreation Area Name	Size (acres)	Distance from Hollister Mine Project (miles)	Recreation Uses	Direct Effects Study Area	Cumulative Effects Study Area
BLM Wilderness Area					
North Jackson Mountains	23,439	96	Hiking, backpacking, and hunting.		X
South Jackson Mountains	54,535	100	Hiking, backpacking, and hunting.		X
Black Rock Desert	314,835	105	Hiking, backpacking, and hunting.		X
Pahute Peak	56,890	122	Hiking, backpacking, and hunting.		X
North Black Rock Range	30,648	125	Hiking, backpacking, and hunting.		X
High Rock Lake	59,107	133	Hiking, backpacking, and hunting.		X
Calico Mountains	64,968	135	Hiking, backpacking, and hunting.		X
East Fork High Rock Canyon	52,618	140	Hiking, backpacking, and hunting.		X
Little High Rock Canyon	48,354	143	Hiking, backpacking, and hunting.		X
USFS Wilderness Areas					
Santa Rosa-Paradise Peaks Wilderness	32,035	60	Hiking, horseback riding, cross-country skiing, photography, camping, and hunting.		X
Ruby Mountain Wilderness	93,094	64	Hiking, horseback riding, cross-country skiing, photography, camping, and hunting.	X	X
Jarbidge Wilderness	111,899	62	Hiking, horseback riding, cross-country skiing, photography, camping, and hunting.	X	X
East Humboldt Wilderness	36,687	70	Hiking, horseback riding, cross-country skiing, photography, camping, and hunting.	X	X

Source: BLM 2010j; USFS 2010.

Upon completion of mining, closure, and reclamation activities, much of the disturbed area would be available for dispersed recreation use (see Section 2.4.10, Reclamation and Site Closure). After successful revegetation of disturbed areas, these areas would be expected to provide habitat for wildlife and offer hunting opportunities to hunters.

There would be a minor increase in regional human population resulting from the Proposed Action (see Section 3.20, Social and Economic Values). The new residents would increase the demand for recreational resources and opportunities in the region, but the increase would be very small in the context of the existing population base. There is ample public land in the region to accommodate dispersed recreational needs of the population increase. Any adverse effects would be greatest at parks and other developed recreation facilities in the communities where the population increment would reside, primarily Winnemucca, Elko, Spring Creek, Carlin, and Battle Mountain communities. Such effects would be expected to be minor.

Because the amount of surface disturbance is minor, and because there is an ample supply of alternative land for dispersed recreational activities in the project vicinity, and because no unique recreational resources would be impacted as a result of the proposed project, effects on recreational resources would be considered minimal.

Wilderness

The project area does not contain any land that meets the criteria for wilderness characteristics or designation. Additionally, the Little Humboldt WSA and the Jarbidge Wilderness Area, are located 16 miles and 62 miles away, respectively, and are the closest WSA or wilderness area to the Hollister Site. As a result, there would be no direct effects or measurable indirect effects from the proposed project on wilderness resources. Due to distance and topography, night lighting from the proposed project would be negligible during operations (see Section 3.22, Visual Resources).

3.18.2.2 Mud Springs Road Transmission Line Alternative

Recreation

The effects on recreational resources under this alternative would be similar to those described for the Proposed Action except this alternative would have less surface disturbance (9.5 acres for the North Option and 15.2 acres for the South Option) than the Proposed Action. Under either alternative option, the area would be available for dispersed recreation uses.

Wilderness

There would be no direct effects or measurable indirect effects on wilderness resources from this alternative. Impacts would be the same as described for the Proposed Action.

3.18.2.3 Mud Springs Waste Rock Storage Facility Alternative

Recreation

Under the Mud Springs WRSF Alternative, the West Pit WRSF would not be constructed. Alternately, the Mud Springs WRSF would be constructed east of the reclaimed heap leach facility. Short-term minor impacts would affect hunters and other dispersed recreational activities. However, upon completion of mining, closure, and reclamation activities, much of the disturbed area would be available for dispersed recreational use. The effects would be the same as the Proposed Action.

Wilderness

Under the Mud Springs WRSF Alternative, there would be no direct effects or measurable indirect effects on wilderness due to the relatively long distance separating the project area and the nearest wilderness area and WSA. The effects would be the same as the Proposed Action.

3.18.2.4 Backfill Alternative

Recreation

Under the Backfill Alternative, short-term minor impacts would affect hunters and other dispersed recreational activities; however, upon completion of mining, closure, and reclamation activities, much of the disturbed area would be available for dispersed recreation use. Additionally, this alternative would enhance public safety. The effects of the alternative on recreational use would be the same as those under the Proposed Action.

Wilderness

Under the Backfill Alternative, the relatively long distance separating the project area and the nearest wilderness area and WSA would result in effects that would be the same as those under the Proposed Action.

3.18.2.5 No Action Alternative

Recreation

Under the No Action Alternative, no additional disturbance to private or public land or direct impacts to recreation resources would occur. The Hollister Development Block Project would continue to operate under current authorizations and permits.

Wilderness

No additional disturbance to private or public land or direct impacts to wilderness resources would occur under the No Action Alternative. The Hollister Development Block project would continue to operate under current authorizations and permits.

3.18.3 Cumulative Impacts

The CESA for recreation and wilderness is shown in **Figure 3.18-2**. Past, present, and RFFAs in the CESA are described in Section 3.2, Past, Present, and Reasonably Foreseeable Future Actions.

3.18.3.1 Recreation

Past, present, and RFFAs in the CESA have resulted, or would result, in approximately 47,043 acres of mine, mineral exploration, and pipeline construction surface disturbance in the Carlin Trend. The changes in cumulative impacts to recreation and hunting from past, present, and the reasonably foreseeable mining related activities in the Carlin Trend is likely to remain minimal, in part because of access restrictions related to mining areas currently existing and unrestricted areas adjacent to the Carlin Trend area that remain available for dispersed recreation. The proposed project would disturb an additional 117 acres (less than 1 percent of the CESA) of land currently open and available for recreation, resulting in a total cumulative disturbance of approximately 47,160 acres associated with mining where no recreation could occur while active mining is ongoing. Wildfires have further reduced recreational opportunities in northern Nevada, during suppression activities. After the fire is out, the public lands are open for recreation. However, burned areas are less appealing to the general public.

Although the cumulative surface disturbance in the CESA would preclude recreational use in active mining areas, the 117 acres of disturbance for the Proposed Action is minor compared with the vast millions of acres of available public land in the CESA. There would be more than sufficient recreational resources to accommodate dispersed recreational activities displaced by past, present, and RFFAs in the CESA. Because all the disturbance associated with the proposed project would be reclaimed, there are no cumulative impacts due to unreclaimed surface disturbance.

3.18.3.2 Wilderness

There would be no measurable cumulative effects on wilderness resources as a result of the relatively long distances separating the project area and the nearest wilderness area or WSA.

3.18.4 Potential Monitoring and Mitigation Measures

Based on the conclusion of the analysis that there are no impacts, no monitoring or mitigation measures would be required for recreation or wilderness.

3.18.5 Residual Impacts

Residual effects to recreation and wilderness would not occur because all disturbed lands would be reclaimed and available for public use.

3.19 Air Quality

3.19.1 Affected Environment

The Hollister Site and existing Midas Mill are located entirely within the Rock Creek Air Quality Basin (No. 62). Esmeralda Mill is located within the East Walker Area Air Quality Basin (No. 109). The air quality study area encompasses the project area and the area within 6.2 miles (10 kilometers [km]) of the mine, the ore transportation route along gravel/dirt roads to the mills, and the area within 6.2 miles (10 km) of the Esmeralda and Midas mills (**Figure 3.19-1**). The Cumulative Effects Study Area (CESA) for air quality encompasses the four air basins in the Hollister Site vicinity: Willow Creek Valley, Rock Creek Valley, Boulder Flat, and Maggie Creek (**Figure 3.19-2**); the ore transportation corridor from the mine to the mills (**Figure 3.19-1**); and an area within 62 miles (100 km) of the Esmeralda Mill that includes Yosemite National Park (**Figure 3.19-3**). The rationale for selecting these air basins for the CESA is based on previous air quality modeling done for regulated air pollutant sources conducted for the Nevada Division of Environmental Protection (NDEP) air quality permit process. The CESA represents an adequate area of analysis in which to evaluate the air quality effects of the proposed project with other actions within the basins that contribute to cumulative effects.

The project area is located near the north-central portion of the Great Basin. The surrounding terrain consists of alternating mountain ranges and sagebrush-covered valleys, with the mine site situated in the Basin and Range physiographic province. Elevations in the project area range from approximately 5,300 feet to 6,500 feet above mean sea level (amsl).

Regional meteorology, air quality, and dispersion conditions in the project area are characterized from data records from the closest climate monitoring station at Elko, Nevada, which is approximately 45 miles southeast of the project area. The climate in the project region is classified as arid, with elevations below 6,500 feet amsl receiving approximately 5 to 9 inches per year of precipitation, while the mountainous areas typically receive approximately 11 to over 16 inches of precipitation annually.

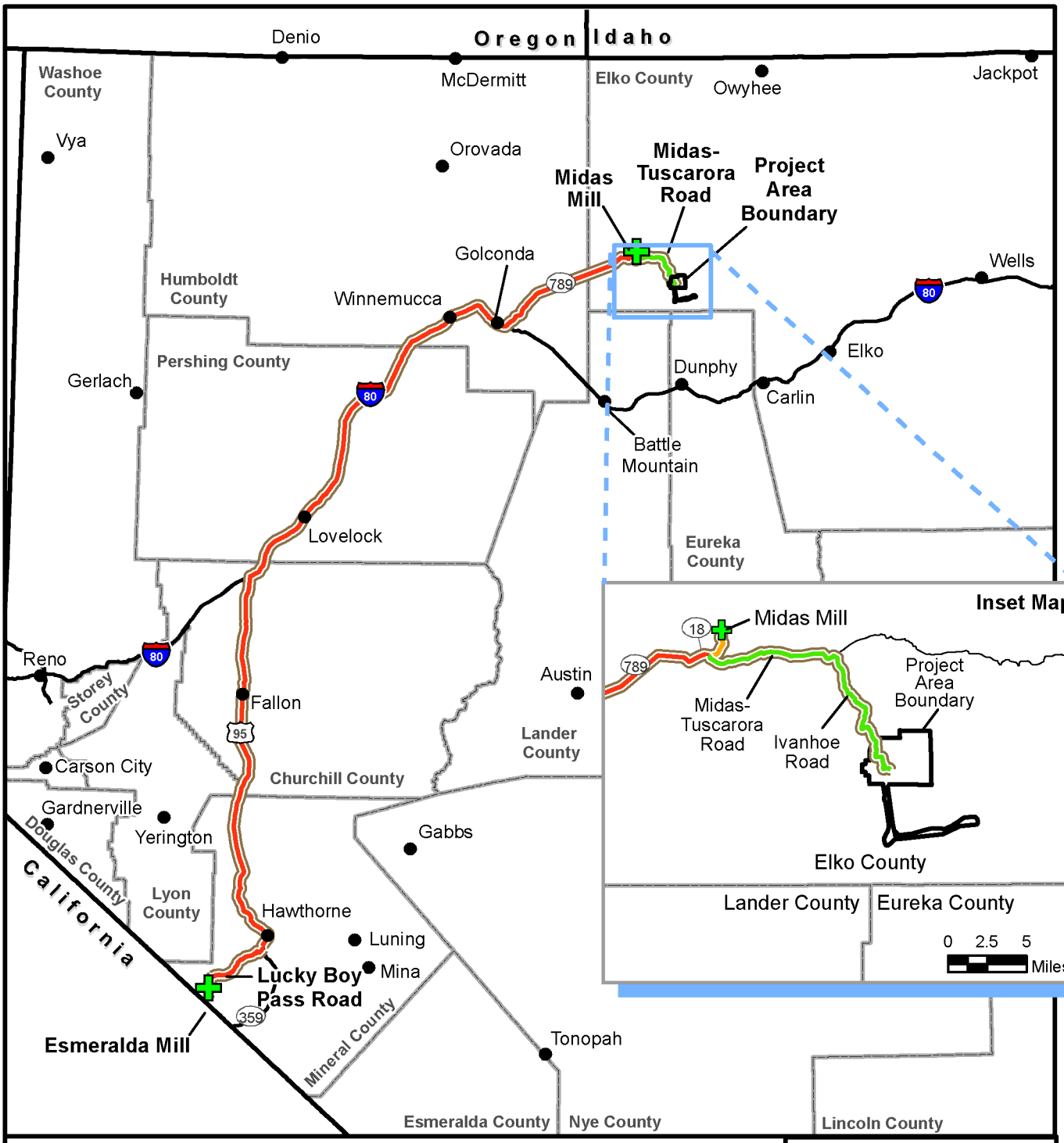
Although the area was previously mined for mercury, such mining occurred in shallow Tertiary deposits. Whereas the Proposed Action would mine at depths where the mercury concentrations in the ore are minimal.

3.19.1.1 Climatology and Meteorology

Nevada has great climatic diversity, ranging from scorching lowland desert in the south to cool mountain forests in the north. Its varied and rugged topography, mountain ranges, and narrow valleys range in elevation from approximately 1,500 to more than 10,000 feet amsl. Large local variations of temperature and rainfall are common.

Nevada lies on the eastern side (i.e., lee side) of the Sierra Nevada Mountains, a massive mountain barrier that markedly influences the climate. One of the greatest contrasts in precipitation found within a short distance in the United States (U.S.) occurs between the western slopes of the Sierra Nevada Mountains in California and the valleys immediately east of this range.

The prevailing winds are from the west. As the warm moist air from the Pacific Ocean ascends the western slopes of the Sierra Nevada Mountains, the air cools, condensation occurs, and most of the available moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt throughout the state and have resulted in the formation of deserts and steppes in the lowlands of Nevada. The principal climatic features are bright sunshine; low annual precipitation (averaging 9 inches in the valleys and deserts), heavy snowfall in the higher mountains; clean, dry air; and exceptionally large daily temperature fluctuations.



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Esmeralda Mill Route
- Midas Mill Route
- Esmeralda Mill and Midas Mill Routes
- Mill Site
- Nevada State Route
- U.S. Federal Highway
- U.S. Interstate Highway

N

0 20 40 Miles

Note: CESA width is not drawn to scale.
Source: RCG 2010b.

Hollister Underground Mine Project EIS

Figure 3.19-1

Air Quality for Transportation Cumulative Effects Study Area

3/20/2012

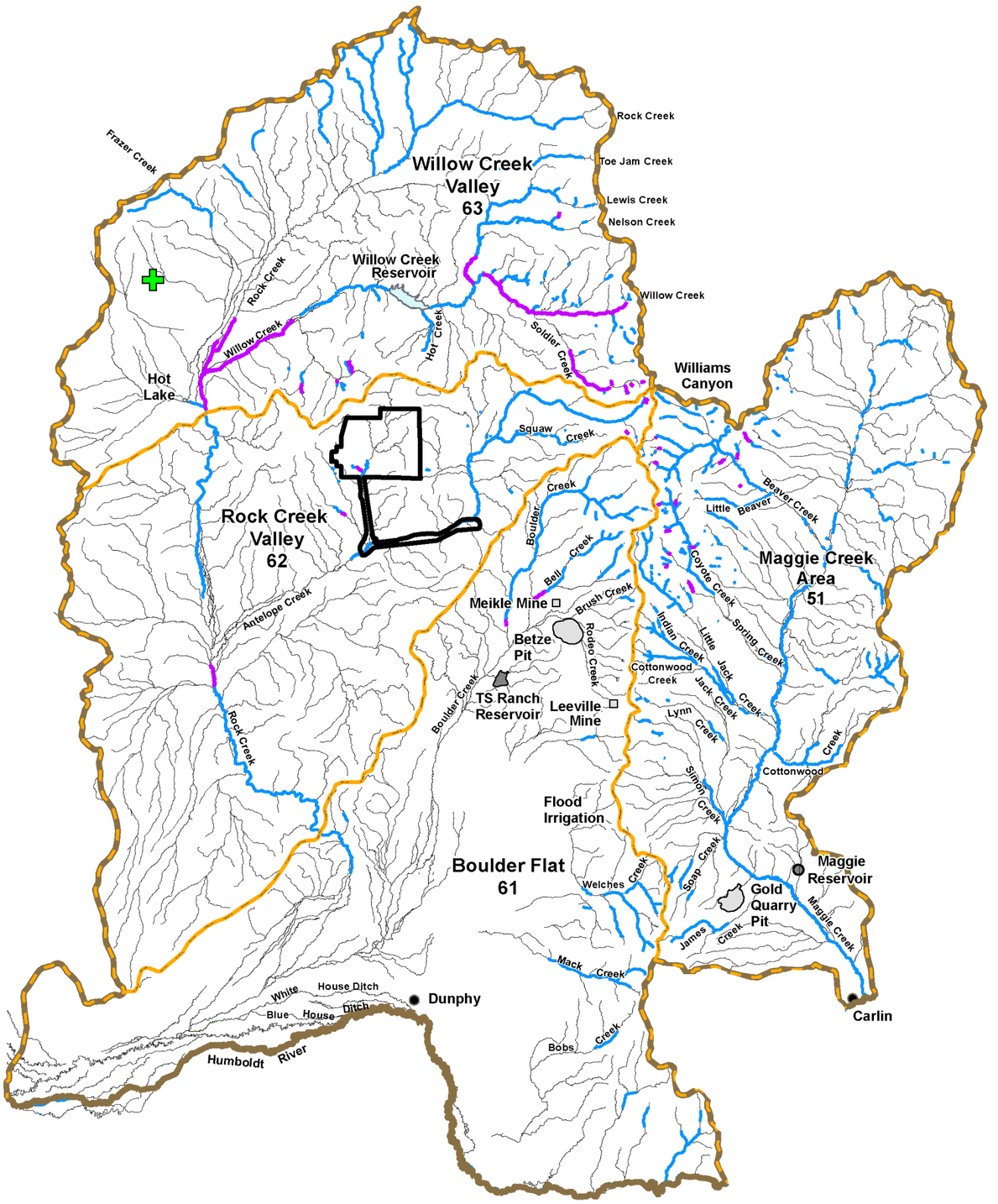
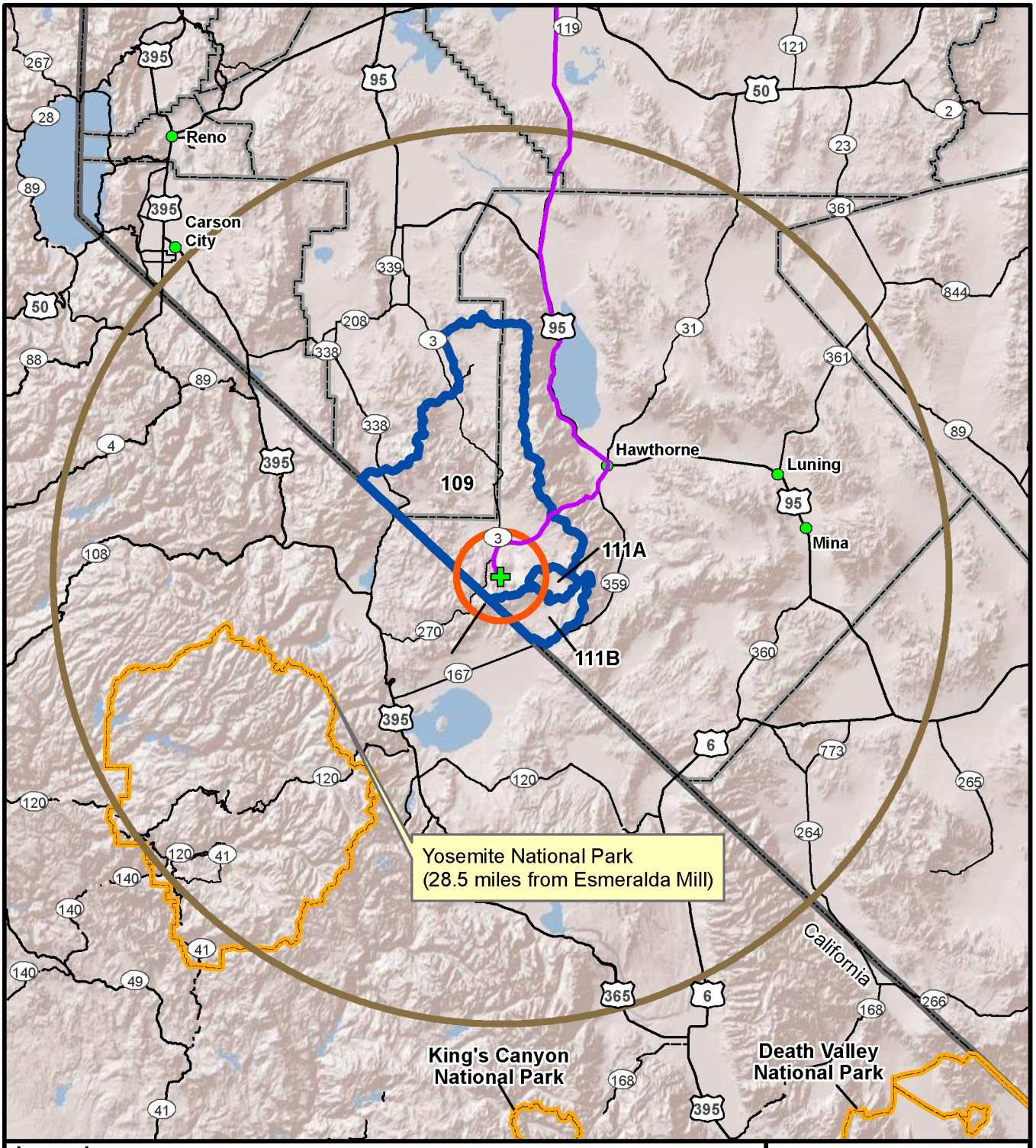


Figure 3.19-2

Air Quality
Cumulative Effects
Study Area
Hollister Site

Hollister Underground Mine Project EIS

3/1/2012



Hollister Underground Mine Project EIS

Figure 3.19-3

Air Quality
Cumulative Effects
Study Area
Esmeralda Mill

10/20/2011

Three important meteorological factors influence the dispersion of pollutants in the atmosphere: mixing height, wind (speed and direction), and stability. Mixing height is the height aboveground within which rising warm air from the surface mixes by convection and turbulence. Local atmospheric conditions, terrain configuration, and source location determine dilution of pollutants in this mixed layer. Mixing heights vary diurnally, with the passage of weather systems and season. For the project area, the mean annual morning mixing height is estimated to be approximately 984 feet (300 meters). However, during the winter months the mean morning mixing height is approximately 722 feet (220 meters) (Holzworth 1972). The mean annual afternoon mixing height exceeds 7,874 feet (2,400 meters).

Morning atmospheric stability conditions tend to be stable because of the cooling of the air layers nearest the ground. Afternoon conditions, especially during the warmer months, tend to be neutral to unstable because of the rapid heating of the ground surface under clear skies. During the winter, periods of stable afternoon conditions may persist for several days in the absence of synoptic (continental-scale) storm systems to generate higher winds with more turbulence and mixing. A high frequency of inversions at lower elevations during the winter can be attributed to the nighttime cooling and sinking air flowing from higher elevations to the low lying areas in the basins. Although winter inversions are generally quite shallow, they tend to be more stable because of reduced surface heating.

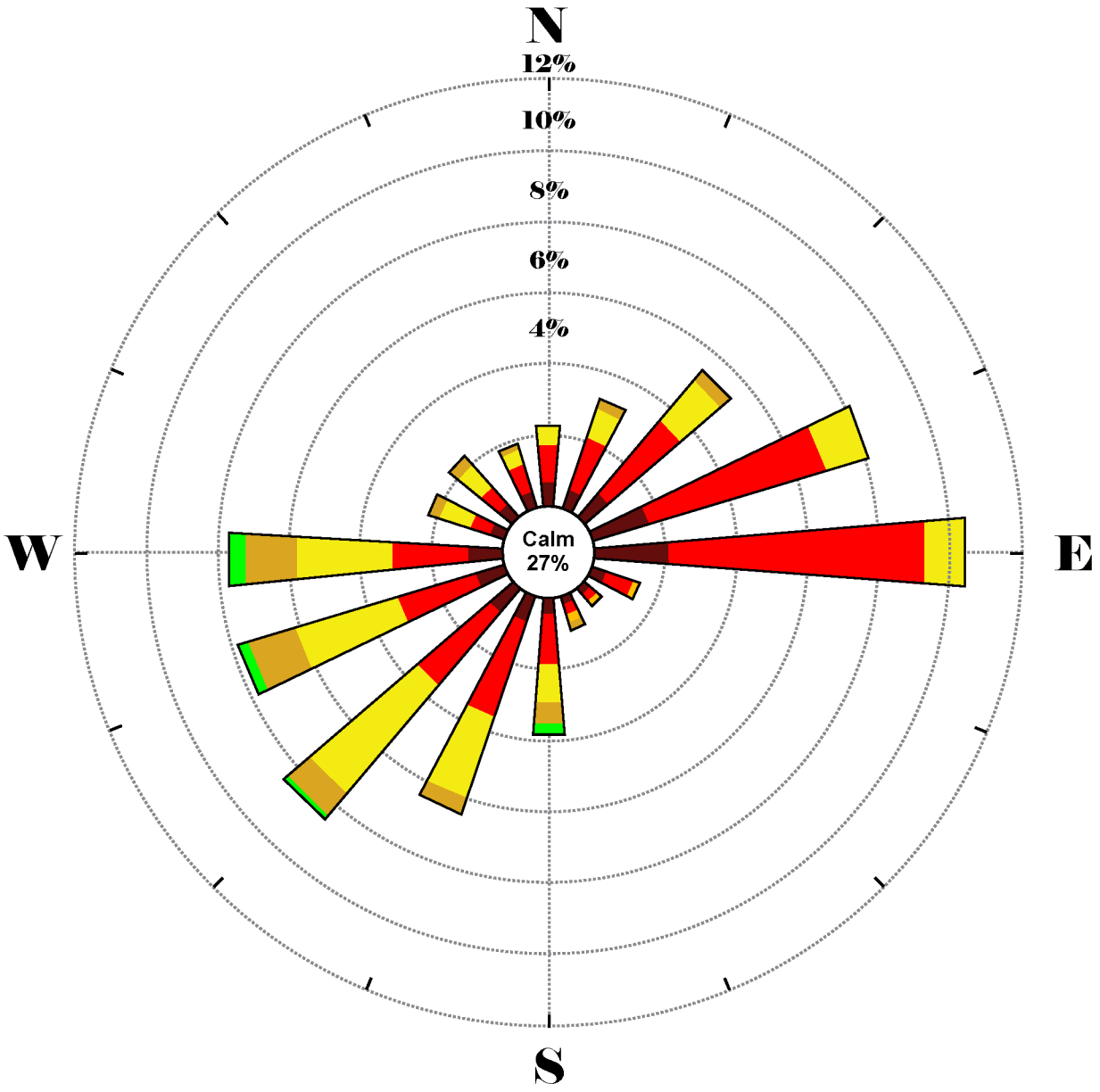
The latitude of the project area places it within the belt of prevailing westerly winds that circle the globe around the earth's northern hemisphere. However, the proposed Hollister Mine is located in complex terrain where the winds are affected by local topographic features.

Due to the typically dry atmosphere, bright sunny days and clear nights frequently occur. This in turn, allows rapid heating of the ground surface during daylight hours and rapid cooling at night. Because heated air rises, and cooled air sinks, winds tend to blow uphill during the daytime and down slope at night. The complexity of terrain features causes complex movements in the cyclic air patterns, with thin layers of moving air embedded within the larger scale movements. The lower level, thermally driven winds also are embedded within larger scale upper wind systems (i.e., synoptic winds). Synoptic winds in the region are predominantly west to east, are characterized by daily weather variations that enhance or diminish the boundary layer winds, and are channeled by regional and local topography.

The wind rose for Elko (**Figure 3.19-4**) is representative of the regional wind climatology for the proposed Hollister Mine and existing Midas Mill. The Elko wind rose indicates that winds are predominantly from the west to southwest, but also it shows that there is a secondary maximum of wind occurrences from the northeast. Wind speed has an important effect on area ventilation and the dilution of pollutant concentrations from individual sources. Light winds, in conjunction with large source emissions, may lead to an accumulation of pollutants that can stagnate or move slowly to downwind areas.

During stable conditions, downwind usually means down valley or toward lower elevations. Climate data from Elko indicate that the potential for air pollution episodes to last 5 or more days is nearly zero (Holzworth 1972). A potential air pollution episode is defined as a period of time with wind speeds less than 6.6 feet (2 meters) per second and mixing heights less than 3,281 feet (1,000 meters).

Table 3.19-1 shows the monthly climate summary data for temperature and precipitation for Elko during the 123-year period from January 1888 through December 2010. These data are generally representative of climatic conditions for the proposed Hollister Mine and existing Midas Mill. Summers are typically hot and dry. Precipitation falls throughout the year with much of it occurring as snowfall during the winter. The average annual precipitation at Elko is approximately 9.6 inches. Importantly, precipitation can vary with elevation, with higher precipitation occurring at higher elevation sites. The elevation of the Hollister Site is approximately 5,500 feet amsl, while Elko is approximately 5,000 feet amsl. While precipitation data are not collected at the Hollister Site, it is reasonable to assume the precipitation measured at Elko is representative of the project area.



Legend

Average Wind Speed (mph)

- 1.3 - 4
- 4 - 8
- 8 - 13
- 13 - 19
- 19 - 25
- 25 - 32
- 32 - 39
- 39 - 47
- 47+

Station:	Elko Airport Nevada
Latitude:	40º 49' 30" N
Longitude:	115º 47' 30" W
Elevation:	0 ft.
Start Date:	Jan. 1, 2001
End Date:	Jan. 31, 2006

Source: Western Regional Climate Center 2011a.

Hollister Underground Mine Project EIS

Figure 3.19-4

5-year Composite Wind Rose Plot for Elko, Nevada 2001 to 2006

10/20/11

Table 3.19-1 Monthly Climate Summary Elko Airport, Nevada

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	36.7	42.4	51.0	59.9	69.5	80.0	91.1	88.8	78.8	65.8	50.3	38.9	62.8
Average Minimum Temperature (°F)	10.8	17.4	23.7	29.1	35.6	42.3	48.2	45.7	36.7	28.0	20.4	13.1	29.3
Average Total Precipitation (in.)	1.18	0.93	0.92	0.85	0.97	0.78	0.37	0.40	0.45	0.72	0.92	1.10	9.60
Average Total Snowfall (in.)	7.9	4.6	3.8	1.8	0.5	0.0	0.0	0.0	0.0	0.5	3.2	6.5	28.7
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

Note: Period of Record: 1/1/1888 to 12/31/2010.

Source: Western Regional Climate Center 2011a.

Esmeralda Mill is about 22 miles southwest of Hawthorne, Nevada. A summary of the climate for Hawthorne is presented in **Table 3.19-2**. These data indicate that this area in the lee side of the Sierra Nevada Mountains is very dry, receiving less than 5 inches of rainfall annually. Temperatures show a large diurnal and annual range, largely as a result of this dryness. Summers are warm but only July and August record average daytime highs in the 90s. Winters are moderately cold with the average nighttime lows below freezing for 4 months of the year, November through February. A large diurnal range of temperatures supports dispersion and mixing of air, and this contributes to a relatively clean quality of the air in the region.

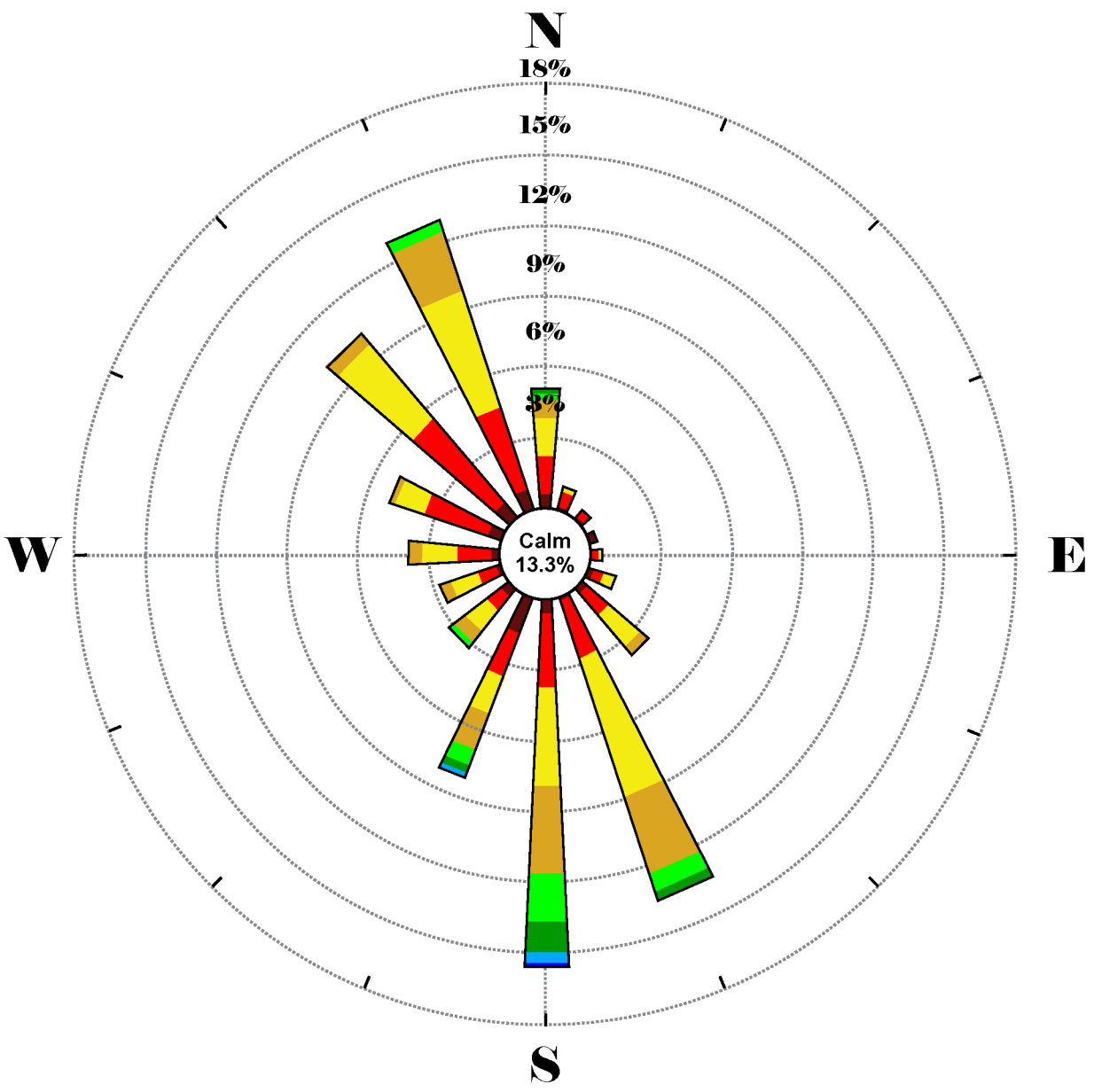
Table 3.19-2 Period of Record Monthly Climate Summary for Hawthorne, Nevada

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	47.2	53.4	62.2	67.8	76.7	86.1	96.3	93.9	85.2	72.2	57.0	48.5	70.5
Average Minimum Temperature (°F)	24.1	28.1	33.2	37.3	46.4	54.1	62.3	60.1	51.7	41.6	30.9	25.4	41.3
Average Total Precipitation (in.)	0.41	0.47	0.38	0.42	0.67	0.41	0.27	0.18	0.21	0.23	0.36	0.24	4.25
Average Total Snowfall (in.)	0.6	0.4	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.1	2.3
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Period of Record: 8/19/1954 to 12/31/2010.

Source: Western Regional Climate Center 2011b.

The wind rose for the Brawley Peaks monitoring station located 4 miles southeast of the Esmeralda Mill is shown in **Figure 3.19-5**. The Brawley Peaks wind rose indicates that winds are predominately from the south with a secondary maximum of wind occurrences from the northwest.



Legend

Average Wind Speed (mph)

- 1.3 - 4
- 4 - 8
- 8 - 13
- 13 - 19
- 19 - 25
- 25 - 32
- 32 - 39
- 39 - 47
- 47+

Station:	Brawley Peaks Nevada
Latitude:	38º 15' 40" N
Longitude:	112º 52' 49" W
Elevation:	8080 ft.
Start Date:	Jan. 1, 2006
End Date:	Dec. 31, 2010

Source: Western Regional Climate Center 2011b.

Hollister Underground Mine Project EIS

Figure 3.19-5

5-year Composite Wind Rose Plot for Brawley Peaks, Nevada 2006 to 2010

10/20/11

3.19.1.2 Air Quality

Air quality is defined by the concentration of various pollutants and their interactions in the atmosphere. Pollution effects on human health have been used to establish Ambient Air Quality Standards (AAQS). Measurement of pollutants in the atmosphere is expressed in units of parts per million or micrograms per cubic meter ($\mu g/m^3$). Both long-term climatic factors and short-term weather fluctuations are considered when assessing air quality concentrations because they control dispersion and transport. Physical effects of air quality depend on many factors, such as the type, amount, and duration of exposure. Air quality standards specify acceptable upper limits of pollutant concentrations and duration of exposure. Air pollutant concentrations below the standards generally are not considered to be detrimental to public health and welfare.

The relative importance of pollutant concentrations can be determined by comparison with appropriate National and/or State AAQS. National and State AAQS are presented in **Table 3.19-3**. The pollutants of concern for the Hollister Underground Mine Project are nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM), including PM_{10}, and PM with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$). Lead (Pb), hydrogen sulfide, and ozone (O_3) are not emitted or produced in sufficient quantities to be of concern for this project.

Table 3.19-3 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
O_3[1]	1-hour	235	NA	NA
O_3[1]	8-hour	157	157	157
CO	1-hour	40,000	40,000	40,000
CO less than 5,000 feet amsl	8-hour	10,000	10,000	10,000
CO at or greater than 5,000 feet amsl	8-hour	6,670		
SO_2	1-hour	NA	196	None
SO_2	3-hour	1,300	None	1,300
SO_2	24-hour	365	365	None
SO_2	Annual Average	80	80	None
NO_2	1-hour	188	188	None
NO_2	Annual Average	100	100	100
PM_{10}	24-hour	150	150	150
PM_{10}	Annual Average	50	NA	NA
$PM_{2.5}$	24-hour	35	35	35
$PM_{2.5}$	Annual Average	15	15	15
Pb[1]	Rolling 3-month Average	0.15	0.15	0.15
Pb[1]	Quarterly Arithmetic Mean	1.5	1.5	1.5

Table 3.19-3 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
Hydrogen Sulfide	1-hour	112	--	--
Visibility	Observation	Insufficient amount to reduce the prevailing visibility to less than 30 miles when humidity is less than 70 percent.	--	--

[1] Pollutant not applicable to modeling analysis.

Source: Nevada Administrative Code 445B.22097 Standards of Quality for Ambient Air (Nevada Revised Statute 445B.210, 445B.300); U.S. Environmental Protection Agency (USEPA) 2010.

An area is designated by the USEPA as being in attainment for a pollutant if ambient concentrations of that pollutant are below the National AAQS (NAAQS). An area is not in attainment if violations of NAAQS for that pollutant occur. Areas where insufficient data are available to make an attainment status designation are listed as unclassifiable and are treated as being in attainment for regulatory purposes.

The existing air quality of the project area is typical of the largely undeveloped regions of the western U.S. For the purposes of statewide regulatory planning, this area has been designated as in attainment (not exceeding NAAQS for criteria pollutants) for all pollutants that have an AAQS. Current sources of air pollutants in the region include several precious metals mines that are sources for PM with aerodynamic diameters (in micrometers) designated as PM_{10} and $PM_{2.5}$.

Global Mercury

Mercury is a naturally occurring element in many soils, volcanic rocks, and marine and geothermal water sources. It assumes many forms and can be found naturally in the environment as free metallic mercury, chemically combined with other elements in a number of soil or rock types, and in the form of methylmercury (CH_3Hg+) in plants and animals. Mercury is generally present in the atmosphere in one of three chemical forms: gaseous elemental mercury, reactive gaseous mercury (RGM), or particulate mercury. RGM and particulate mercury account for less than 2 percent of the total concentration in air, with elemental mercury accounting for more than 98 percent of the total (Fitzgerald et al. 1991).

Mercury emissions to the atmosphere come from both background and man-made sources. Background sources of mercury include natural sources such as naturally enriched soils and volcanoes. The fate of mercury emissions follows pathways from the emission source to transport, deposition, exposure, and potential human uptake risks. From a single source such as a power plant or mill, or other thermal source, a portion of the emissions are deposited locally near the source while the remaining mercury is dispersed regionally and globally.

Discerning mercury speciation is important in understanding the deposition and bioaccumulation of mercury in the environment. Gaseous elemental mercury (Hg_0) must be transformed to particulate or oxidized mercury in order to contribute substantially to mercury deposition and subsequent entry into water bodies where further transformation to CH_3Hg+ can make the mercury available in the aquatic food chain (Porcella 1994). The final pathway to humans for mercury exposure is eating fish with CH_3Hg+ stored in their tissues. About 0.3 percent of the total mercury emitted from a point source is deposited in lakes and streams to form a CH_3Hg+ compound (Porcella 1994).

Elemental mercury travels the farthest and can be transported on wind currents for months to years if not oxidized, thus providing an opportunity for global transport and dispersion. Concentrations of

mercury in the air are usually low and of little direct concern. However, RGM and particulate mercury falls to earth through rain or snow and enters lakes, rivers, and estuaries. Once there, it can transform to its most toxic form, CH_3Hg+, and accumulate in fish and animal tissues.

RGM has an average atmospheric residence time of days to weeks (less in the presence of precipitation or bromine compounds often present in saline water bodies). It is not easily volatilized, and very water-soluble. It is easily taken up in precipitation or adsorbed on small particles in the atmosphere and falls out as wet or dry deposition. RGM has a higher potential to enter the food chain than elemental mercury and is more easily converted into CH_3Hg+.

Particulate mercury has an average atmospheric residence time of hours to days (depending on the presence or absence of precipitation and the particle size). It has low volatility and is easily taken up in precipitation or adsorbed on small particles, falling out relatively close to the emission source in the presence of precipitation, or as dry deposition that may be transported for longer distances if associated with very small particle sizes. Particle-bound mercury is relatively stable and is not easily converted to CH_3Hg+ (USEPA 1997).

Mercury accumulates most efficiently in aquatic species as CH_3Hg+. Predatory species at the top of the aquatic food chain generally have higher mercury concentrations. Nearly all of the mercury that accumulates in fish tissue is CH_3Hg+. Inorganic mercury is less efficiently absorbed, more readily eliminated from the body than CH_3Hg+, and does not tend to bio-accumulate.

Local Mercury

When bound in mineral forms that typically appear in ore (e.g., cinnabar), mercury is a stable compound that remains in solid form. Ore processing has the potential to liberate mercury from these stable minerals by dissolving it in process solutions. Because it has a boiling point of 675 degrees Fahrenheit, mercury has the potential to volatilize into a gaseous form when subjected to thermal processes in a recovery and refining circuit. This mercury is then released to the atmosphere where it may convert into RGM or particulate mercury.

3.19.2 Environmental Consequences

Issues related to air quality include potential impacts associated with project-generated air emissions.

3.19.2.1 Proposed Action

Criteria Pollutant Emissions

Air emissions of both gaseous and particulate pollutants would result from the Proposed Action. Gaseous pollutant emissions associated with the Proposed Action would result from construction and mining equipment and vehicle exhaust. Because the Hollister operations are underground, fugitive dust (i.e., particulate) emissions would be generated primarily by haul trucks transporting ore to processing facilities. Other sources of PM include access roads, ore stockpiles, and disposal of waste rock. For the purposes of calculating emissions for the Proposed Action, the activities that generate emissions were grouped into one of these three categories: stationary sources at Hollister Mine; portable, non-road engines used for drilling at Hollister Mine; and mobile sources that transport ore from Hollister Mine to processing facilities. Future emissions (potential to emit) associated with milling the Hollister ore at Esmeralda Mill and Midas Mill would not change as a result of the Proposed Action. In general, the stationary sources at the Hollister Site would remain largely unchanged as a result of the Proposed Action, except the existing Hollister Site power source, the two diesel generators located in the East Pit, would be taken out of service once electricity becomes available from the proposed 120-kilovolt (kV) and 24.9-kV electric power transmission lines (transmission lines), thereby greatly reducing the emissions associated with the generators.

In addition to reducing the emissions from the generators, Rodeo Creek Gold Inc (RCG) has committed to several Applicant-committed Environmental Protection Measures, which are described in Section 2.4.9.6, in order to minimize air emissions associated with the Proposed Action. Gaseous emissions would be minimized by proper equipment maintenance and operation. Particulate emissions would be mitigated by minimization of drop heights during loading, and implementing dust suppression measures. Fugitive dust is specifically addressed as a condition in the Fugitive Dust Control Plan portion of the NDEP Surface Area Disturbance Permit Application. RCG would implement an ongoing program to control fugitive dust from disturbed areas using Applicant-committed Environmental Protection Measures such as application of water and/or chemical dust suppressants (e.g., magnesium chloride), phased construction, and revegetation as appropriate. Access roads, project area roads, and other traffic areas would be maintained on a regular basis to minimize dust and provide for safe travel conditions. These Applicant-committed Environmental Protection Measures are accounted for in the Proposed Action emissions shown in **Table 3.19-4**. Note that fugitive dust was assumed to be controlled through the application of water.

Table 3.19-4 Total Annual Emissions for Proposed Action

Emissions Source	Tons per Year (tpy)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Non-Road Engines (Drill Rig Engines)	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic – All Ore to Midas Mill	2.75	1.23	0.15	298.70	29.95	744
Ore Hauling Traffic – All Ore to Esmeralda Mill	31.90	14.33	1.62	687.77	69.63	10,515
Total[1]	63.71	24.00	4.24	690.24	72.10	13,530

[1] For a conservatively high estimate of emissions total emissions are calculated assuming all ore is transported to Esmeralda Mill, and none of the ore is transported to Midas Mill. Therefore, the values in this table do not sum together to provide the total maximum emissions from the Proposed Action.

CO_2 = carbon dioxide.

NO_X = nitrogen oxide

Air modeling was performed using the USEPA-recommended SCREEN3 Model. SCREEN3 is a single source Gaussian plume model which provides an estimate of maximum ground-level concentrations for point, area, flare, and volume sources. SCREEN3 is a screening model used to assess whether or not refined modeling is required. If SCREEN3 impacts are predicted to be below applicable AAQS, then refined modeling is not required. Note: SCREEN3 modeling was completed prior to implementation of the final version of AERSCREEN (Version 11126).

For this study, SCREEN3 model version 96043 was used to evaluate impacts from trucks on haul roads. The trucks were modeled as volume sources using full meteorology as well as regulatory model default values for mixing heights and anemometer heights. Impacts were assessed at a distance of 46 feet (14 meters) from the road for a generic road segment that is representative of all dirt roads in the direct impacts assessment area. Results of the conservative screening level dispersion modeling analysis for the Proposed Action are shown in **Table 3.19-5** and indicate that the impacts from haul road traffic are well within the National and State AAQS. **Appendix G**, Air Quality Technical Support Document for the Hollister Underground Mine Project EIS, provides details on the air quality modeling performed.

Table 3.19-5 Hollister Mine SCREEN3 Model Results for Haul Roads

Pollutant	Averaging Time	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	Percent of NAAQS (%)
NO_2	1-hour	NA	1.9	1.0
	Annual	NA	0.1	0.1
CO	1-hour	NA	0.9	0.0
	8-hour	NA	0.6	0.0
SO_2	1-hour	NA	0.1	0.1
	3-hour	NA	0.1	0.0
	24-hour	NA	0.0	0.0
	Annual	NA	0.0	0.0
PM_{10}	24-hour	10.2	30.2	20.1
	Annual	9.0	11.0	22.0
$PM_{2.5}$	24-hour	6.92	8.9	25.5
	Annual	2.58	2.8	18.5

[1] The background values for NO_2, SO_2, CO, and PM_{10} are from previous modeling demonstrations for the Hollister Site (RCG 2010e, 2009b). The background concentration for $PM_{2.5}$ is calculated as described in the text above based on the approved modeling protocol (**Appendix G**).

Table 3.19-6 shows the Hollister Mine criteria pollutant emissions from stationary sources, including the backup emergency generator units, in tons per year. It is important to note that these annual emissions are at the potential to emit if the generator units were to operate for 500 hours per year to generate power on-site when electric grid power is unavailable. When grid power is available, the engines would be run only 10 to 20 percent of that time (i.e., only enough to ensure their proper maintenance and readiness for emergency standby use).

Table 3.19-6 Stationary Source Emissions for Proposed Action

Unit or Process Description	Tons per Year (tpy)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Cummins Model QSK60-G6, 2,647 hp[1]; 500 hours/year	7.7	0.8	1.3	0.1	0.1	671
Cummins Model QSK60-G6, 2,647 hp[1]; 500 hours/year	8.9	0.8	1.3	0.1	0.1	671
Shotcrete Batch Plant; 60 tons/hr Process Rate; 8,760 hours/year	0.0	0.0	0.0	1.8	1.8	0.0
Total	16.6	1.6	2.6	2.0	2.0	1,342

[1] Model analyzed. Actual diesel generation equipment may be replaced periodically in the ordinary course of operations.

Source: RCG 2009b.

As part of current air operating permits for the Hollister Site (RCG 2010e, 2009b, 2007), compliance demonstrations have been completed for the Hollister Site stationary sources for all pollutants and averaging periods, except for a new 1-hour NO_2 standard and new 24-hour and annual standard for $PM_{2.5}$, which were promulgated following the last required compliance demonstrations pursuant to such permits.

The modeling analysis previously performed for PM_{10} (RCG 2009b) was used as the basis for the comparison to the $PM_{2.5}$ standard, which would more than offset the NO_X and SO_2 emissions from haul trucks associated with the proposed project that would be available to potentially contribute to the secondary formation of $PM_{2.5}$. This approach conservatively overestimates the direct $PM_{2.5}$ impacts since emissions of $PM_{2.5}$ are equal to or less than PM_{10} by definition. The USEPA recently has confirmed that while "air quality modeling of direct $PM_{2.5}$ emissions can be accomplished using a USEPA-approved model to predict ambient $PM_{2.5}$ impacts caused by new and modeled sources of $PM_{2.5}$ emissions," it "has not approved any models that can reliably predict the localized ambient $PM_{2.5}$ impacts of precursors (e.g., SO_2 and NO_X) emitted from individual stationary sources." Accordingly, USEPA instructs that an evaluation of $PM_{2.5}$ ambient impacts associated with a single source focus on direct $PM_{2.5}$ emissions (Federal Register 2010). In addition to direct $PM_{2.5}$ emissions, the USEPA has recognized that $PM_{2.5}$ also may include a secondary component that is formed as a result of complex atmospheric reactions involving precursor pollutant emissions. There are four potential pollutant precursors: sulfur dioxide (SO_2), NO_X, volatile organic compounds (VOCs), and ammonia (NH_3). The USEPA presumes that emissions of SO_2 and NO_X would have some secondary contribution to $PM_{2.5}$ ambient concentrations and that emissions of VOCs and NH_3 would not contribute to $PM_{2.5}$ impacts based on its current level of understanding (Federal Register 2008).

As described in the modeling protocol (**Appendix G**), annual and 24-hour $PM_{2.5}$ background values were calculated for the Hollister Site based on 3 years of measurements of $PM_{2.5}$ conducted at Jarbidge Wilderness Area and Great Basin National Park. The results indicate that the conservative evaluation of the No Action Alternative plus background are well within the annual and 24-hour standards for $PM_{2.5}$ as shown in **Table 3.19-7**. The $PM_{2.5}$ impacts shown in **Table 3.19-7** represent the impacts for the No Action Alternative. It is anticipated that impacts for the Proposed Action would be lower due to the reduction of diesel generator emissions and the removal of other stationary sources.

Table 3.19-7 Hollister Site Model Results for $PM_{2.5}$ for the No Action Alternative

Pollutant	Averaging Time	Impact ($\mu g/m^3$)[1]	Background ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
$PM_{2.5}$	24-hour	16.86	6.92	23.78	35	68
	Annual	3.45	2.58	6.03	15	40

[1] AERMOD-modeled PM_{10} impacts for No Action Alternative (RCG 2009b). The 24-hour impact represents the highest-eighth-high modeled PM_{10} results in accord with the form of the $PM_{2.5}$ standard. Impacts for the Proposed Action would be lower due to reduction of the diesel generator emissions.

A modeling analysis was conducted as described in the Air Quality Technical Support Document for comparison to the 1-hour NO_2 AAQS. The SCREEN3 predicted maximum impacts from the stationary source emergency generators are shown in **Table 3.19-8,** and are below the 1-hour NO_2 AAQS.

Table 3.19-8 Hollister Mine SCREEN3 Model Results for Emergency Generators

Pollutant	Averaging Time	Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
NO_2	1-hour	154.8	n/a	154.8	188	82.3

[1] NDEP Bureau of Air Pollution Control has approved the use of a background value of zero for NO_2 at the Hollister Site in past modeling demonstrations (RCG 2010e).

GHG Emissions

Combustion of fossil fuels results in emissions of greenhouse gases (GHG). Proposed mining operations at the Hollister Site would involve combustion of diesel, propane, and gasoline, all of which contribute CO_2 and other GHG to the atmosphere. In Nevada, the estimated total GHG emissions were approximately 56 million metric tons in 2005 (NDEP 2008b).

Industrial sources account for approximately 2.5 million metric tons and, thus, represent approximately 4 percent of the state's emissions of GHG. Under the Proposed Action, the diesel generators at the mine would be decommissioned and would operate fewer than 500 hours per year as emergency power back-up. Stationary sources at the mine then would have the potential to emit about 1,342 tons per year (tpy) of GHG. Hauling ore to the Esmeralda Mill for processing would result in additional GHG emissions of about 10,515 tpy. Hollister Mine would require electrical generation by a utility (NVEnergy) to supply power to the mine through the proposed 120-kV and 24.9-kV transmission lines. The net effect on GHG emissions from stationary sources would be a net increase from utility supplied electricity. If all of the Hollister Mine ore went to Midas Mill for processing, the haul trucks have the potential to generate about 744 tpy of GHG. Section 3.25, Energy Requirements, Climate Change, and West Nile Virus, summarizes the estimated fuel and electrical power consumption for the proposed project and alternatives.

Hazardous Air Pollutants and Mercury Emissions

The only Hazardous Air Pollutant (HAP) that would be emitted due to this project is mercury. Mined ore containing mercury would be processed at either the Esmeralda Mill or the Midas Mill. Antler Peak Gold Inc has obtained mercury operating permit number AP1041-2248 for the ore processing at the Esmeralda Mill under the Nevada Maximum Achievable Control Technology rules. The permitted emissions for mercury at Esmeralda Mill would be about 7 pounds per year. The thermal units that are permitted by NDEP under the Phase 2 Mercury Operating Permit to Construct at the Esmeralda Mill include: two mercury retorts, a carbon kiln, and two tanks (pregnant and barren solution tanks).

Newmont Midas Operations, Inc. has obtained mercury operating permit number AP1041-2253 for ore processed at Midas Mill. Processing Hollister ore at Midas Mill would result in mercury emissions at the same level as Esmeralda Mill, which is anticipated to be less than 7 pounds per year. Thermal units permitted at the Midas Mill include: two refinery furnaces; two mercury retorts; and associated ancillary equipment (hot plates, drying ovens, and atomic adsorption spectrometer). As part of the permit process, HAPs (including mercury) were modeled. Given that the permitted amount of ore processing would not increase at either Esmeralda or Midas mills as a result of this project an additional modeling demonstration is not required.

Visibility at Class I Areas

The Hollister Site is located approximately 62 miles (100 km) from the Jarbidge Wilderness Area, the nearest Class I area. According to the Federal Land Managers' Air Quality Related Values Work Group (FLAG) 2010 Phase 1 Report (FLAG 2010), all sources greater than 31 miles (50 km) from a

Class I area would have negligible visibility impacts if the ratio of emission to distance (Q/D) is 10 or less. The Q/D ratio is the combined emissions (Q, in units of tpy) of SO_2, NO_X, PM_{10}, and sulfuric acid, divided by the distance (in kilometers) from the nearest Class I area. **Table 3.19-9** below shows the total emissions for the Proposed Action from stationary sources, ore hauling road traffic, and drill rig engines. Ore hauling traffic emissions were conservatively assumed for all ore transport to Midas Mill due to its proximity to the Jarbidge Wilderness Area as opposed to the Esmerelda Mill, which is closer to Yosemite National Park.

Table 3.19-9 Total Annual Emissions for Proposed Action when Ore is Transported to Midas Mill

	Tons per Year					
Emissions Source	**NO_X**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Non-road Engines (Drill Rig Engines)	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic	2.75	1.23	0.15	298.40	29.95	744
Total	34.56	10.90	2.77	300.87	32.42	3,759

Based on the total emissions presented in **Table 3.19-9**, Q would be equal to 338.5 tons. The Jarbidge Wilderness Area is 62 miles (100 km) away which gives a total Q/D of approximately 2.10 tons per mile (3.39 tons/km), well below the upper limit of 10. Based on this screening method, the Q/D value of 2.10 tons per mile (3.39 tons/km) shows that the emissions from the Hollister Mine would have negligible visibility impacts at the Jarbidge Wilderness Area. The Esmeralda Mill also is a proposed ore processing site for the Hollister Mine ore, and is located about 22 miles southwest of Hawthorne, Nevada, near the California border, and is about 28 miles east of Yosemite National Park, California. Yosemite National Park is considered a federal Class I area. Areas designated as mandatory Class I areas are those national parks exceeding 6,000 acres, wilderness areas and national memorial parks exceeding 5,000 acres, and all international parks, which were in existence on August 7, 1977 (40 CFR part 81,subpart D).

Visibility impairment is caused by particles and gases in the atmosphere. Some particles and gases scatter light while others absorb light. The net effect is called “light extinction.” The result of the scattering and absorption processes is a reduction of the amount of light from a scene that is returned to the observer, and scattering of other light into the sight path, creating a hazy condition. A screening level assessment of the impacts on visibility from processing Hollister Mine ore at the Esmeralda Mill was performed using the VISCREEN model version 88341. The plume visual impact screening model VISCREEN is designed to ascertain whether the plume from a facility (i.e., Esmeralda Mill) has the potential to be perceptible to untrained observers under "reasonable worst-case" conditions.

The perceptibility of a plume depends on the plume contrast at all visible wavelengths. At a single wavelength, the contrast between the plume and its surroundings is determined by the difference in the intensity of the light reaching the observer from each. Therefore a single measure, intensity, could be used to quantify contrast if visible light were composed of a single wavelength. With a range of wavelengths, a measure of contrast must recognize both "overall" intensity, and perceived color, and so perceptibility is a function of changes in both brightness and color. To address the added dimension of color as well as brightness, the color contrast parameter, Delta E, was used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. Delta E provides a single measure of the difference between two arbitrary colors as perceived by humans. This parameter allows us to make quantitative comparisons of the perceptibility of two plumes, even though one may

be a reddish discoloration viewed against a blue sky while the other may be a white plume viewed against a dark green forest canopy.

In the plume visual impact screening model VISCREEN, contrasts at three wavelengths (0.45, 0.55, and 0.65 micrometers [µm]) were used to characterize blue, green, and red regions of the visible spectrum. VISCREEN modeling was performed to ascertain whether the plume from the Esmeralda Mill associated with processing of ore for the Hollister Mine would be brighter or darker or discolored compared to its viewing background by evaluating its contrasts in the blue, green, and red portions of the visible spectrum. If plume contrast is positive, the plume is brighter than its viewing background; if negative, the plume is darker. If contrasts are different at different wavelengths, the plume is discolored. If contrasts are all zero, the plume is indistinguishable from its background (i.e., imperceptible).

For screening level analysis, the first criterion is a Delta E value of 2.0; the second is a green (0.55 µm) contrast value of 0.05. Results of the modeling are shown in **Table 3.19-10**.

Table 3.19-10 Maximum Visual Impacts Inside Yosemite National Park

Background	Theta (degrees)	Azimuth (degrees)	Distance	Delta E		Contrast	
				Criteria	Plume	Criteria	Plume
Sky – forward scatter	10	157	53 miles (86 km)	2.00	4.227*	0.05	0.082*
Sky – backward scatter	140	157	53 miles (86 km)	2.00	0.644	0.05	-0.020
Terrain – forward scatter	10	84	28 miles (45 km)	2.00	7.887*	0.05	0.060*
Terrain – backward scatter	140	84	28 miles (45 km)	2.00	0.326	0.05	0.004

* Exceeds screening criteria.

Results are provided for two assumed worst-case sun angles. The "forward scatter" case refers to a situation in which the sun is in front of the observer such that the scattering angle theta is 10 degrees. Such a sun angle would tend to maximize the light scattered by plume particulates and maximize the brightness of the plume. In reality, such a sun angle may or may not occur during worst-case meteorology conditions for the given line of sight as discussed more in the next paragraph. The "backward scatter" case refers to a situation in which the sun is behind the observer such that the scattering angle is 140 degrees. A plume is likely to appear the darkest with such a sun angle. **Table 3.19-10** shows that contrast and change in light extinction values (Delta E) exceed the screening criteria level. These results indicate that there could be visibility impacts to Yosemite National Park due to ore processing at the mill.

The visibility screening modeling results indicate that under certain worst-case conditions, when the sun is in front of the observer, the delta-E value exceeds the criterion by a factor greater than 2 and the contrast by a smaller margin. The low sun angles would occur only during the early morning hours when a person in Yosemite looking in the direction of the Esmeralda Mill would have the sun in front of them at a low angle. An observer looking north and east from the National Park might be able to see a

visible plume against the sky or terrain. A visible plume would only be present if the meteorology during the night before and during the early part of that day is conducive to the emissions plume remaining intact and not dispersed. The complex terrain at the mill site and between the mill site and the National Park would favor mixing and dispersion of the plume due to differential heating and cooling of the mountain slopes. During periods of stable atmospheric conditions that would favor a coherent plume, the emissions plume would likely flow with the valley airflow down valley. At Esmeralda, this is generally towards the east; therefore, during the early hours of the day, a plume would not be visible to an observer 28 miles to the south and west because the plume would be moving away from Yosemite. The screening level results for theta values of 140 degrees indicate that the plume formed by emissions from the mill would not be perceptible against either the sky or the terrain during the evening hours when the sun is behind the observer.

Emission rates used in the screening level analysis were the maximum short-term rates expected during the course of a year, and are based on the maximum emission rates in the air quality permit.

3.19.2.2 Mud Springs Road Transmission Line Alternative

During construction of the transmission line, impacts to air quality from gaseous pollutants under this alternative would be similar to the impacts described for the Proposed Action. Since this alternative would result in 9.5 and 15.2 fewer acres of surface disturbance for the North Option and South Option, respectively, than the transmission line route for the Proposed Action, there would be less potential for fugitive dust generation and somewhat less impacts during construction.

3.19.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under this alternative, the Mud Springs Waste Rock Storage Facility (WRSF) would be constructed east of the proposed Hatter production shaft, ramp, or raise (HPS). Placement of waste rock in this alternate location would result in shorter haul distances when waste rock is transported from the HPS, and longer haul distances when waste rock is transported from the portal in the East Pit. The overall average waste rock haul distance is expected to be similar between the Mud Springs WRSF and the Proposed Action. Approximately 2,080 feet of the existing Mud Springs Road would need to be relocated and another 1,800 feet of road would need to be upgraded under this alternative. All other project facilities would be the same as described for the Proposed Action.

Air quality impacts for the Mud Springs Road WRSF Alternative would be the same as described for the Proposed Action with the following exception related to the WRSFs. Potentially slightly higher localized fugitive dust emissions would occur under the Mud Springs Road WRSF Alternative because 21 acres of new surface disturbance would be required for the Mud Springs WRSF and susceptible to erosion. Construction impacts are expected to remain below applicable National and State AAQS.

3.19.2.4 Backfill Alternative

Under this alternative, the HPS and East and West raises would be backfilled with waste rock at mine closure. This alternative would implement all other components described in the Proposed Action.

Air quality impacts under this alternative would be the same as described for the Proposed Action, with the following exceptions: the Backfill Alternative would require approximately 1,536 truck round trips from the WRSFs to the HPS, 175 truck round trips from the WRSFs to the East Raise, and 234 truck round trips from the WRSFs to the West Raise. This activity would result in increased gaseous emissions and fugitive dust from loading and hauling of waste rock over gravel roads.

3.19.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed, and the associated air quality impacts would not occur. Under this alternative, the existing Hollister Site would continue to

operate under current authorizations. No exceedences of the applicable national and state AAQS are expected.

An analysis of potential air quality impacts associated with the existing exploration and bulk sampling operation are presented in the recent air permit application submitted to NDEP (RCG 2010e, 2009b). Based on these analyses, the modeled concentrations of criteria pollutants are well within the applicable ambient air quality standards.

3.19.3 Cumulative Impacts

Cumulative impacts to air quality would include impacts from the proposed project emission sources in combination with impacts from background emission sources, which reflect emissions associated with the past and present actions, as well as proposed future actions. Reasonably foreseeable future actions are described in Section 3.2. The CESA is illustrated in **Figures 3.19-1, 3.19-2**, and **3.19-3**.

Fugitive Dust and Gaseous Emissions

Fugitive dust and gaseous emissions from nearby mine operations in the Carlin Trend and the TS Power Plant affect air quality in the CESA (Bureau of Land Management [BLM] 2010d). The existing operations at the Hollister Site would have haul truck traffic as currently authorized. Ambient air quality data for the region currently reflects impacts of existing mining operations in the airshed. The estimated emissions from the Hollister Proposed Action are shown with other emissions sources within the Hollister Site CESA in **Table 3.19-11**. While the Leeville Project (BLM 2010d) did not include the Hollister operations in the air quality cumulative effects modeling analysis, the findings are consistent with the modeled impacts for this project. Air modeling completed for Hollister and other facilities in the CESA has shown that air pollutant concentrations are localized near the project boundaries and modeled air impacts diminish rapidly with distance from project boundaries (BLM 2010d). Air quality in the region meets applicable standards and would be expected to remain in compliance under the Hollister Proposed Action, including accounting for existing and anticipated future emissions sources in the CESA. The air quality dispersion modeling study for Hollister operations included predicted impacts of gaseous criteria air pollutants SO_2, NO_2, and CO. By applying the ambient air quality standard as a reference, it is reasonable to assume that the predicted SO_2, NO_2, and CO air quality impacts from the Hollister Proposed Action dispersion modeling demonstrate only minor effects in the CESA.

Existing emissions sources in the CESA surrounding Esmeralda Mill are shown in **Table 3.19-12**. The cumulative air quality impacts from processing Hollister ore at the Esmeralda Mill are negligible and are not expected to impact the existing air quality in this area.

Regional Haze

The primary cause of regional haze in many parts of the country is light scattering resulting from fine particles (i.e., $PM_{2.5}$) in the atmosphere. These fine particles can contain a variety of chemical species including carbonaceous species (i.e., organics and elemental carbon), as well as ammonium nitrate, sulfates, and soil. Additionally, coarse particles between 2.5 and 10 microns in diameter, can contribute to light extinction. Each of these components can be naturally occurring or the result of human activity. The natural levels of these species result in some level of visibility impairment, in the absence of any human influences, and would vary with season, daily meteorology, and geography.

The proposed project would be a minor source of fine particulate matter, mostly in the form of road dust from haul roads and would contribute negligible impacts to visibility conditions and regional haze at Class I areas that are all beyond 62 miles (100 km) from the Hollister Site (e.g., Jarbidge Wilderness Area). As shown in **Table 3.19-11**, the Hollister Proposed Action would comprise a small percent of existing and proposed future emissions sources. As such, the cumulative impact to visibility conditions at Jarbidge Wilderness Area is not anticipated to change as a result of the proposed project.

Table 3.19-11 Total Annual Emissions for the Proposed Action and Other Sources in the CESA

Facility	Tons per year			
	NO_X	CO	SO_2	PM_{10}
Hollister Mine Proposed Action[1]	63.7	24	4.2	690.2
South Operations Area Project Amendment[2]	354	337	276	568
Leeville[2]	0	0	0	0.5
North Operations[2]	0	0	0	93.8
Betze/Post[2]	311	400	996	579
TS Power Plant[2]	1,170	744	1546	598
Total[1]	1,898.7	1,505	2,822.2	2,529.5
Hollister Mine Emissions Percent of Total (%)	3.4	1.6	0.1	27.3

[1] Total Emissions are calculated assuming all ore is transported to Esmeralda Mill.

[2] Source: BLM 2010d.

Table 3.19-12 Annual Emissions for the Esmeralda Mill Vicinity

Facility	Tons per Year				
	NO_X	CO	SO_2	PM_{10}	Hg
Esmeralda Mill	4.61	0.87	0.54	9.28	0
Sierra Pacific Power Company – FT Churchill Generating Station	27,776.07	13,267.07	27,747.83	4,039.02	0
US Department of the Army – Hawthorne Army Depot	149.54	81.04	89.86	25.41	0
US Department of the Army – OPTC (BEDS PROJECT)	63.3	2.85	16.1	0.75	0.00318
US Department of the Army – OPTC (NV COMP A5 COLLECTION SYSTEM)	0	0	0	4.48	0
US Department of the Army – OPTC (RF-9)	28.39	0.8	14.56	8.58	0.000890
Total	28,021.9	13,352.63	27,868.9	4,087.5	0.00407

Source: NDEP 2011.

Yosemite National Park, a Class I area, is about 28 miles (45 km) west of Esmeralda Mine. Emissions of particulates and gaseous pollutants from Esmeralda Mill are conservatively modeled with VISCREEN. While VISCREEN results indicate that visibility impacts may be above the screen criteria level within the National Park during certain meteorological conditions, these meteorological conditions are unlikely to occur between Esmeralda Mill and the National Park, as described in detail in Visibility at Class I Areas section.

Mercury

Approximately 895 pounds of mercury and mercury compounds were reportedly released annually to the air by mining operations in the Carlin Trend (NDEP 2010b). The current predicted mercury

deposition rate in the Carlin Trend ranges between 0.10 g/km^2/yr and 3.00 g/km^2/yr (BLM 2010d) and is generally the lowest in the state. Since ore processing is off-site, the Hollister Site does not have mercury emissions. Processing of Hollister ore at the Midas Mill or the Esmeralda Mill would result in a negligible cumulative increase in mercury. This is consistent with other cumulative effects mercury studies in the Carlin Trend (BLM 2010d).

Cumulative impacts to air quality under the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives would be similar to the Proposed Action.

3.19.4 Potential Monitoring and Mitigation Measures

Based on the conclusions of the analysis that there are impacts; no additional monitoring and mitigation measures would be required beyond RCG complying with their air quality permits and Applicant-committed Environmental Protection Measures.

3.19.5 Residual Impacts

There would be no residual impacts to air quality from the proposed project because reclamation and revegetation would stabilize exposed soil and control fugitive dust emissions. As vegetation becomes established, particulate levels should return to typical conditions of a dry desert environment.

3.19 Air Quality

3.19.1 Affected Environment

The Hollister Site and existing Midas Mill are located entirely within the Rock Creek Air Quality Basin (No. 62). Esmeralda Mill is located within the East Walker Area Air Quality Basin (No. 109). The air quality study area encompasses the project area and the area within 6.2 miles (10 kilometers [km]) of the mine, the ore transportation route along gravel/dirt roads to the mills, and the area within 6.2 miles (10 km) of the Esmeralda and Midas mills (**Figure 3.19-1**). The Cumulative Effects Study Area (CESA) for air quality encompasses the four air basins in the Hollister Site vicinity: Willow Creek Valley, Rock Creek Valley, Boulder Flat, and Maggie Creek (**Figure 3.19-2**); the ore transportation corridor from the mine to the mills (**Figure 3.19-1**); and an area within 62 miles (100 km) of the Esmeralda Mill that includes Yosemite National Park (**Figure 3.19-3**). The rationale for selecting these air basins for the CESA is based on previous air quality modeling done for regulated air pollutant sources conducted for the Nevada Division of Environmental Protection (NDEP) air quality permit process. The CESA represents an adequate area of analysis in which to evaluate the air quality effects of the proposed project with other actions within the basins that contribute to cumulative effects.

The project area is located near the north-central portion of the Great Basin. The surrounding terrain consists of alternating mountain ranges and sagebrush-covered valleys, with the mine site situated in the Basin and Range physiographic province. Elevations in the project area range from approximately 5,300 feet to 6,500 feet above mean sea level (amsl).

Regional meteorology, air quality, and dispersion conditions in the project area are characterized from data records from the closest climate monitoring station at Elko, Nevada, which is approximately 45 miles southeast of the project area. The climate in the project region is classified as arid, with elevations below 6,500 feet amsl receiving approximately 5 to 9 inches per year of precipitation, while the mountainous areas typically receive approximately 11 to over 16 inches of precipitation annually.

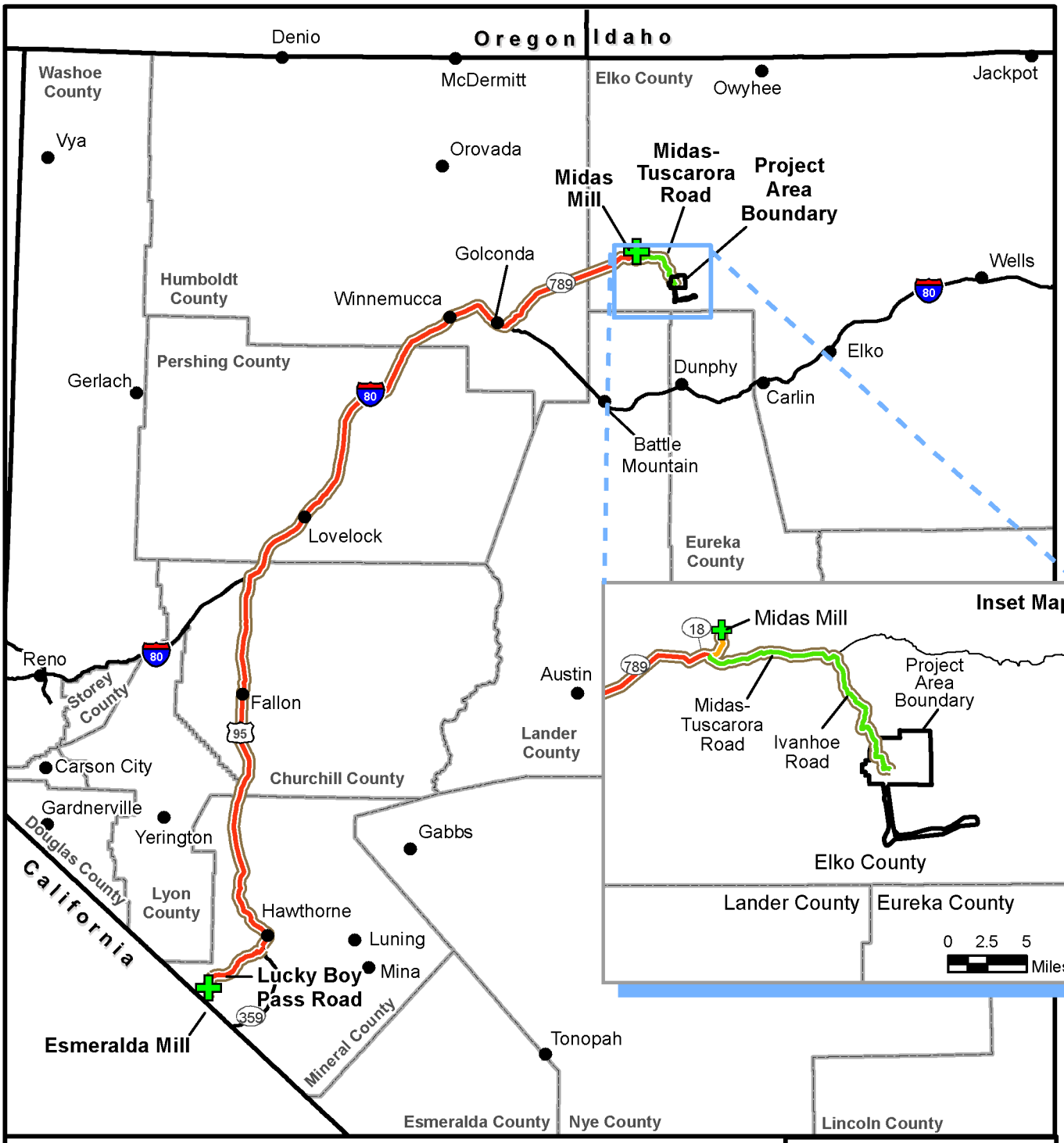
Although the area was previously mined for mercury, such mining occurred in shallow Tertiary deposits. Whereas the Proposed Action would mine at depths where the mercury concentrations in the ore are minimal.

3.19.1.1 Climatology and Meteorology

Nevada has great climatic diversity, ranging from scorching lowland desert in the south to cool mountain forests in the north. Its varied and rugged topography, mountain ranges, and narrow valleys range in elevation from approximately 1,500 to more than 10,000 feet amsl. Large local variations of temperature and rainfall are common.

Nevada lies on the eastern side (i.e., lee side) of the Sierra Nevada Mountains, a massive mountain barrier that markedly influences the climate. One of the greatest contrasts in precipitation found within a short distance in the United States (U.S.) occurs between the western slopes of the Sierra Nevada Mountains in California and the valleys immediately east of this range.

The prevailing winds are from the west. As the warm moist air from the Pacific Ocean ascends the western slopes of the Sierra Nevada Mountains, the air cools, condensation occurs, and most of the available moisture falls as precipitation. As the air descends the eastern slope, it is warmed by compression, and very little precipitation occurs. The effects of this mountain barrier are felt throughout the state and have resulted in the formation of deserts and steppes in the lowlands of Nevada. The principal climatic features are bright sunshine; low annual precipitation (averaging 9 inches in the valleys and deserts), heavy snowfall in the higher mountains; clean, dry air; and exceptionally large daily temperature fluctuations.



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Esmeralda Mill Route
- Midas Mill Route
- Esmeralda Mill and Midas Mill Routes
- Mill Site
- Nevada State Route
- U.S. Federal Highway
- U.S. Interstate Highway

N

0 20 40 Miles

Note: CESA width is not drawn to scale.
Source: RCG 2010b.

Hollister Underground Mine Project EIS

Figure 3.19-1

Air Quality for Transportation Cumulative Effects Study Area

3/20/2012

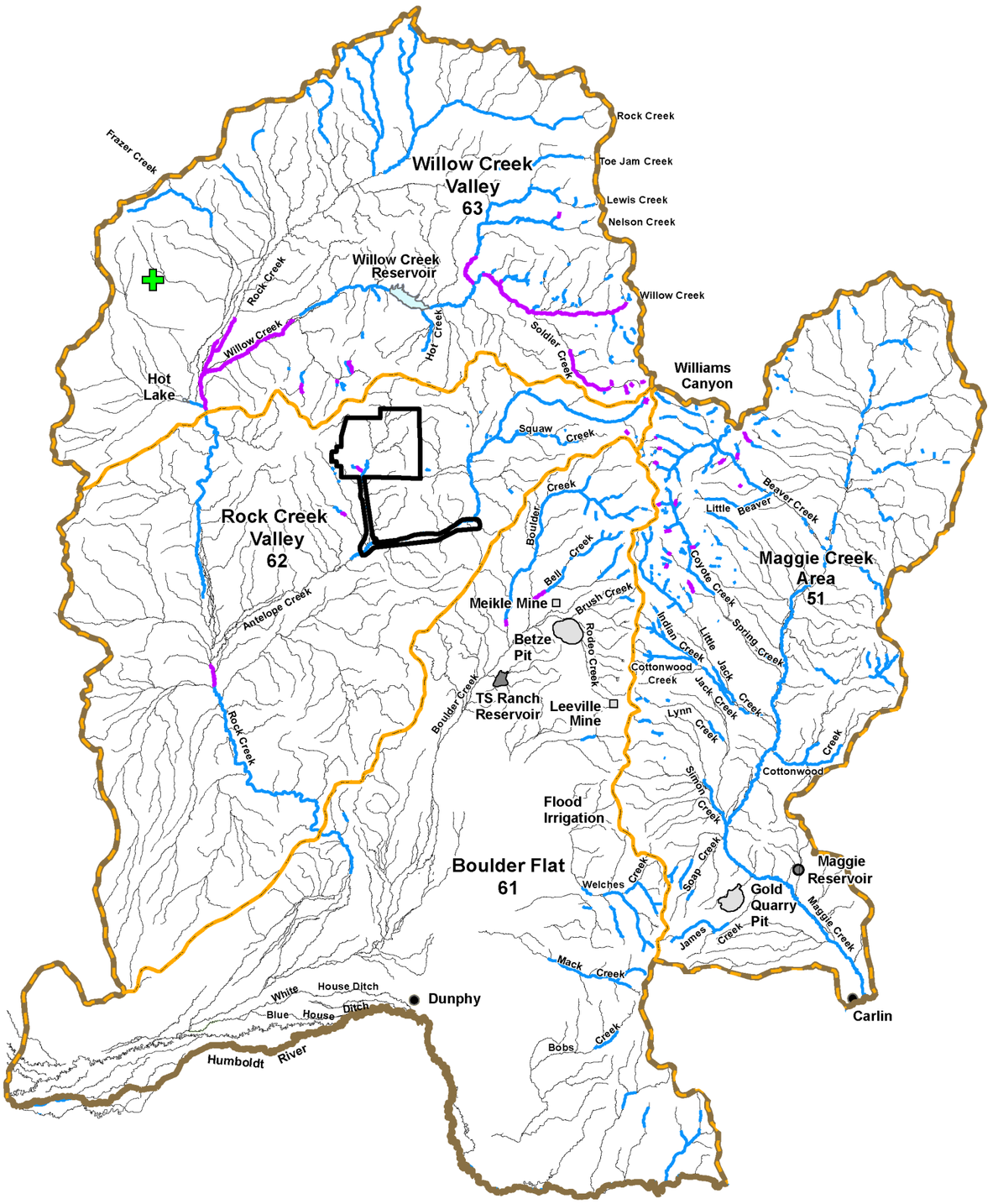
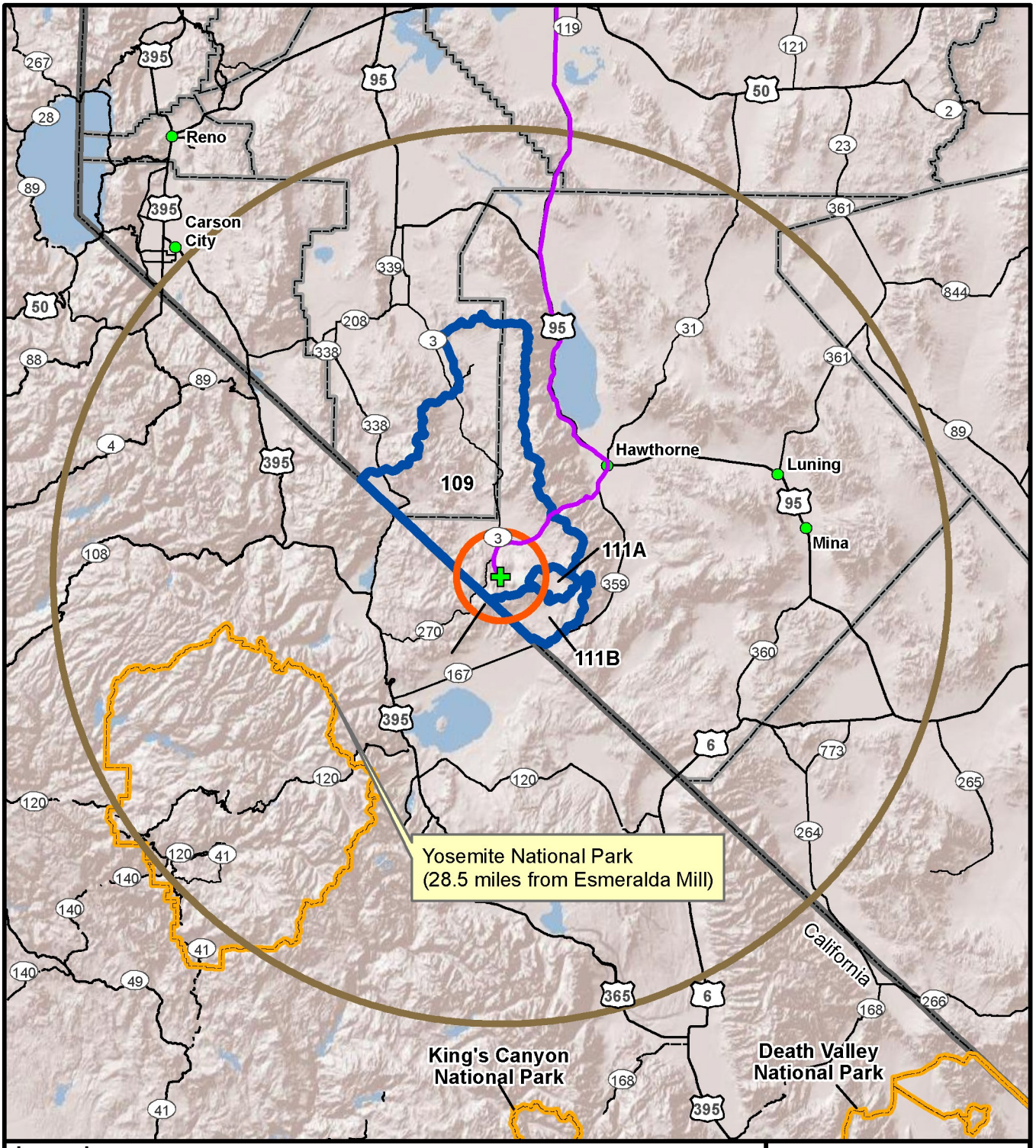


Figure 3.19-2

Air Quality
Cumulative Effects
Study Area
Hollister Site

Hollister Underground Mine Project EIS

3/1/2012



Hollister Underground Mine Project EIS

Figure 3.19-3

Air Quality
Cumulative Effects
Study Area
Esmeralda Mill

10/20/2011

Three important meteorological factors influence the dispersion of pollutants in the atmosphere: mixing height, wind (speed and direction), and stability. Mixing height is the height aboveground within which rising warm air from the surface mixes by convection and turbulence. Local atmospheric conditions, terrain configuration, and source location determine dilution of pollutants in this mixed layer. Mixing heights vary diurnally, with the passage of weather systems and season. For the project area, the mean annual morning mixing height is estimated to be approximately 984 feet (300 meters). However, during the winter months the mean morning mixing height is approximately 722 feet (220 meters) (Holzworth 1972). The mean annual afternoon mixing height exceeds 7,874 feet (2,400 meters).

Morning atmospheric stability conditions tend to be stable because of the cooling of the air layers nearest the ground. Afternoon conditions, especially during the warmer months, tend to be neutral to unstable because of the rapid heating of the ground surface under clear skies. During the winter, periods of stable afternoon conditions may persist for several days in the absence of synoptic (continental-scale) storm systems to generate higher winds with more turbulence and mixing. A high frequency of inversions at lower elevations during the winter can be attributed to the nighttime cooling and sinking air flowing from higher elevations to the low lying areas in the basins. Although winter inversions are generally quite shallow, they tend to be more stable because of reduced surface heating.

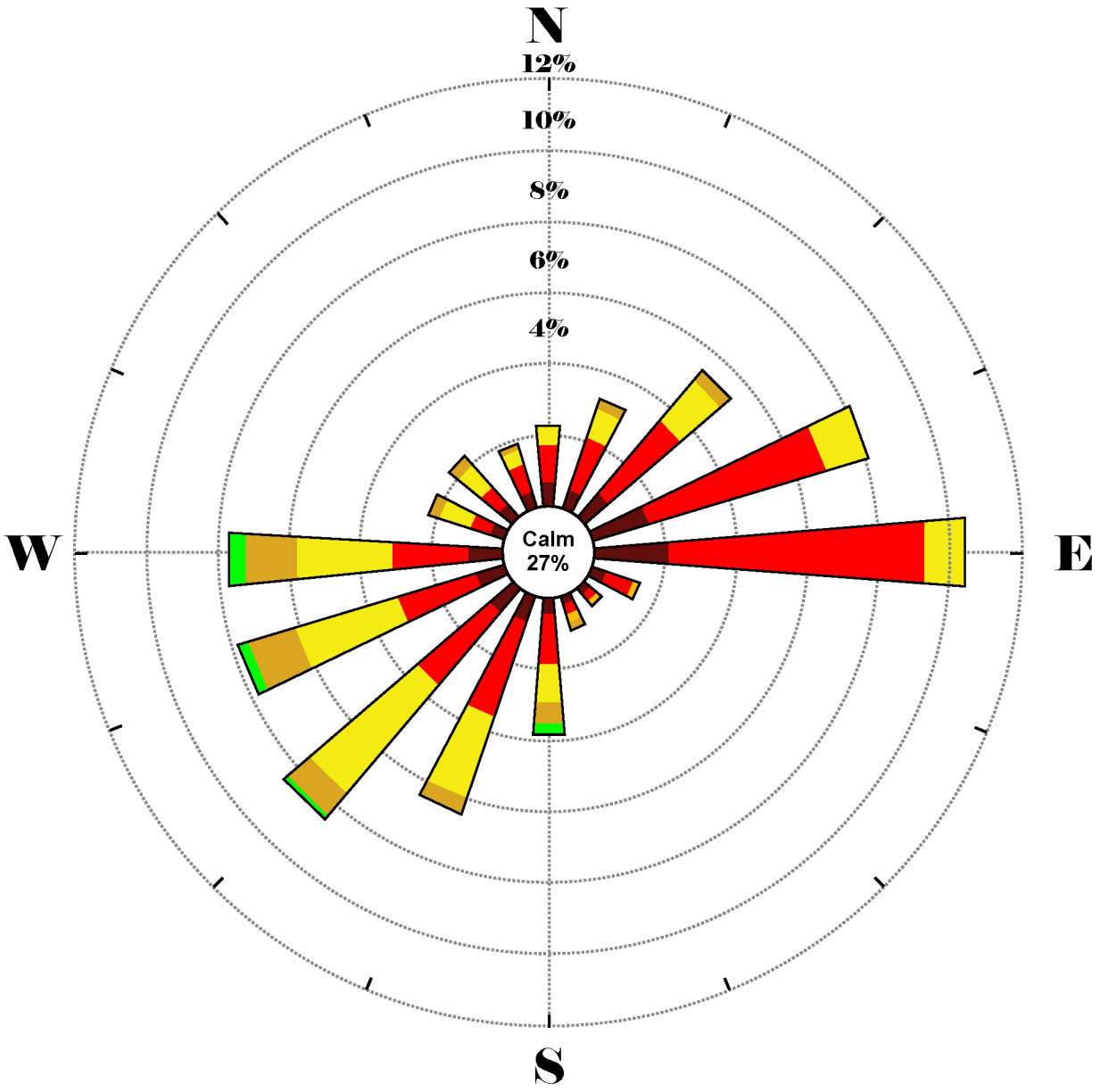
The latitude of the project area places it within the belt of prevailing westerly winds that circle the globe around the earth's northern hemisphere. However, the proposed Hollister Mine is located in complex terrain where the winds are affected by local topographic features.

Due to the typically dry atmosphere, bright sunny days and clear nights frequently occur. This in turn, allows rapid heating of the ground surface during daylight hours and rapid cooling at night. Because heated air rises, and cooled air sinks, winds tend to blow uphill during the daytime and down slope at night. The complexity of terrain features causes complex movements in the cyclic air patterns, with thin layers of moving air embedded within the larger scale movements. The lower level, thermally driven winds also are embedded within larger scale upper wind systems (i.e., synoptic winds). Synoptic winds in the region are predominantly west to east, are characterized by daily weather variations that enhance or diminish the boundary layer winds, and are channeled by regional and local topography.

The wind rose for Elko (**Figure 3.19-4**) is representative of the regional wind climatology for the proposed Hollister Mine and existing Midas Mill. The Elko wind rose indicates that winds are predominantly from the west to southwest, but also it shows that there is a secondary maximum of wind occurrences from the northeast. Wind speed has an important effect on area ventilation and the dilution of pollutant concentrations from individual sources. Light winds, in conjunction with large source emissions, may lead to an accumulation of pollutants that can stagnate or move slowly to downwind areas.

During stable conditions, downwind usually means down valley or toward lower elevations. Climate data from Elko indicate that the potential for air pollution episodes to last 5 or more days is nearly zero (Holzworth 1972). A potential air pollution episode is defined as a period of time with wind speeds less than 6.6 feet (2 meters) per second and mixing heights less than 3,281 feet (1,000 meters).

Table 3.19-1 shows the monthly climate summary data for temperature and precipitation for Elko during the 123-year period from January 1888 through December 2010. These data are generally representative of climatic conditions for the proposed Hollister Mine and existing Midas Mill. Summers are typically hot and dry. Precipitation falls throughout the year with much of it occurring as snowfall during the winter. The average annual precipitation at Elko is approximately 9.6 inches. Importantly, precipitation can vary with elevation, with higher precipitation occurring at higher elevation sites. The elevation of the Hollister Site is approximately 5,500 feet amsl, while Elko is approximately 5,000 feet amsl. While precipitation data are not collected at the Hollister Site, it is reasonable to assume the precipitation measured at Elko is representative of the project area.



Legend

Average Wind Speed (mph)

- 1.3 - 4
- 4 - 8
- 8 - 13
- 13 - 19
- 19 - 25
- 25 - 32
- 32 - 39
- 39 - 47
- 47+

Station:	Elko Airport Nevada
Latitude:	40º 49' 30" N
Longitude:	115º 47' 30" W
Elevation:	0 ft.
Start Date:	Jan. 1, 2001
End Date:	Jan. 31, 2006

Source: Western Regional Climate Center 2011a.

Hollister Underground Mine Project EIS

Figure 3.19-4

5-year Composite Wind Rose Plot for Elko, Nevada 2001 to 2006

10/20/11

Table 3.19-1 Monthly Climate Summary Elko Airport, Nevada

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	36.7	42.4	51.0	59.9	69.5	80.0	91.1	88.8	78.8	65.8	50.3	38.9	62.8
Average Minimum Temperature (°F)	10.8	17.4	23.7	29.1	35.6	42.3	48.2	45.7	36.7	28.0	20.4	13.1	29.3
Average Total Precipitation (in.)	1.18	0.93	0.92	0.85	0.97	0.78	0.37	0.40	0.45	0.72	0.92	1.10	9.60
Average Total Snowfall (in.)	7.9	4.6	3.8	1.8	0.5	0.0	0.0	0.0	0.0	0.5	3.2	6.5	28.7
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	1	0

Note: Period of Record: 1/1/1888 to 12/31/2010.

Source: Western Regional Climate Center 2011a.

Esmeralda Mill is about 22 miles southwest of Hawthorne, Nevada. A summary of the climate for Hawthorne is presented in **Table 3.19-2**. These data indicate that this area in the lee side of the Sierra Nevada Mountains is very dry, receiving less than 5 inches of rainfall annually. Temperatures show a large diurnal and annual range, largely as a result of this dryness. Summers are warm but only July and August record average daytime highs in the 90s. Winters are moderately cold with the average nighttime lows below freezing for 4 months of the year, November through February. A large diurnal range of temperatures supports dispersion and mixing of air, and this contributes to a relatively clean quality of the air in the region.

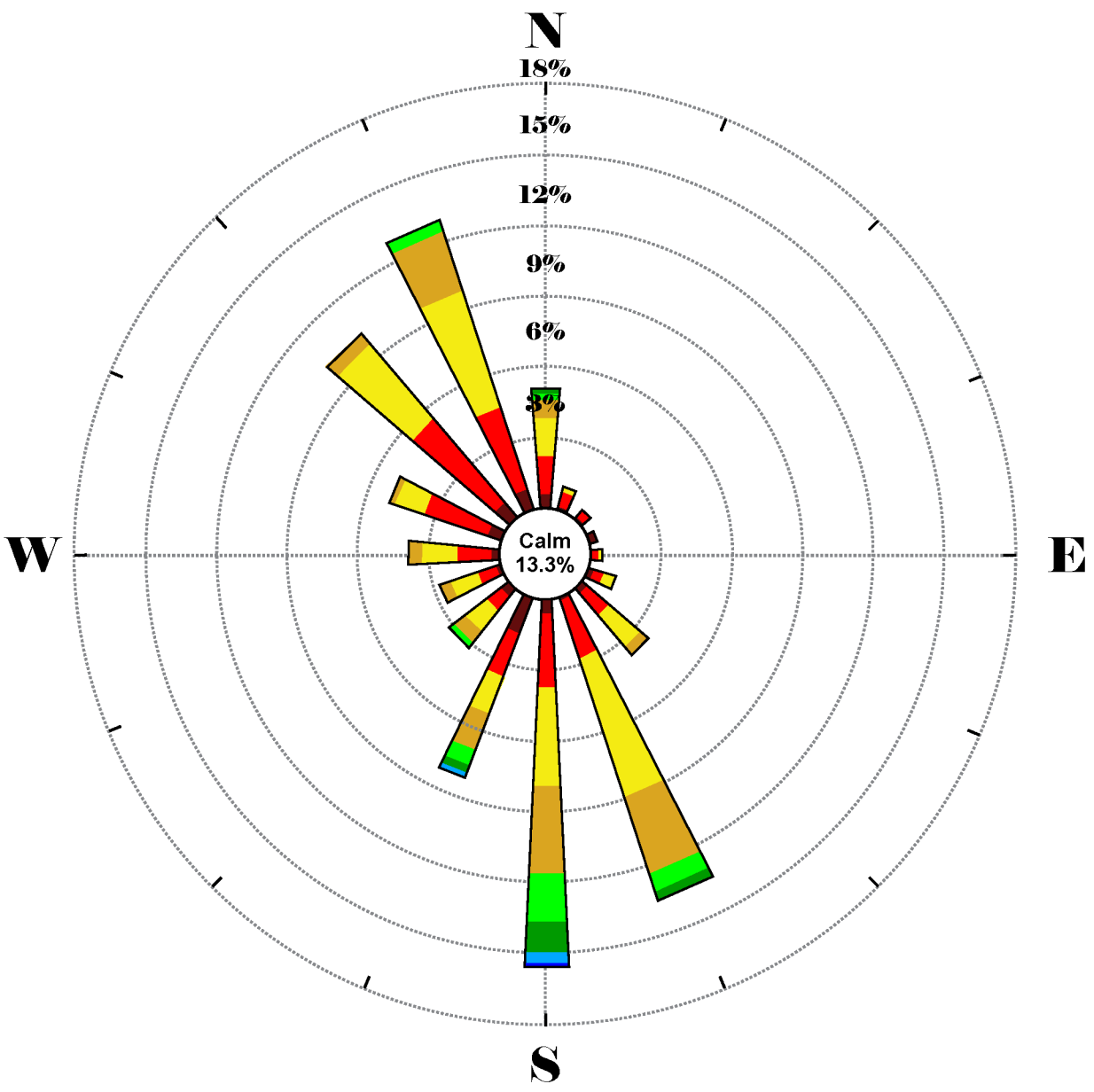
Table 3.19-2 Period of Record Monthly Climate Summary for Hawthorne, Nevada

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)	47.2	53.4	62.2	67.8	76.7	86.1	96.3	93.9	85.2	72.2	57.0	48.5	70.5
Average Minimum Temperature (°F)	24.1	28.1	33.2	37.3	46.4	54.1	62.3	60.1	51.7	41.6	30.9	25.4	41.3
Average Total Precipitation (in.)	0.41	0.47	0.38	0.42	0.67	0.41	0.27	0.18	0.21	0.23	0.36	0.24	4.25
Average Total Snowfall (in.)	0.6	0.4	0.2	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.8	0.1	2.3
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Period of Record: 8/19/1954 to 12/31/2010.

Source: Western Regional Climate Center 2011b.

The wind rose for the Brawley Peaks monitoring station located 4 miles southeast of the Esmeralda Mill is shown in **Figure 3.19-5**. The Brawley Peaks wind rose indicates that winds are predominately from the south with a secondary maximum of wind occurrences from the northwest.



Legend

Average Wind Speed (mph)

- 1.3 - 4
- 4 - 8
- 8 - 13
- 13 - 19
- 19 - 25
- 25 - 32
- 32 - 39
- 39 - 47
- 47+

Station:	Brawley Peaks Nevada
Latitude:	38º 15' 40" N
Longitude:	112º 52' 49" W
Elevation:	8080 ft.
Start Date:	Jan. 1, 2006
End Date:	Dec. 31, 2010

Source: Western Regional Climate Center 2011b.

Hollister Underground Mine Project EIS

Figure 3.19-5

5-year Composite Wind Rose Plot for Brawley Peaks, Nevada 2006 to 2010

10/20/11

3.19.1.2 Air Quality

Air quality is defined by the concentration of various pollutants and their interactions in the atmosphere. Pollution effects on human health have been used to establish Ambient Air Quality Standards (AAQS). Measurement of pollutants in the atmosphere is expressed in units of parts per million or micrograms per cubic meter ($\mu g/m^3$). Both long-term climatic factors and short-term weather fluctuations are considered when assessing air quality concentrations because they control dispersion and transport. Physical effects of air quality depend on many factors, such as the type, amount, and duration of exposure. Air quality standards specify acceptable upper limits of pollutant concentrations and duration of exposure. Air pollutant concentrations below the standards generally are not considered to be detrimental to public health and welfare.

The relative importance of pollutant concentrations can be determined by comparison with appropriate National and/or State AAQS. National and State AAQS are presented in **Table 3.19-3**. The pollutants of concern for the Hollister Underground Mine Project are nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM), including PM_{10}, and PM with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$). Lead (Pb), hydrogen sulfide, and ozone (O_3) are not emitted or produced in sufficient quantities to be of concern for this project.

Table 3.19-3 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
O_3[1]	1-hour	235	NA	NA
O_3[1]	8-hour	157	157	157
CO	1-hour	40,000	40,000	40,000
CO less than 5,000 feet amsl	8-hour	10,000	10,000	10,000
CO at or greater than 5,000 feet amsl	8-hour	6,670		
SO_2	1-hour	NA	196	None
SO_2	3-hour	1,300	None	1,300
SO_2	24-hour	365	365	None
SO_2	Annual Average	80	80	None
NO_2	1-hour	188	188	None
NO_2	Annual Average	100	100	100
PM_{10}	24-hour	150	150	150
PM_{10}	Annual Average	50	NA	NA
$PM_{2.5}$	24-hour	35	35	35
$PM_{2.5}$	Annual Average	15	15	15
Pb[1]	Rolling 3-month Average	0.15	0.15	0.15
Pb[1]	Quarterly Arithmetic Mean	1.5	1.5	1.5

Table 3.19-3 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
Hydrogen Sulfide	1-hour	112	--	--
Visibility	Observation	Insufficient amount to reduce the prevailing visibility to less than 30 miles when humidity is less than 70 percent.	--	--

[1] Pollutant not applicable to modeling analysis.

Source: Nevada Administrative Code 445B.22097 Standards of Quality for Ambient Air (Nevada Revised Statute 445B.210, 445B.300); U.S. Environmental Protection Agency (USEPA) 2010.

An area is designated by the USEPA as being in attainment for a pollutant if ambient concentrations of that pollutant are below the National AAQS (NAAQS). An area is not in attainment if violations of NAAQS for that pollutant occur. Areas where insufficient data are available to make an attainment status designation are listed as unclassifiable and are treated as being in attainment for regulatory purposes.

The existing air quality of the project area is typical of the largely undeveloped regions of the western U.S. For the purposes of statewide regulatory planning, this area has been designated as in attainment (not exceeding NAAQS for criteria pollutants) for all pollutants that have an AAQS. Current sources of air pollutants in the region include several precious metals mines that are sources for PM with aerodynamic diameters (in micrometers) designated as PM_{10} and $PM_{2.5}$.

Global Mercury

Mercury is a naturally occurring element in many soils, volcanic rocks, and marine and geothermal water sources. It assumes many forms and can be found naturally in the environment as free metallic mercury, chemically combined with other elements in a number of soil or rock types, and in the form of methylmercury (CH_3Hg+) in plants and animals. Mercury is generally present in the atmosphere in one of three chemical forms: gaseous elemental mercury, reactive gaseous mercury (RGM), or particulate mercury. RGM and particulate mercury account for less than 2 percent of the total concentration in air, with elemental mercury accounting for more than 98 percent of the total (Fitzgerald et al. 1991).

Mercury emissions to the atmosphere come from both background and man-made sources. Background sources of mercury include natural sources such as naturally enriched soils and volcanoes. The fate of mercury emissions follows pathways from the emission source to transport, deposition, exposure, and potential human uptake risks. From a single source such as a power plant or mill, or other thermal source, a portion of the emissions are deposited locally near the source while the remaining mercury is dispersed regionally and globally.

Discerning mercury speciation is important in understanding the deposition and bioaccumulation of mercury in the environment. Gaseous elemental mercury (Hg_0) must be transformed to particulate or oxidized mercury in order to contribute substantially to mercury deposition and subsequent entry into water bodies where further transformation to CH_3Hg+ can make the mercury available in the aquatic food chain (Porcella 1994). The final pathway to humans for mercury exposure is eating fish with CH_3Hg+ stored in their tissues. About 0.3 percent of the total mercury emitted from a point source is deposited in lakes and streams to form a CH_3Hg+ compound (Porcella 1994).

Elemental mercury travels the farthest and can be transported on wind currents for months to years if not oxidized, thus providing an opportunity for global transport and dispersion. Concentrations of

mercury in the air are usually low and of little direct concern. However, RGM and particulate mercury falls to earth through rain or snow and enters lakes, rivers, and estuaries. Once there, it can transform to its most toxic form, CH_3Hg+, and accumulate in fish and animal tissues.

RGM has an average atmospheric residence time of days to weeks (less in the presence of precipitation or bromine compounds often present in saline water bodies). It is not easily volatilized, and very water-soluble. It is easily taken up in precipitation or adsorbed on small particles in the atmosphere and falls out as wet or dry deposition. RGM has a higher potential to enter the food chain than elemental mercury and is more easily converted into CH_3Hg+.

Particulate mercury has an average atmospheric residence time of hours to days (depending on the presence or absence of precipitation and the particle size). It has low volatility and is easily taken up in precipitation or adsorbed on small particles, falling out relatively close to the emission source in the presence of precipitation, or as dry deposition that may be transported for longer distances if associated with very small particle sizes. Particle-bound mercury is relatively stable and is not easily converted to CH_3Hg+ (USEPA 1997).

Mercury accumulates most efficiently in aquatic species as CH_3Hg+. Predatory species at the top of the aquatic food chain generally have higher mercury concentrations. Nearly all of the mercury that accumulates in fish tissue is CH_3Hg+. Inorganic mercury is less efficiently absorbed, more readily eliminated from the body than CH_3Hg+, and does not tend to bio-accumulate.

Local Mercury

When bound in mineral forms that typically appear in ore (e.g., cinnabar), mercury is a stable compound that remains in solid form. Ore processing has the potential to liberate mercury from these stable minerals by dissolving it in process solutions. Because it has a boiling point of 675 degrees Fahrenheit, mercury has the potential to volatilize into a gaseous form when subjected to thermal processes in a recovery and refining circuit. This mercury is then released to the atmosphere where it may convert into RGM or particulate mercury.

3.19.2 Environmental Consequences

Issues related to air quality include potential impacts associated with project-generated air emissions.

3.19.2.1 Proposed Action

Criteria Pollutant Emissions

Air emissions of both gaseous and particulate pollutants would result from the Proposed Action. Gaseous pollutant emissions associated with the Proposed Action would result from construction and mining equipment and vehicle exhaust. Because the Hollister operations are underground, fugitive dust (i.e., particulate) emissions would be generated primarily by haul trucks transporting ore to processing facilities. Other sources of PM include access roads, ore stockpiles, and disposal of waste rock. For the purposes of calculating emissions for the Proposed Action, the activities that generate emissions were grouped into one of these three categories: stationary sources at Hollister Mine; portable, non-road engines used for drilling at Hollister Mine; and mobile sources that transport ore from Hollister Mine to processing facilities. Future emissions (potential to emit) associated with milling the Hollister ore at Esmeralda Mill and Midas Mill would not change as a result of the Proposed Action. In general, the stationary sources at the Hollister Site would remain largely unchanged as a result of the Proposed Action, except the existing Hollister Site power source, the two diesel generators located in the East Pit, would be taken out of service once electricity becomes available from the proposed 120-kilovolt (kV) and 24.9-kV electric power transmission lines (transmission lines), thereby greatly reducing the emissions associated with the generators.

In addition to reducing the emissions from the generators, Rodeo Creek Gold Inc (RCG) has committed to several Applicant-committed Environmental Protection Measures, which are described in Section 2.4.9.6, in order to minimize air emissions associated with the Proposed Action. Gaseous emissions would be minimized by proper equipment maintenance and operation. Particulate emissions would be mitigated by minimization of drop heights during loading, and implementing dust suppression measures. Fugitive dust is specifically addressed as a condition in the Fugitive Dust Control Plan portion of the NDEP Surface Area Disturbance Permit Application. RCG would implement an ongoing program to control fugitive dust from disturbed areas using Applicant-committed Environmental Protection Measures such as application of water and/or chemical dust suppressants (e.g., magnesium chloride), phased construction, and revegetation as appropriate. Access roads, project area roads, and other traffic areas would be maintained on a regular basis to minimize dust and provide for safe travel conditions. These Applicant-committed Environmental Protection Measures are accounted for in the Proposed Action emissions shown in **Table 3.19-4**. Note that fugitive dust was assumed to be controlled through the application of water.

Table 3.19-4 Total Annual Emissions for Proposed Action

Emissions Source	Tons per Year (tpy)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Non-Road Engines (Drill Rig Engines)	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic – All Ore to Midas Mill	2.75	1.23	0.15	298.70	29.95	744
Ore Hauling Traffic – All Ore to Esmeralda Mill	31.90	14.33	1.62	687.77	69.63	10,515
Total[1]	63.71	24.00	4.24	690.24	72.10	13,530

[1] For a conservatively high estimate of emissions total emissions are calculated assuming all ore is transported to Esmeralda Mill, and none of the ore is transported to Midas Mill. Therefore, the values in this table do not sum together to provide the total maximum emissions from the Proposed Action.

CO_2 = carbon dioxide.

NO_X = nitrogen oxide

Air modeling was performed using the USEPA-recommended SCREEN3 Model. SCREEN3 is a single source Gaussian plume model which provides an estimate of maximum ground-level concentrations for point, area, flare, and volume sources. SCREEN3 is a screening model used to assess whether or not refined modeling is required. If SCREEN3 impacts are predicted to be below applicable AAQS, then refined modeling is not required. Note: SCREEN3 modeling was completed prior to implementation of the final version of AERSCREEN (Version 11126).

For this study, SCREEN3 model version 96043 was used to evaluate impacts from trucks on haul roads. The trucks were modeled as volume sources using full meteorology as well as regulatory model default values for mixing heights and anemometer heights. Impacts were assessed at a distance of 46 feet (14 meters) from the road for a generic road segment that is representative of all dirt roads in the direct impacts assessment area. Results of the conservative screening level dispersion modeling analysis for the Proposed Action are shown in **Table 3.19-5** and indicate that the impacts from haul road traffic are well within the National and State AAQS. **Appendix G**, Air Quality Technical Support Document for the Hollister Underground Mine Project EIS, provides details on the air quality modeling performed.

Table 3.19-5 Hollister Mine SCREEN3 Model Results for Haul Roads

Pollutant	Averaging Time	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	Percent of NAAQS (%)
NO_2	1-hour	NA	1.9	1.0
	Annual	NA	0.1	0.1
CO	1-hour	NA	0.9	0.0
	8-hour	NA	0.6	0.0
SO_2	1-hour	NA	0.1	0.1
	3-hour	NA	0.1	0.0
	24-hour	NA	0.0	0.0
	Annual	NA	0.0	0.0
PM_{10}	24-hour	10.2	30.2	20.1
	Annual	9.0	11.0	22.0
$PM_{2.5}$	24-hour	6.92	8.9	25.5
	Annual	2.58	2.8	18.5

[1] The background values for NO_2, SO_2, CO, and PM_{10} are from previous modeling demonstrations for the Hollister Site (RCG 2010e, 2009b). The background concentration for $PM_{2.5}$ is calculated as described in the text above based on the approved modeling protocol (**Appendix G**).

Table 3.19-6 shows the Hollister Mine criteria pollutant emissions from stationary sources, including the backup emergency generator units, in tons per year. It is important to note that these annual emissions are at the potential to emit if the generator units were to operate for 500 hours per year to generate power on-site when electric grid power is unavailable. When grid power is available, the engines would be run only 10 to 20 percent of that time (i.e., only enough to ensure their proper maintenance and readiness for emergency standby use).

Table 3.19-6 Stationary Source Emissions for Proposed Action

Unit or Process Description	Tons per Year (tpy)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Cummins Model QSK60-G6, 2,647 hp[1]; 500 hours/year	7.7	0.8	1.3	0.1	0.1	671
Cummins Model QSK60-G6, 2,647 hp[1]; 500 hours/year	8.9	0.8	1.3	0.1	0.1	671
Shotcrete Batch Plant; 60 tons/hr Process Rate; 8,760 hours/year	0.0	0.0	0.0	1.8	1.8	0.0
Total	16.6	1.6	2.6	2.0	2.0	1,342

[1] Model analyzed. Actual diesel generation equipment may be replaced periodically in the ordinary course of operations.

Source: RCG 2009b.

As part of current air operating permits for the Hollister Site (RCG 2010e, 2009b, 2007), compliance demonstrations have been completed for the Hollister Site stationary sources for all pollutants and averaging periods, except for a new 1-hour NO_2 standard and new 24-hour and annual standard for $PM_{2.5}$, which were promulgated following the last required compliance demonstrations pursuant to such permits.

The modeling analysis previously performed for PM_{10} (RCG 2009b) was used as the basis for the comparison to the $PM_{2.5}$ standard, which would more than offset the NO_X and SO_2 emissions from haul trucks associated with the proposed project that would be available to potentially contribute to the secondary formation of $PM_{2.5}$. This approach conservatively overestimates the direct $PM_{2.5}$ impacts since emissions of $PM_{2.5}$ are equal to or less than PM_{10} by definition. The USEPA recently has confirmed that while "air quality modeling of direct $PM_{2.5}$ emissions can be accomplished using a USEPA-approved model to predict ambient $PM_{2.5}$ impacts caused by new and modeled sources of $PM_{2.5}$ emissions," it "has not approved any models that can reliably predict the localized ambient $PM_{2.5}$ impacts of precursors (e.g., SO_2 and NO_X) emitted from individual stationary sources." Accordingly, USEPA instructs that an evaluation of $PM_{2.5}$ ambient impacts associated with a single source focus on direct $PM_{2.5}$ emissions (Federal Register 2010). In addition to direct $PM_{2.5}$ emissions, the USEPA has recognized that $PM_{2.5}$ also may include a secondary component that is formed as a result of complex atmospheric reactions involving precursor pollutant emissions. There are four potential pollutant precursors: sulfur dioxide (SO_2), NO_X, volatile organic compounds (VOCs), and ammonia (NH_3). The USEPA presumes that emissions of SO_2 and NO_X would have some secondary contribution to $PM_{2.5}$ ambient concentrations and that emissions of VOCs and NH_3 would not contribute to $PM_{2.5}$ impacts based on its current level of understanding (Federal Register 2008).

As described in the modeling protocol (**Appendix G**), annual and 24-hour $PM_{2.5}$ background values were calculated for the Hollister Site based on 3 years of measurements of $PM_{2.5}$ conducted at Jarbidge Wilderness Area and Great Basin National Park. The results indicate that the conservative evaluation of the No Action Alternative plus background are well within the annual and 24-hour standards for $PM_{2.5}$ as shown in **Table 3.19-7**. The $PM_{2.5}$ impacts shown in **Table 3.19-7** represent the impacts for the No Action Alternative. It is anticipated that impacts for the Proposed Action would be lower due to the reduction of diesel generator emissions and the removal of other stationary sources.

Table 3.19-7 Hollister Site Model Results for $PM_{2.5}$ for the No Action Alternative

Pollutant	Averaging Time	Impact ($\mu g/m^3$)[1]	Background ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
$PM_{2.5}$	24-hour	16.86	6.92	23.78	35	68
	Annual	3.45	2.58	6.03	15	40

[1] AERMOD-modeled PM_{10} impacts for No Action Alternative (RCG 2009b). The 24-hour impact represents the highest-eighth-high modeled PM_{10} results in accord with the form of the $PM_{2.5}$ standard. Impacts for the Proposed Action would be lower due to reduction of the diesel generator emissions.

A modeling analysis was conducted as described in the Air Quality Technical Support Document for comparison to the 1-hour NO_2 AAQS. The SCREEN3 predicted maximum impacts from the stationary source emergency generators are shown in **Table 3.19-8,** and are below the 1-hour NO_2 AAQS.

Table 3.19-8 Hollister Mine SCREEN3 Model Results for Emergency Generators

Pollutant	Averaging Time	Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
NO_2	1-hour	154.8	n/a	154.8	188	82.3

[1] NDEP Bureau of Air Pollution Control has approved the use of a background value of zero for NO_2 at the Hollister Site in past modeling demonstrations (RCG 2010e).

GHG Emissions

Combustion of fossil fuels results in emissions of greenhouse gases (GHG). Proposed mining operations at the Hollister Site would involve combustion of diesel, propane, and gasoline, all of which contribute CO_2 and other GHG to the atmosphere. In Nevada, the estimated total GHG emissions were approximately 56 million metric tons in 2005 (NDEP 2008b).

Industrial sources account for approximately 2.5 million metric tons and, thus, represent approximately 4 percent of the state's emissions of GHG. Under the Proposed Action, the diesel generators at the mine would be decommissioned and would operate fewer than 500 hours per year as emergency power back-up. Stationary sources at the mine then would have the potential to emit about 1,342 tons per year (tpy) of GHG. Hauling ore to the Esmeralda Mill for processing would result in additional GHG emissions of about 10,515 tpy. Hollister Mine would require electrical generation by a utility (NVEnergy) to supply power to the mine through the proposed 120-kV and 24.9-kV transmission lines. The net effect on GHG emissions from stationary sources would be a net increase from utility supplied electricity. If all of the Hollister Mine ore went to Midas Mill for processing, the haul trucks have the potential to generate about 744 tpy of GHG. Section 3.25, Energy Requirements, Climate Change, and West Nile Virus, summarizes the estimated fuel and electrical power consumption for the proposed project and alternatives.

Hazardous Air Pollutants and Mercury Emissions

The only Hazardous Air Pollutant (HAP) that would be emitted due to this project is mercury. Mined ore containing mercury would be processed at either the Esmeralda Mill or the Midas Mill. Antler Peak Gold Inc has obtained mercury operating permit number AP1041-2248 for the ore processing at the Esmeralda Mill under the Nevada Maximum Achievable Control Technology rules. The permitted emissions for mercury at Esmeralda Mill would be about 7 pounds per year. The thermal units that are permitted by NDEP under the Phase 2 Mercury Operating Permit to Construct at the Esmeralda Mill include: two mercury retorts, a carbon kiln, and two tanks (pregnant and barren solution tanks).

Newmont Midas Operations, Inc. has obtained mercury operating permit number AP1041-2253 for ore processed at Midas Mill. Processing Hollister ore at Midas Mill would result in mercury emissions at the same level as Esmeralda Mill, which is anticipated to be less than 7 pounds per year. Thermal units permitted at the Midas Mill include: two refinery furnaces; two mercury retorts; and associated ancillary equipment (hot plates, drying ovens, and atomic adsorption spectrometer). As part of the permit process, HAPs (including mercury) were modeled. Given that the permitted amount of ore processing would not increase at either Esmeralda or Midas mills as a result of this project an additional modeling demonstration is not required.

Visibility at Class I Areas

The Hollister Site is located approximately 62 miles (100 km) from the Jarbidge Wilderness Area, the nearest Class I area. According to the Federal Land Managers' Air Quality Related Values Work Group (FLAG) 2010 Phase 1 Report (FLAG 2010), all sources greater than 31 miles (50 km) from a

Class I area would have negligible visibility impacts if the ratio of emission to distance (Q/D) is 10 or less. The Q/D ratio is the combined emissions (Q, in units of tpy) of SO_2, NO_X, PM_{10}, and sulfuric acid, divided by the distance (in kilometers) from the nearest Class I area. **Table 3.19-9** below shows the total emissions for the Proposed Action from stationary sources, ore hauling road traffic, and drill rig engines. Ore hauling traffic emissions were conservatively assumed for all ore transport to Midas Mill due to its proximity to the Jarbidge Wilderness Area as opposed to the Esmerelda Mill, which is closer to Yosemite National Park.

Table 3.19-9 Total Annual Emissions for Proposed Action when Ore is Transported to Midas Mill

	Tons per Year					
Emissions Source	**NO_X**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Non-road Engines (Drill Rig Engines)	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic	2.75	1.23	0.15	298.40	29.95	744
Total	34.56	10.90	2.77	300.87	32.42	3,759

Based on the total emissions presented in **Table 3.19-9**, Q would be equal to 338.5 tons. The Jarbidge Wilderness Area is 62 miles (100 km) away which gives a total Q/D of approximately 2.10 tons per mile (3.39 tons/km), well below the upper limit of 10. Based on this screening method, the Q/D value of 2.10 tons per mile (3.39 tons/km) shows that the emissions from the Hollister Mine would have negligible visibility impacts at the Jarbidge Wilderness Area. The Esmeralda Mill also is a proposed ore processing site for the Hollister Mine ore, and is located about 22 miles southwest of Hawthorne, Nevada, near the California border, and is about 28 miles east of Yosemite National Park, California. Yosemite National Park is considered a federal Class I area. Areas designated as mandatory Class I areas are those national parks exceeding 6,000 acres, wilderness areas and national memorial parks exceeding 5,000 acres, and all international parks, which were in existence on August 7, 1977 (40 CFR part 81,subpart D).

Visibility impairment is caused by particles and gases in the atmosphere. Some particles and gases scatter light while others absorb light. The net effect is called “light extinction.” The result of the scattering and absorption processes is a reduction of the amount of light from a scene that is returned to the observer, and scattering of other light into the sight path, creating a hazy condition. A screening level assessment of the impacts on visibility from processing Hollister Mine ore at the Esmeralda Mill was performed using the VISCREEN model version 88341. The plume visual impact screening model VISCREEN is designed to ascertain whether the plume from a facility (i.e., Esmeralda Mill) has the potential to be perceptible to untrained observers under "reasonable worst-case" conditions.

The perceptibility of a plume depends on the plume contrast at all visible wavelengths. At a single wavelength, the contrast between the plume and its surroundings is determined by the difference in the intensity of the light reaching the observer from each. Therefore a single measure, intensity, could be used to quantify contrast if visible light were composed of a single wavelength. With a range of wavelengths, a measure of contrast must recognize both "overall" intensity, and perceived color, and so perceptibility is a function of changes in both brightness and color. To address the added dimension of color as well as brightness, the color contrast parameter, Delta E, was used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. Delta E provides a single measure of the difference between two arbitrary colors as perceived by humans. This parameter allows us to make quantitative comparisons of the perceptibility of two plumes, even though one may

be a reddish discoloration viewed against a blue sky while the other may be a white plume viewed against a dark green forest canopy.

In the plume visual impact screening model VISCREEN, contrasts at three wavelengths (0.45, 0.55, and 0.65 micrometers [µm]) were used to characterize blue, green, and red regions of the visible spectrum. VISCREEN modeling was performed to ascertain whether the plume from the Esmeralda Mill associated with processing of ore for the Hollister Mine would be brighter or darker or discolored compared to its viewing background by evaluating its contrasts in the blue, green, and red portions of the visible spectrum. If plume contrast is positive, the plume is brighter than its viewing background; if negative, the plume is darker. If contrasts are different at different wavelengths, the plume is discolored. If contrasts are all zero, the plume is indistinguishable from its background (i.e., imperceptible).

For screening level analysis, the first criterion is a Delta E value of 2.0; the second is a green (0.55 µm) contrast value of 0.05. Results of the modeling are shown in **Table 3.19-10**.

Table 3.19-10 Maximum Visual Impacts Inside Yosemite National Park

Background	Theta (degrees)	Azimuth (degrees)	Distance	Delta E		Contrast	
				Criteria	Plume	Criteria	Plume
Sky – forward scatter	10	157	53 miles (86 km)	2.00	4.227*	0.05	0.082*
Sky – backward scatter	140	157	53 miles (86 km)	2.00	0.644	0.05	-0.020
Terrain – forward scatter	10	84	28 miles (45 km)	2.00	7.887*	0.05	0.060*
Terrain – backward scatter	140	84	28 miles (45 km)	2.00	0.326	0.05	0.004

* Exceeds screening criteria.

Results are provided for two assumed worst-case sun angles. The "forward scatter" case refers to a situation in which the sun is in front of the observer such that the scattering angle theta is 10 degrees. Such a sun angle would tend to maximize the light scattered by plume particulates and maximize the brightness of the plume. In reality, such a sun angle may or may not occur during worst-case meteorology conditions for the given line of sight as discussed more in the next paragraph. The "backward scatter" case refers to a situation in which the sun is behind the observer such that the scattering angle is 140 degrees. A plume is likely to appear the darkest with such a sun angle. **Table 3.19-10** shows that contrast and change in light extinction values (Delta E) exceed the screening criteria level. These results indicate that there could be visibility impacts to Yosemite National Park due to ore processing at the mill.

The visibility screening modeling results indicate that under certain worst-case conditions, when the sun is in front of the observer, the delta-E value exceeds the criterion by a factor greater than 2 and the contrast by a smaller margin. The low sun angles would occur only during the early morning hours when a person in Yosemite looking in the direction of the Esmeralda Mill would have the sun in front of them at a low angle. An observer looking north and east from the National Park might be able to see a

visible plume against the sky or terrain. A visible plume would only be present if the meteorology during the night before and during the early part of that day is conducive to the emissions plume remaining intact and not dispersed. The complex terrain at the mill site and between the mill site and the National Park would favor mixing and dispersion of the plume due to differential heating and cooling of the mountain slopes. During periods of stable atmospheric conditions that would favor a coherent plume, the emissions plume would likely flow with the valley airflow down valley. At Esmeralda, this is generally towards the east; therefore, during the early hours of the day, a plume would not be visible to an observer 28 miles to the south and west because the plume would be moving away from Yosemite. The screening level results for theta values of 140 degrees indicate that the plume formed by emissions from the mill would not be perceptible against either the sky or the terrain during the evening hours when the sun is behind the observer.

Emission rates used in the screening level analysis were the maximum short-term rates expected during the course of a year, and are based on the maximum emission rates in the air quality permit.

3.19.2.2 Mud Springs Road Transmission Line Alternative

During construction of the transmission line, impacts to air quality from gaseous pollutants under this alternative would be similar to the impacts described for the Proposed Action. Since this alternative would result in 9.5 and 15.2 fewer acres of surface disturbance for the North Option and South Option, respectively, than the transmission line route for the Proposed Action, there would be less potential for fugitive dust generation and somewhat less impacts during construction.

3.19.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under this alternative, the Mud Springs Waste Rock Storage Facility (WRSF) would be constructed east of the proposed Hatter production shaft, ramp, or raise (HPS). Placement of waste rock in this alternate location would result in shorter haul distances when waste rock is transported from the HPS, and longer haul distances when waste rock is transported from the portal in the East Pit. The overall average waste rock haul distance is expected to be similar between the Mud Springs WRSF and the Proposed Action. Approximately 2,080 feet of the existing Mud Springs Road would need to be relocated and another 1,800 feet of road would need to be upgraded under this alternative. All other project facilities would be the same as described for the Proposed Action.

Air quality impacts for the Mud Springs Road WRSF Alternative would be the same as described for the Proposed Action with the following exception related to the WRSFs. Potentially slightly higher localized fugitive dust emissions would occur under the Mud Springs Road WRSF Alternative because 21 acres of new surface disturbance would be required for the Mud Springs WRSF and susceptible to erosion. Construction impacts are expected to remain below applicable National and State AAQS.

3.19.2.4 Backfill Alternative

Under this alternative, the HPS and East and West raises would be backfilled with waste rock at mine closure. This alternative would implement all other components described in the Proposed Action.

Air quality impacts under this alternative would be the same as described for the Proposed Action, with the following exceptions: the Backfill Alternative would require approximately 1,536 truck round trips from the WRSFs to the HPS, 175 truck round trips from the WRSFs to the East Raise, and 234 truck round trips from the WRSFs to the West Raise. This activity would result in increased gaseous emissions and fugitive dust from loading and hauling of waste rock over gravel roads.

3.19.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed, and the associated air quality impacts would not occur. Under this alternative, the existing Hollister Site would continue to

operate under current authorizations. No exceedences of the applicable national and state AAQS are expected.

An analysis of potential air quality impacts associated with the existing exploration and bulk sampling operation are presented in the recent air permit application submitted to NDEP (RCG 2010e, 2009b). Based on these analyses, the modeled concentrations of criteria pollutants are well within the applicable ambient air quality standards.

3.19.3 Cumulative Impacts

Cumulative impacts to air quality would include impacts from the proposed project emission sources in combination with impacts from background emission sources, which reflect emissions associated with the past and present actions, as well as proposed future actions. Reasonably foreseeable future actions are described in Section 3.2. The CESA is illustrated in **Figures 3.19-1, 3.19-2**, and **3.19-3**.

Fugitive Dust and Gaseous Emissions

Fugitive dust and gaseous emissions from nearby mine operations in the Carlin Trend and the TS Power Plant affect air quality in the CESA (Bureau of Land Management [BLM] 2010d). The existing operations at the Hollister Site would have haul truck traffic as currently authorized. Ambient air quality data for the region currently reflects impacts of existing mining operations in the airshed. The estimated emissions from the Hollister Proposed Action are shown with other emissions sources within the Hollister Site CESA in **Table 3.19-11**. While the Leeville Project (BLM 2010d) did not include the Hollister operations in the air quality cumulative effects modeling analysis, the findings are consistent with the modeled impacts for this project. Air modeling completed for Hollister and other facilities in the CESA has shown that air pollutant concentrations are localized near the project boundaries and modeled air impacts diminish rapidly with distance from project boundaries (BLM 2010d). Air quality in the region meets applicable standards and would be expected to remain in compliance under the Hollister Proposed Action, including accounting for existing and anticipated future emissions sources in the CESA. The air quality dispersion modeling study for Hollister operations included predicted impacts of gaseous criteria air pollutants SO_2, NO_2, and CO. By applying the ambient air quality standard as a reference, it is reasonable to assume that the predicted SO_2, NO_2, and CO air quality impacts from the Hollister Proposed Action dispersion modeling demonstrate only minor effects in the CESA.

Existing emissions sources in the CESA surrounding Esmeralda Mill are shown in **Table 3.19-12**. The cumulative air quality impacts from processing Hollister ore at the Esmeralda Mill are negligible and are not expected to impact the existing air quality in this area.

Regional Haze

The primary cause of regional haze in many parts of the country is light scattering resulting from fine particles (i.e., $PM_{2.5}$) in the atmosphere. These fine particles can contain a variety of chemical species including carbonaceous species (i.e., organics and elemental carbon), as well as ammonium nitrate, sulfates, and soil. Additionally, coarse particles between 2.5 and 10 microns in diameter, can contribute to light extinction. Each of these components can be naturally occurring or the result of human activity. The natural levels of these species result in some level of visibility impairment, in the absence of any human influences, and would vary with season, daily meteorology, and geography.

The proposed project would be a minor source of fine particulate matter, mostly in the form of road dust from haul roads and would contribute negligible impacts to visibility conditions and regional haze at Class I areas that are all beyond 62 miles (100 km) from the Hollister Site (e.g., Jarbidge Wilderness Area). As shown in **Table 3.19-11**, the Hollister Proposed Action would comprise a small percent of existing and proposed future emissions sources. As such, the cumulative impact to visibility conditions at Jarbidge Wilderness Area is not anticipated to change as a result of the proposed project.

Table 3.19-11 Total Annual Emissions for the Proposed Action and Other Sources in the CESA

Facility	Tons per year			
	NO_X	CO	SO_2	PM_{10}
Hollister Mine Proposed Action[1]	63.7	24	4.2	690.2
South Operations Area Project Amendment[2]	354	337	276	568
Leeville[2]	0	0	0	0.5
North Operations[2]	0	0	0	93.8
Betze/Post[2]	311	400	996	579
TS Power Plant[2]	1,170	744	1546	598
Total[1]	1,898.7	1,505	2,822.2	2,529.5
Hollister Mine Emissions Percent of Total (%)	3.4	1.6	0.1	27.3

[1] Total Emissions are calculated assuming all ore is transported to Esmeralda Mill.

[2] Source: BLM 2010d.

Table 3.19-12 Annual Emissions for the Esmeralda Mill Vicinity

Facility	Tons per Year				
	NO_X	CO	SO_2	PM_{10}	Hg
Esmeralda Mill	4.61	0.87	0.54	9.28	0
Sierra Pacific Power Company – FT Churchill Generating Station	27,776.07	13,267.07	27,747.83	4,039.02	0
US Department of the Army – Hawthorne Army Depot	149.54	81.04	89.86	25.41	0
US Department of the Army – OPTC (BEDS PROJECT)	63.3	2.85	16.1	0.75	0.00318
US Department of the Army – OPTC (NV COMP A5 COLLECTION SYSTEM)	0	0	0	4.48	0
US Department of the Army – OPTC (RF-9)	28.39	0.8	14.56	8.58	0.000890
Total	28,021.9	13,352.63	27,868.9	4,087.5	0.00407

Source: NDEP 2011.

Yosemite National Park, a Class I area, is about 28 miles (45 km) west of Esmeralda Mine. Emissions of particulates and gaseous pollutants from Esmeralda Mill are conservatively modeled with VISCREEN. While VISCREEN results indicate that visibility impacts may be above the screen criteria level within the National Park during certain meteorological conditions, these meteorological conditions are unlikely to occur between Esmeralda Mill and the National Park, as described in detail in Visibility at Class I Areas section.

Mercury

Approximately 895 pounds of mercury and mercury compounds were reportedly released annually to the air by mining operations in the Carlin Trend (NDEP 2010b). The current predicted mercury

deposition rate in the Carlin Trend ranges between 0.10 g/km^2/yr and 3.00 g/km^2/yr (BLM 2010d) and is generally the lowest in the state. Since ore processing is off-site, the Hollister Site does not have mercury emissions. Processing of Hollister ore at the Midas Mill or the Esmeralda Mill would result in a negligible cumulative increase in mercury. This is consistent with other cumulative effects mercury studies in the Carlin Trend (BLM 2010d).

Cumulative impacts to air quality under the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives would be similar to the Proposed Action.

3.19.4 Potential Monitoring and Mitigation Measures

Based on the conclusions of the analysis that there are impacts; no additional monitoring and mitigation measures would be required beyond RCG complying with their air quality permits and Applicant-committed Environmental Protection Measures.

3.19.5 Residual Impacts

There would be no residual impacts to air quality from the proposed project because reclamation and revegetation would stabilize exposed soil and control fugitive dust emissions. As vegetation becomes established, particulate levels should return to typical conditions of a dry desert environment.

3.20 Social and Economic Values

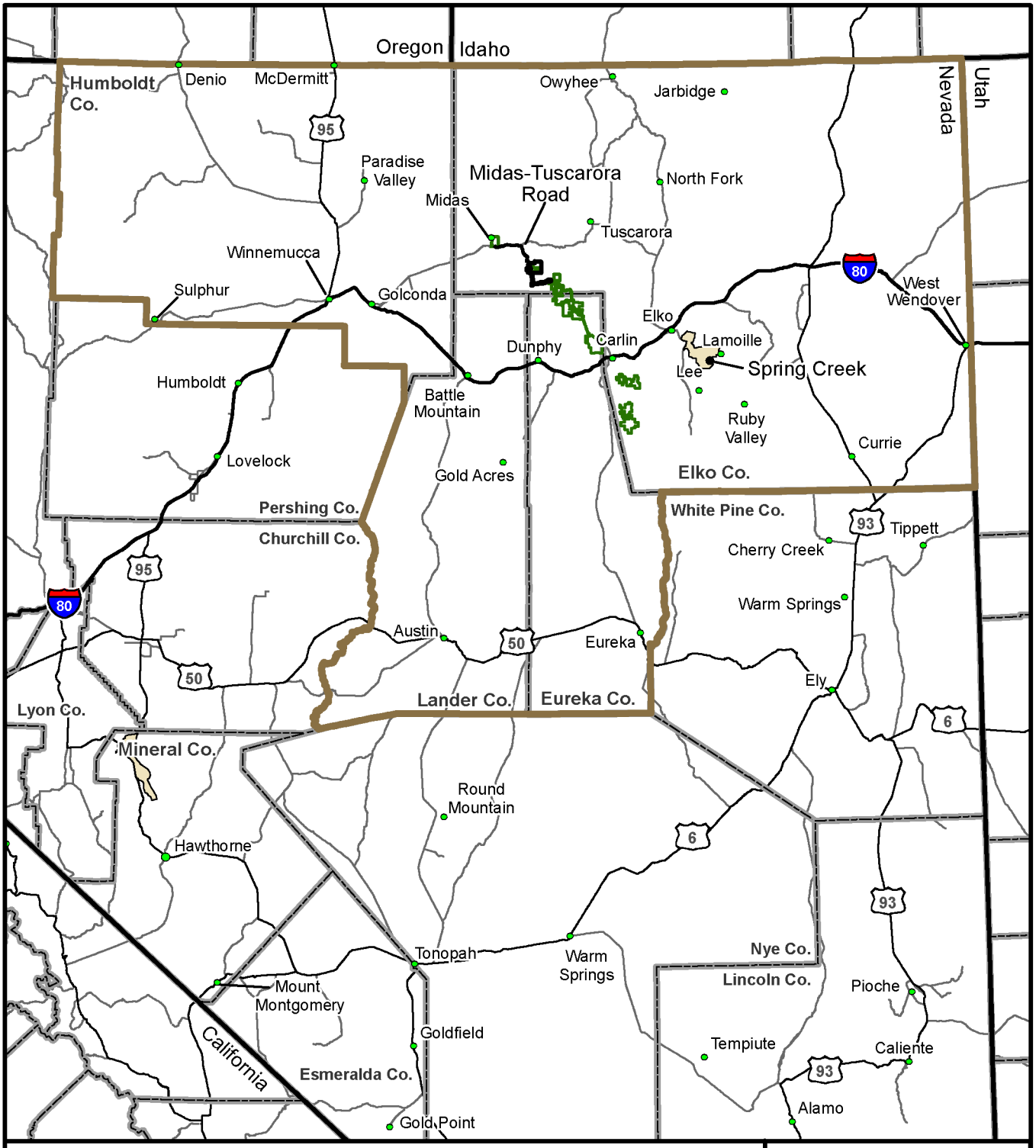
3.20.1 Affected Environment

The social and economic values study area for direct and indirect impacts and the cumulative effects study area (CESA) includes Elko, Humboldt, Eureka, and Lander counties (**Figure 3.20-1**). Past, present, and reasonably foreseeable future actions (RFFAs) occurring within the CESA and considered in cumulative effects are described in Section 3.2. The focus of the analysis is on the major communities nearest the mine site, including Winnemucca, Elko, Spring Creek, Carlin, and Battle Mountain. The Hollister Underground Mine Project is located in Elko County. Elko is both the largest city and the regional trade center for northeast Nevada. Because of road conditions, however, the site is more readily accessible from Winnemucca; a majority of the Hollister work force (70.3 percent) resides in Winnemucca, Golconda, or Paradise Valley in Humboldt County. Approximately 20 percent of the workers are scattered throughout Nevada, including almost 9 percent in Elko County; and slightly under 10 percent claim primary residences in other nearby states. Lander and Eureka counties are included because of their proximity to the project site and their integral involvement in the mining economy of the area. As suggested by these factors, the study area and CESA were selected because the most substantial social and economic effects would occur where employees are concentrated, where the major project-related tax revenues would accrue, and where the greatest amount of project-related commercial transactions would take place.

The following social and economic values assessment is focused on issues relevant to the proposed project. Due to the extensive previous analyses in recent years, this report is tiered to studies conducted for the South Operations Area Project Amendment (SOAPA) and Leeville projects (Bureau of Land Management [BLM] 2002b,c), as well as the Betze Pit Expansion Project Final Supplemental Environmental Impact Statement (SEIS) (BLM 2009a). The No Action Alternative may be especially relevant because closing down the activity at the end of the current permit period would result in loss of jobs for current employees. Project-related effects are analyzed in the context of the existing regional community and cumulative development activities addressed in the final Leeville and SOAPA cumulative impact analyses (BLM 2010d,e) and the Betze Pit Expansion Project Draft SEIS (BLM 2008b).

3.20.1.1 Population and Demography

Elko is the 5th largest county in Nevada, by population, with 48,818 people in 2010 (U.S. Census Bureau 2010a). Humboldt County is approximately one-third as large with 16,528 people, ranking 9th among Nevada's 17 counties. The other two counties in the CESA are much smaller, ranking 12th (Lander), and 16th (Eureka) (**Table 3.20-1**). The entire CESA contains 73,108 people, which accounts for approximately 2.7 percent of Nevada's total estimated population (U.S. Census Bureau 2010a). Nevada has been one of the country's fastest growing states for much of the past three decades. It also was one of the hardest hit by the recent recession; the state demographer estimates the state lost population between 2008 and 2010. During the expansion, the bulk of the growth occurred in urbanized areas, particularly southern Nevada. Elko County experienced very rapid growth in the 1980s, which continued into the 1990s, but tapered off in recent years (**Table 3.20-1**). Humboldt County has grown consistently, though not as rapidly as Elko County. It's growth rate also has slowed since 2000. Lander County had a growth spurt in the 1980s, lost population in the 1990s, and is virtually unchanged since the 2000 census, likely in response to the ebb and flow of mining in the Battle Mountain area. Eureka County has trailed the state growth rate by a substantial margin for three decades but was the fastest growing for the four counties since 2000. The most dramatic growth in the CESA has occurred in unincorporated Spring Creek, which is more than six times as large as it was in 1980 (**Table 3.20-1**).



Legend

- Project Area Boundary
- Direct, Indirect, and Cumulative Effects Study Area
- Other Mine Plan Boundaries
- County Boundary
- City
- Census-designated Place

N

0 20 40 Miles

Source: BLM 2010d,e, 2007b.

Hollister Underground Mine Project EIS

Figure 3.20-1

Social and Economic Values and Environmental Justice Direct, Indirect, and Cumulative Effects Study Area

3/8/2012

Table 3.20-1 Population Characteristics

Area	1980	1990	2000	2010	Average Annual Percent Change 1980-1990	Average Annual Percent Change 1990-2000	Average Annual Percent Change 2000-2010
Elko City	8,771	14,736	16,708	18,297	5.3	1.3	0.9
Spring Creek CDP[1]	2,002	5,866	10,548	12,361	11.3	6.0	1.6
Carlin	1,233	2,220	2,161	2,368	6.1	(0.3)	0.9
Elko County	**17,269**	**33,530**	**45,291**	**48,818**	**6.9**	**3.1**	**0.8**
Eureka County	**1,198**	**1,550**	**1,651**	**1,987**	**2.6**	**0.6**	**1.9**
Winnemucca	4,140	6,134	7,175	7,396	4.0	1.6	0.3
Humboldt County	**9,434**	**12,844**	**16,197**	**16,528**	**3.1**	**2.3**	**0.2**
Battle Mountain CDP[1]	2,749	3,542	2,871	3,635	2.6	(2.1)	2.4
Lander County	**4,076**	**6,266**	**5,794**	**5,775**	**4.4**	**(0.8)**	**0.0**
Nevada	**800,493**	**1,201,833**	**1,998,257**	**2,700,551**	**4.1**	**5.2**	**3.1**

[1] CDP – Census Designated Place.

Source: U.S. Census Bureau 2010a, 2000, 1981.

Workers typically choose a residence location based on some combination of job proximity, housing availability, and access to public and private services. Currently, much of the Hollister Project work force resides in the Winnemucca area because it is the most accessible community with a reasonable selection of services and housing. Elko is notably larger than Winnemucca with commensurately more commercial activity and services. Consequently, it could be an attractive alternative to Winnemucca for project workers. Winnemucca, the Elko-Spring Creek-Carlin area and, potentially, Battle Mountain are the communities most likely to experience social or economic effects from the proposed project. They are the primary focus of some topics in the following discussion.

The ethnic and racial makeup of counties in the CESA is fairly consistent. As is typical of rural Nevada, all four counties have lower percentages of Black and Asian people than the state as a whole (**Table 3.20-2**). They also have lower percentages of Hispanics, although Elko, Humboldt, and Lander counties are only modestly lower in this category. All of the counties, except Eureka County, have sizeable Native American populations. The Te-Moak Tribe of Western Shoshone Indians has its headquarters in Elko. Elko County is home to three of the four colonies of the tribe: the Elko Band, South Fork Band, and the Wells Band. A portion of the Duck Valley Indian Reservation also is located in northern Elko County on the Idaho-Nevada border. A third colony of the Te-Moak Tribe, the Battle Mountain Band, is located in Lander County immediately outside Battle Mountain. Humboldt County hosts the Fort McDermitt Indian Reservation of the Fort McDermitt Paiute and Shoshone Tribe. The largest part of the reservation straddles the Nevada-Oregon border; a smaller segment follows the Quinn River approximately 45 miles northwest of Winnemucca.

Table 3.20-2 Race and Ethnicity by County (percent)

	Elko County	Eureka County	Humboldt County	Lander County	State of Nevada
White Not of Hispanic Origin	69.1	83.6	68.9	73.7	54.1
Black Not of Hispanic Origin	0.7	0.1	0.5	0.3	7.7
American Indian, Eskimo or Aleut	4.7	2.1	3.8	3.4	0.9
Asian or Pacific Islander Non-Hispanic	1.0	0.9	0.8	0.3	7.7
Other and Two or More (Mixed) Races	1.7	1.3	1.6	1.1	3.1
Hispanic Origin of Any Race	22.9	12.0	24.4	21.1	26.5

Source: U.S. Census Bureau 2010a.

3.20.1.2 Income

Average mining wages and salaries are the highest for any industry in Nevada, averaging $54,024 in 2009, more than 38 percent higher than the all industries category average of $39,004 (Nevada Department of Employment, Training & Rehabilitation [NDETR] 2010a). The differential holds true for CESA counties, as well, with average natural resources and mining wages ranging from $50,277 in Elko County to $56,830 in Eureka County. All industry category average wages range from $34,754 in Elko County to $45,044 in Lander County. Eureka County's all industry average of $52,772 is heavily skewed because nearly 90 percent of all employment in the county is mining related (NDETR 2010a). The only industry sector that comes close to matching mining industry wages in the CESA counties is the education and health services sector, which includes well paid health care professionals.

Although mining wages and salaries are typically higher than average, per capita personal income (PCPI) in the study area continues to lag behind the state level (**Table 3.20-3**). Data from 2000 indicated a state income average of $30,986. Average PCPI for the CESA counties in 2000 ranged from $23,757 (76.7 percent of the state level) in Eureka County to $26,250 (84.7 percent of the state level) in Lander County (Bureau of Economic Analysis [BEA] 2010). By 2008, the state PCPI had risen to $40,936, an increase of 32 percent. The PCPI for the CESA counties ranged from $33,249 for Humboldt County to $41,812 for Lander County in 2008. Humboldt County had lagged behind the state's PCPI growth rate slightly, ending with 81.2 percent of the state average. The other counties had exceeded the state's PCPI growth rate, standing at 99.4 percent of the state average in Eureka County, 91.1 percent in Elko County, and 102.1 percent in Lander County (BEA 2010). CESA counties ranked between 5th (Lander County) and 13th (Humboldt County) out of 17 counties in the state in terms of county PCPI as a percent of Nevada PCPI.

In contrast to PCPI, estimated median household incomes in three of the four CESA study area counties are at or above statewide household incomes. The median household income for the state for 2008 was estimated at $56,432, compared with $70,125 for Elko County (124.3 percent of the state level), $55,090 for Eureka County (97.6 percent), $58,005 for Humboldt County (102.8 percent) and $61,938 for Lander County (109.8 percent of the state level) (U.S. Census Bureau 2009).

An estimated 7.5 percent of Elko County's population was considered to be living in poverty in 2008 (U.S. Census Bureau 2009). The levels for the other three counties were estimated at 10.0 percent for Eureka County, 10.2 percent for Humboldt County, and 9.9 percent for Lander County (U.S. Census Bureau 2009). These county poverty rates were all lower than the statewide 11.2 percent rate. The rates

for children and youth under 18 living in poverty also were below the 15.0 percent state level (U.S. Census Bureau 2009).

Table 3.20-3 Per Capita Personal Income – Nevada and Study Area Counties

Area Name	2000	2008	% Change	% of Nevada State Total (2000)	% of Nevada State Total (2008)
Nevada State Total	$30,986	$40,936	+32.1	100.0	100.0
Elko County	$25,418	$37,300	+46.7	82.0	91.1
Eureka County	$23,757	$40,674	+71.2	76.7	99.4
Humboldt County	$25,244	$33,249	+31.7	81.5	81.2
Lander County	$26,250	$41,812	+59.3	84.7	102.1

Note: Per capita personal income was computed using Census Bureau mid-year population estimates. Estimates for 2000-2008 reflect county population estimates available as of April 2010.

Source: BEA 2010.

3.20.1.3 Economy and Employment

The four counties in the CESA are major contributors to Nevada's mining economy. As listed in **Table 3.20-4**, the combined natural resources and mining sector employment in the four counties comprise nearly two thirds of the total state employment in that economic sector; a large majority of the sector statewide is devoted to metal mining. All of the CESA counties are substantially more dependent on mining than is the state as a whole. The employment numbers are based on work location not residence, which explains why Eureka County has more employees in the natural resources and mining sector than it has residents. Several major mines on the Carlin Trend are located in Eureka County, but most of those mines' workers live in Elko County. Elko and Humboldt counties are notably more economically diverse than the other two counties with a larger and broader selection of services, particularly in Elko and Winnemucca, the largest communities in the CESA. Both have substantial casino and hospitality industries and offer a variety of other services, which notably broadens their employment bases. Lander County, with Battle Mountain, also is more diverse in its employment than Eureka County, but with a smaller base of employment and, consequently, a less extensive complement of available services.

The combined labor force in the CESA counties is currently estimated at 40,765 individuals, approximately 37,390 of whom are employed. The remaining 3,375 unemployed individuals represent an 8.3 percent unemployment rate (**Table 3.20-5**). This level is notably lower than the 13.0 percent statewide unemployment rate and is somewhat lower than the national rate, estimated at approximately 9.7 percent (NDETR 2010b). Two of the four counties are below the 8.3 percent aggregate unemployment rate (**Table 3.20-5**). The pattern of unemployment rates for the CESA counties has been consistently below the state average for several years. Unemployment rates for all 4 counties have risen dramatically in the last 3 years, as they have all over Nevada. Current rates for all 4 counties are approximately double their 2007 average annual rates. A potentially important consequence of the high unemployment rates is the availability of up to 3,700 workers for any available jobs related to the proposed project.

Table 3.20-4 2008 Non-agricultural Wage and Salary Employment by Sector

	State of Nevada		Elko County		Eureka County		Humboldt County		Lander County	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Goods Producing - Private										
Natural Resources & Mining	14,570	1.2	2,475	11.6	3,958	88.9	1,776	23.4	1,370	48.5
Construction	116,448	9.3	1,253	5.9	*	0.0	352	4.6	*	0.0
Manufacturing	48,083	3.8	221	1.0	*	0.0	312	4.1	*	0.0
Subtotal	**179,101**	**14.3**	**3,949**	**18.5**	**3,958**	**88.9**	**2,440**	**32.1**	**1,370**	**48.5**
Service Providing - Private										
Trade, Transp. & Utilities	230,747	18.4	3,806	17.8	129	2.9	1,409	18.5	531	18.8
Information	15,077	1.2	186	0.9	*	0.0	80	1.1	*	0.0
Financial Activities	61,482	4.9	543	2.5	*	0.0	105	1.4	19	0.7
Prof. & Business Services	152,007	12.1	973	4.6	14	0.3	484	6.4	20	0.7
Educational & Health Services	95,343	7.6	1,299	6.1	*	0.0	304	4.0	29	1.0
Leisure & Hospitality	332,546	26.5	6,192	29.0	45	1.0	1,180	15.5	215	7.6
Other Services	29,143	2.3	617	2.8	8	0.2	160	2.1	21	0.7
Subtotal	**916,345**	**73.0**	**13,616**	**63.7**	**196**	**4.4**	**3,722**	**49.0**	**835**	**29.5**
Unclassified[1]	**1,375**	**0.2**	**15**	**0.1**	**92**	**2.1**	**5**	**0.1**	**90**	**3.3**
Subtotal - Private	**1,096,821**	**87.5**	**17,580**	**82.3**	**4,246**	**95.4**	**6,167**	**81.2**	**2,295**	**81.3**
Service Providing - Public										
Government	156,122	12.5	3,787	17.7	204	4.6	1,430	18.8	527	18.7
Subtotal - Public	**156,122**	**12.5**	**3,787**	**17.7**	**204**	**4.6**	**1,430**	**18.8**	**527**	**18.7**
Total**	**1,252,943**	**100.0**	**21,367**	**100.0**	**4,450**	**100.0**	**7,597**	**100.0**	**2,822**	**100.0**

[1] County unclassified numbers include aggregated data not released by industry for reasons of confidentiality.

Note: 2008 Annual Averages were used to calculate employment; minor inconsistencies in percentages result from rounding.

* = Confidential data, not released.

** = Totals have been rounded to the nearest percentage.

Source: NDETR 2009.

Table 3.20-5 2010 Labor Force, Employment and Unemployment

	Labor Force	Employment	Unemployment	Unemployment Rate (percent)
Elko County	27,402	25,185	2,217	8.1
Eureka County	873	796	77	8.8
Humboldt County	8,372	7,608	764	9.1
Lander County	4,118	3,801	317	7.7
Total	**40,765**	**37,390**	**3,375**	**8.3**
Nevada	1,373,447	1,194,959	178,488	13.0

Source: NDETR 2010b.

3.20.1.4 Housing

The 2010 census found 30,340 housing units in the 4-county study area; 19,566 units, or nearly 65 percent, were in Elko County, 1,076 units were in Eureka County, 7,123 units were in Humboldt County, and 2,575 units were in Lander County (**Table 3.20-6**). At the time of the census, 26,780 of the housing units were occupied, leaving 3,565 (11.7 percent) vacant. The overall vacancy rate can be misleading, however, as some portion of the vacant units were for seasonal, recreational or occasional use and not readily available for people seeking housing. In Elko County, for example, 17,442 units, were occupied in 2010 and 2,124 (10.9 percent) were vacant. Some of the vacant units were seasonal, recreational, or for occasional use only. Vacancy rates were at an extremely low 1.3 percent in homeowner units, but a notably higher 10.2 percent in rental units (U.S. Census Bureau 2010a). Vacancy rates varied geographically as well as by type. The Spring Creek area had a 95.7 percent occupancy rate, while Elko was at 93.4 percent and Carlin was at 84.6 percent. The vacancy rates for just homeowner units ranged from 1.0 percent in Humboldt County to 3.3 percent in Eureka County; the overall rate was just 1.4 percent for the 4 counties. Vacancy rates for rental units ranged from 7.4 percent in Humboldt County to 13.8 percent in Lander County, with a 4-county rate of 9.9 percent.

Short-term housing opportunities in the study area are amply available in the major communities. Elko is home to 31 motels, hotels, and casinos hosting over 2,000 rooms. There are several mobile home parks and 6 recreational vehicle (RV) parks in the city with approximately 500 spaces. There are several campgrounds in the surrounding area, several of which are on BLM-administered lands. Winnemucca has approximately 21 motels and hotels with in excess of 1,150 rooms, and 4 RV parks with 350 spaces. Battle Mountain has 5 hotels and motels; Carlin has a Comfort Inn with approximately 60 rooms plus limited opportunities for weekly rentals.

3.20.1.5 Community Facilities and Services

Public Utilities

Water

The City of Elko obtains municipal water from 18 deep-water wells, with 25 million gallons of storage capacity. The system has a maximum production capacity of 14.5 million gallons per day (mgd) with current usage ranging from 3 mgd to a peak of 13 mgd. Spring Creek residents are served by nine public wells. Carlin obtains water from one deep-water well and several natural springs. Water is stored in a 2-million-gallon tank. Peak production capacity is 1.4 mgd, averaging approximately 1 mgd.

Table 3.20-6 2010 Housing Vacancy Rates

Geographic Area	Housing Units				Vacancy Rate by Type (%)	
	Total	Occupied	Vacant	Vacancy Rate (%)	Homeowner Units	Rental Units
City of Elko	7,221	6,743	478	6.6	0.9	6.9
Spring Creek CDP[1]	4,394	4,204	190	4.3	1.2	4.6
City of Carlin	1,043	882	161	15.4	1.0	21.3
Elko County	**19,566**	**17,442**	**2,124**	**10.9**	**1.3**	**10.2**
Eureka County	**1,076**	**836**	**240**	**22.3**	**3.3**	**11.9**
Winnemucca	3,214	2,926	288	9.0	1.4	8.7
Humboldt County	**7,123**	**6,289**	**834**	**11.7**	**1.0**	**7.4**
Battle Mountain CDP[1]	1,518	1,364	154	10.1	2.6	15.0
Lander County	**2,575**	**2,213**	**362**	**14.1**	**2.6**	**13.8**

[1] CDP = Census Designated Place.

Source: U.S. Census Bureau 2010a.

Winnemucca's municipal water comes from 7 wells, 5 of which are used regularly. Current use is approximately 2.7 mgd, which is estimated to be less than half of the system capacity and the city has additional water rights that are not yet being tapped (West 2010). Battle Mountain has a system of 4 wells providing production at approximately 2 mgd in summer months and an annual average of 1 mgd. Battle Mountain's current water is above national standards for arsenic, but the town is working on a plan to drill a new well south of town in a deeper aquifer that meets the arsenic standard. The new well and piping was to have been completed by January 2011.

Wastewater

Elko and Carlin both have wastewater treatment facilities. Elko's is a "fixed film" biological treatment plant averaging 3.5 mgd. Approximately 60 percent of treated water is reused for irrigation. Carlin employs two lagoons with rapid infiltration basins. Wastewater treatment in Spring Creek utilizes private septic systems. Winnemucca utilizes a primary treatment lagoon system for wastewater with a capacity of 1.5 mgd and current usage of approximately 1.0 mgd. Upgrading to a mechanical system may be necessary in the future. Battle Mountain built a new "state of the art' wastewater treatment facility in 2002. The system has capacity for 0.8 mgd with current use at approximately 0.4 mgd. The system was engineered for expansion to 1.2 mgd should it be needed in the future.

Solid Waste

The City of Elko operates a regional solid waste landfill. At current use rates, it has capacity in excess of 200 years. Battle Mountain operates a Class 1 industrial/municipal solid waste facility with capacity for modest growth. Winnemucca disposes of solid waste at the Humboldt County Regional Landfill.

Public Safety

Law Enforcement

Law enforcement for unincorporated areas in Elko County is provided by the County Sheriff. Elko and Carlin police departments are responsible for incorporated area jurisdictions. The Bureau of Indian Affairs Police are responsible for the 193-acre Elko Band Colony. The Eureka County Sheriff provides law enforcement for rural Eureka County. Lander County Sheriff's personnel cover all of Lander County, including Battle Mountain. The City of Winnemucca has its own police department, but law enforcement in rural Humboldt County is provided by the County Sheriff. The Nevada Highway Patrol provides law enforcement on the state highway system.

Fire Protection

Fire protection services are provided by numerous agencies throughout the study area. The Elko City Fire Department is the largest of the agencies with 3 staff positions and 15 career firefighters augmented by 34 volunteer positions. The department has 10 major pieces of equipment, including 7 regular engines, 2 smaller specialty trucks, and a specialized airport engine. The department also houses four pieces of Nevada Department of Forestry firefighting equipment. Carlin Volunteer Fire Department serves the city and surrounding area with fire protection and ambulance services with a volunteer membership of 33. Battle Mountain's Volunteer Fire Department serves the community and an extended surrounding area with approximately 25 volunteer members and 6 fire engines. Winnemucca, and an area several miles to the west, are served by the Winnemucca Volunteer Fire Department with approximately 25 volunteer staff. Nearby areas also are served by the Paradise Valley, Paradise Ranchos, Golconda and Grass Valley Volunteer Fire Departments.

In addition to the local fire departments, the BLM, U.S. Forest Service, and the Northeastern Fire Protection Department of the Nevada Division of Forestry provide fire protection, primarily in outlying areas where they are primarily responsible for fighting wildland fires. Local, state and federal agencies are all involved in mutual aid/cooperative agreements, supporting each other as appropriate and as needed, depending on the circumstances of each fire.

Health Care

The Northeast Nevada Regional Hospital in Elko is the principal health care facility for all of northeastern Nevada. It provides 24–hour emergency care and has 75 acute care rooms. The hospital has a full service laboratory, an intensive care unit, both magnetic resonance imaging and computerized aerial tomography scan capabilities, and provides most major medical specialty services. The hospital also provides services to the Elko Band Colony Health Center under an Indian Health Service contract.

The Carlin Community Health Center is one of a series of federally supported clinics providing health care to medically underserved areas operated by Nevada Health Centers, a private, non-profit organization. The Carlin clinic is staffed by physicians, physician assistants and nurse practitioners. The center provides service in family medicine, preventative health, women's health, children's health and immunizations, health education, prenatal and newborn care, and pharmacy services.

Battle Mountain General Hospital provides a variety of medical services to the Battle Mountain/northern Lander County area. The hospital has 23 beds, 7 for acute care and 16 for long-term nursing care. It has an emergency/trauma suite, laboratory, x-ray, respiratory therapy, and physical therapy facilities. The hospital also houses a clinic staffed by three physicians and an advanced nurse practitioner. The hospital provides 24-hour service with a staff of over 60 physicians, medical technologists, nurses, therapists and support personnel.

Medical services in the Winnemucca area are provided by the Humboldt General Hospital and several affiliated physicians. The 52-bed hospital has a 6-bed emergency department and provides an extensive range of services, including acute care, obstetrics, general surgery, a full suite of radiology services, a 24-hour laboratory, and respiratory therapy. Harmony Manor, a 30-bed skilled nursing facility is affiliated with the hospital as well. Humboldt General Hospital's well-trained and exceptionally well equipped Emergency Medical Services Rescue department provides a broad range of ambulance, emergency response, search and rescue, and hazardous materials services to a 10,000-square-mile area around the community.

Facilities in Winnemucca and Battle Mountain are certified as "Critical Access Hospitals," which qualifies them for more flexible cost reimbursement under Medicare, which is intended to improve their financial capacity.

Education

Elementary and secondary schools in the study area are operated by the 4 county school districts. Elko County School District, with administrative offices in Elko, is by far the largest of the 4 with nearly 9,500 students in the 2009-2010 school year (**Table 3.20-7**).

Eleven of the district's 22 schools are located in the Elko-Spring Creek-Carlin area. Elko has four elementary schools, one junior high, and one high school. Spring Creek has two elementary schools, a middle school, and a high school. Carlin has a combined school for elementary through high school. The districts have an overall ratio of 16.2 students per teacher.

Students from the Elko Band Colony attend Elko District schools. There also is a Head Start Program at the Colony for children from 3 to 5 years old. Eureka County School District is the smallest of the five districts with fewer than 300 students. The district has one elementary school in Crescent Valley and an elementary school and a high school in Eureka. Humboldt County School District has three elementary schools, one middle school, one junior high school, and one high school in Winnemucca. In addition, there are four K-8 schools and one K-12 school in outlying rural areas of the county. Lander County has two elementary schools, a junior high and a high school in Battle Mountain and a single combined school in Austin.

Table 3.20-7 Public Schools Enrollment History

School District/ Year	Enrollment by Grade Level[1]						Gain/Loss Over Prior Year (%)
	Pre-Kindergarten[2]	Kindergarten	Elementary (1-6)	Secondary (7-12)	Ungraded[3]	Total	
Elko County School District							
2005-2006	57	747	4,512	4,495	19	9,830	0.9
2006-2007	59	741	4,545	4,546	16	9,907	0.8
2007-2008	61	690	4,538	4,509	13	9,811	-1.0
2008-2009	65	676	4,441	4,470	17	9,669	-1.4
2009-2010	78	754	4,225	4,407	10	9,474	-2.0
						5-Year Net Change	-3.6
Eureka County School District							
2005-2006	0	10	107	107	0	224	-5.1
2006-2007	0	16	107	112	0	235	4.9
2007-2008	0	16	98	122	0	236	0.4
2008-2009	0	14	100	125	3	242	2.5
2009-2010	13	16	106	125	0	260	7.4
						5-Year Net Change	16.1
Humboldt County School District							
2005-2006	59	243	1,552	1,604	0	3,458	-0.1
2006-2007	41	259	1,540	1,559	0	3,399	-1.7
2007-2008	52	253	1,567	1,522	0	3,394	-0.1
2008-2009	40	250	1,537	1,509	0	3,336	-1.7
2009-2010	49	273	1,567	1,517	0	3,406	2.1
						5-Year Net Change	-1.5
Lander County School District							
2005-2006	9	125	504	650	0	1,288	5.1
2006-2007	10	111	491	646	0	1,258	-2.3
2007-2008	9	119	492	653	0	1,273	1.2
2008-2009	18	98	472	605	0	1,193	-6.3
2009-2010	10	113	429	587	1	1,140	-4.4
						5-Year Net Change	-11.5

[1] Enrollments at the end of the first school month.

[2] Pre-kindergarten refers to 3- and 4-year olds receiving special education (Nevada Administrative Code [NAC] 388.490).

[3] Ungraded refers to a student enrolled in a non-graded class in a school for special education or a student who cannot be assigned to a particular grade because of the nature of his or her condition (NAC 387.111).

Source: Nevada Department of Education 2010a,b, 2009.

As **Table 3.20-7** illustrates, three of the four county school districts have experienced declining enrollments over the past 5 years, ranging from relatively small losses in Elko and Humboldt counties to a substantial percentage loss in Lander County, presumably due to population declines related to losses of jobs. Only Eureka County, operating from a very small base, had more students in the 2009-2010 school year than it did 5 years earlier, possibly due to employment growth at the Cortez Hills-Pipeline mine complex in southern Crescent Valley.

The primary provider of higher education opportunities to residents in the study area is Great Basin College (GBC). The college, a pioneer in distance learning techniques, serves nearly 4,000 students in 6 of Nevada's largest rural counties (GBC 2008). Its main campus, and only residential facility, is located in Elko. GBC also has a branch center with extensive course offerings in Winnemucca and a satellite site with limited offerings in Battle Mountain.

3.20.1.6 Public Finance

Seven general governmental entities comprise the study area; they are Elko, Eureka, Humboldt, and Lander counties, and the cities of Elko, Carlin, and Winnemucca. Elko, Humboldt, and Lander counties have professional managers (respectively designated the county manager, county administrator, and executive director) and five-member Boards of Commissioners, who oversee the operations of the county including administration, law enforcement, courts and public works. Eureka County operates with a three-member Board of Commissioners who function as both policy makers and administrators. The three incorporated cities all employ council-manager governmental structures with professional city managers and policy making city councils each consisting of a directly elected Mayor and council members.

Local government finance in Nevada is a complex admixture of locally derived and state shared revenues. Local revenues are primarily ad valorem property taxes on real and personal property and the net proceeds of mines in the jurisdiction. State shared revenues include sales, motor vehicle, fuel, and gaming taxes. State revenue sharing addresses major economic disparities between the relatively wealthy urban centers of Reno and Las Vegas and the often less affluent rural agricultural and mining communities.

All 4 counties and the cities of Elko and Winnemucca approved deficit budgets for fiscal year (FY) 2009 to 2010, with plans to access reserves to cover the current revenue shortfalls, if necessary (**Tables 3.20-8** and **3.20-9**). In all cases, the available, unreserved fund balances would be sufficient to cover the budgeted shortfalls, although, in some cases, the reserve funds would be substantially reduced if the budgeted shortfalls should actually occur. Elko County, as an example, chooses to budget conservatively by underestimating revenue for the forthcoming year and appropriating "every dime" for expenditures (Armuth 2008). The county's experience with this approach has been that, at the end of a FY, actual revenue has exceeded their projections and expenditures for most funds rarely reach the appropriated levels (Armuth 2008). The result has been that the county's ending fund balance has consistently held firm or grown in recent years (Armuth 2008). Based on the budgets shown in **Table 3.20-8**, with minor adjustments for "other financing sources/uses" in some cases, Elko County's reserve fund balance would shrink from $53.1 million to $6.66 million; Eureka County's reserve fund balance would decline from $38.1 million to $22.0 million; Humboldt County's reserve fund balance would drop from $20.9 million to $13.9 million; and Lander County's reserve fund balance would decline from $26.6 million to $19.2 million. For the cities (**Table 3.20-9**), Elko's reserve fund balance would shrink from $5.7 million to $2.5 million and Winnemucca's reserve fund would drop slightly from $11.1 million to $10.7 million. Carlin budgeted for a surplus of $83,253, which would raise its reserve fund balance to $2.7 million.

Table 3.20-8 County Budgets for FY 2009-2010

	Governmental Fund Types and Expendable Trust Funds ($)			
	Elko County	**Eureka County**	**Humboldt County**	**Lander County**
Revenues				
Property Taxes	10,022,823	4,919,814	4,589,605	6,264,687
Other Taxes	14,000	120,670	0	950
Licenses and Permits	892,000	8,250	843,000	258,500
Intergovernmental Resources	19,043,586	6,542,892	13,449,712	5,520,907
Charges for Services	2,607,500	1,364,100	757,600	673,022
Fines and Forfeits	1,218,000	113,400	763,000	252,225
Miscellaneous	3,965,000	894,250	548,500	717,178
Total Revenues	**37,762,909**	**13,963,376**	**20,951,417**	**13,687,469**
Expenditures				
General Government	13,536,327	10,408,551	5,717,020	10,004,630
Judicial	10,216,382	1,273,150	3,548,284	4,246,127
Public Safety	10,275,455	3,035,100	7,954,743	1,769,525
Public Works[1]	7,839,305	4,402,600	4,769,990	2,178,520
Sanitation[2]	--	332,000	--	--
Health[2]	344,360	1,105,824	272,666	447,810
Welfare	2,519,455	--	904,564	1,022,935
Culture and Recreation	1,725,794	1,178,659	1,782,247	878,040
Community Support	10,664,391	812,807	1,767,766	132,215
Intergovernmental Expenditures	4,002,249	7,195,000	884,324	24,118
Capital Projects	--	--	--	--
Contingencies	450,000	300,000	325,000	75,000
Utility Enterprises	--	--	--	--
Hospitals	20,307,018	--	--	--
Transit Systems	--	--	--	--
Airports	--	--	--	--
Other Enterprises	--	--	--	--
Debt Service - Principal	1,849,219	--	76,975	290,000
Interest Cost	932,597	--	--	89,900
Total Expenditures	**84,662,552**	**30,043,691**	**28,003,579**	**21,158,820**
Excess Revenues Over (Under) Expenditures	**(46,899,643)**	**(16,080,315)**	**(7,052,162)**	**(7,471,351)**

[1] Lander County's Highways and Streets expenditure was combined with the Public Works expenditure.

[2] Lander County combined Sanitation and Health into a single line item.

Source: Nevada Department of Taxation 2010.

Table 3.20-9 City Budgets for FY 2009-2010

	Governmental Fund Types and Expendable Trust Funds ($)		
	Elko	**Carlin**	**Winnemucca**
Revenues			
Property Taxes	3,435,522	291,859	1,439,296
Other Taxes	2,556,447	61,000	280,000
Licenses and Permits	1,478,905	60,700	457,000
Intergovernmental Resources	10,711,849	1,476,890	3,014,000
Charges for Services	756,404	91,699	383,610
Fines and Forfeits	289,000	19,050	--
Miscellaneous	172,130	111,152	891,176
Total Revenues	**19,400,257**	**2,112,350**	**6,465,082**
Expenditures			
General Government	2,491,008	631,989	1,094,215
Judicial	407,000	65,550	93,475
Public Safety	9,006,378	555,142	3,019,182
Public Works	5,598,024	220,831	1,640,503
Sanitation	--	--	--
Health[1]	578,440	94,785	--
Welfare[1]	--	--	--
Culture and Recreation	3,354,042	295,535	766,726
Community Support	36,000	52,850	--
Intergovernmental Expenditures	--	--	--
Capital Projects	--	--	59,500
Contingencies	254,444	50,000	132,497
Utility Enterprises	--	--	--
Hospitals	--	--	--
Transit Systems	--	--	--
Airports	--	--	--
Other Enterprises	--	--	--
Debt Service - Principal	336,500	43,957	173,700
Interest Cost	78,169	18,458	55,100
Total Expenditures	**22,140,005**	**2,029,097**	**7,034,898**
Excess Revenues Over (Under) Expenditures	**(2,739,748)**	**83,253**	**(569,816)**

[1] The City of Elko combines Health and Welfare expenditures into one combined expenditure; Carlin and Winnemucca do not indentify Welfare budgets.

Source: Nevada Department of Taxation 2010.

Nevada county governments obtain revenues from both local and state shared sources. Local sources include ad valorem property taxes on real and personal property and on the net proceeds of mines in the county. They also collect revenues from fines, licenses and permits, and fees for services. State shared revenues include sales, motor vehicle, fuel, and gaming revenues. All four counties in the study area list intergovernmental transfers, primarily from state revenue sharing, as their largest revenue source, followed by their own taxes. Ad valorem property taxes are the second largest revenue source for each county. Expenditure emphases vary notably among jurisdictions, as illustrated in **Tables 3.20-8** and **3.20-9**.

Tax revenues have been a particular concern in rural counties throughout Nevada as the mining industry contracted in past years. Assessed valuations for all property except net proceeds of mines have been up each of the last 2 years in 3 of the 4 study area counties; only Humboldt County's slipped slightly from FY 2008-2009 to FY 2009-2010. Taxable net proceeds of mines have been more erratic. They are projected to be modestly lower for FY 2009-2010 from 2 years prior in Lander County, but up dramatically in the other 3 counties over the same period. Net proceeds of mines make up a large portion of total assessed valuation for Eureka County (40.6 percent) and Lander County (17.2 percent). They are a lesser, but still substantial, portion of assessed valuation for Humboldt County (10.1 percent) and Elko County (8.8 percent). Net proceeds of mines constitute only a tiny fraction of the total assessed valuation in the City of Elko and none of Carlin's or Winnemucca's assessed valuations. Rodeo Creek Gold Inc (RCG) paid $127,295 in property taxes to Elko County in 2009 for the Hollister Underground Mine property, plus $552,196 in net proceeds of mines taxes. These payments represented approximately 7 percent of Elko County's total property tax revenue and slightly under 2 percent of the county' s projected total revenues, which illustrates the potential importance of the mine to the county's budget.

Ad valorem tax rates vary substantially among the study area counties. Elko County's rate was budgeted at $0.8386 per $100 of assessed value for FY 2009–2010. Eureka County's rate was a similar $0.8458 per $100 of assessed value. Humboldt County's rate was $0.7512 per $100. Lander County had a notably higher rate at $1.9243 per $100 of assessed value.

Sales tax rates in Nevada counties held constant at 6.5 percent in most rural counties for several years, but they increased after the Legislature raised the local school support tax from 2.25 percent to 2.60 percent in 2009. Lander County now collects 7.1 percent and the other 3 study area counties collect 6.85 percent on sales. RCG purchases material and services in both Elko County and Humboldt County, generating sales and use tax payments to both. Sales and use tax payments totaled $855,728 in 2009, with an estimated 72 percent attributed to Elko County, and 1 percent to Humboldt County. The counties do not realize all the benefit of the tax; however, because 2 percent (29 percent of the revenue collected) goes to the state general fund and, now, 2.60 percent (38 percent of the revenue) goes to school districts. The county where the tax is generated receives 0.5 percent (7 percent of the revenue), and the remaining 1.75 percent (26 percent of the revenue) is distributed to all counties under a statutory formula (Nevada Department of Taxation 2010).

3.20.1.7 Social Conditions

Counties within the study area grew very rapidly in the 1980s due to a boom in mining and related support activities, but stabilized in subsequent years when they experienced years of modest population growth and decline. Growth has resumed in recent years in most counties, but at more moderate rates. The passage of time and the community's ability to weather not only the booms, but also subsequent downturns, have allowed for development of the relatively stable social setting that now exists. Many residents have lived in the area for a number of years, social ties have become established, and residents take pride in their communities. Many of the people place a high priority on maintaining informal lifestyles and small town traditions.

"Social stratification in the area is often defined by income, length of residence, educational attainment, and ethnicity. Local residents earning high incomes are considered to be the most influential in the community. The most powerful groups viewed by residents as making decisions about the area's future include federal and state government, county commissioners, environmental organizations, and large corporations" (BLM 2002b).

Gold prices continue to be a key factor driving the growth or decline of the communities. When prices dropped in the late 1990s, workers were laid off, some mines announced early closures, and expansion plans were delayed. As prices have risen recently, the reverse is true. Several mines are working towards implementing growth plans to take advantage of the opportunity. Although rural Nevada's larger communities, like Elko and Winnemucca, are more diversified than they were two decades ago, the mining industry is still an important sector, affecting both the economy and the psychology of area communities.

3.20.2 Environmental Consequences

The primary issues related to social and economic values include:

- Potential effects associated with the continued employment of current RCG workers at the proposed project site;
- Potential public finance effects of extending and increasing production of gold and other minerals from the mine;
- Potential economic impacts of 20 years of additional employment for a portion of the mining work force in the area; and
- Potential effects of the No Action Alternative as work forces from existing mines may be unable to find local employment after closure of approved projects.

3.20.2.1 Proposed Action

Population and Demography

Implementation of the proposed project would have a minor long-term effect on the population or demographics of study area counties as most of the permanent work force is already in place at the existing Hollister Site. RCG has estimated that an additional 15 full-time employees would be needed to fully implement the Proposed Action. There also would be an increase of approximately 45 temporary contract workers for 12 to 18 months for construction of the proposed Mine Office Complex, HPS structures, and other facilities. It is expected that these construction projects would be built by workers contracted locally. As noted, they would be relatively short-lived so any non-local workers involved would be unlikely to move their families to the area. With a minor change in the permanent work force, minor increases would be expected in the permanent population of the study area.

Income, Economy, and Employment

The current Hollister Mine work force of approximately 160 would continue to be employed for an additional 20 years beyond the currently permitted exploration and sampling operations. The proposed project is expected to need approximately 15 additional permanent and 45 temporary contract workers beyond the current staff. The effects of closure would occur at some point in time, currently estimated to be 20 years later than under the No Action Alternative. The base of economic activity provided by wages and local purchases by the Hollister operations would continue with only minor adjustments as the project's major components were developed and brought on line. The local economy would benefit from continuation and a slight increase in current activity for an additional 20 years. In addition, local communities in the study area would have additional time in which to continue their efforts to diversify their economies, which are currently heavily dependent on mining. As noted in **Table 3.20-4** all of the

counties are well above the state average for dependence on mining, topped by Eureka County's 88.9 percent. Economic development efforts are long-term endeavors that take time to produce results. Continuation of operations at the Hollister Mine for an additional 20 years would be beneficial to such efforts in the study area.

Housing

With the minor increase in permanent employment and population, a very slight increase in the demand for permanent housing would be anticipated. Although the housing market in Winnemucca is tight, there should be sufficient units available to accommodate the small increase in demand. Temporary non-local contract workers, if any, would need temporary housing. With over 1,100 hotel, motel, and casino rooms in Winnemucca, over 2,000 similar rooms in Elko, and numerous RV spaces with full hookups, there should be no problem housing a relatively small number of temporary workers if necessary without adversely stressing the housing market. A minor, project-related increase in the demand for temporary housing would be a beneficial local economic effect.

Community Facilities and Services

The proposed project would have minimal long-term effect on service demands because most of the permanent work force is already resident in the local communities. Depending on how many, if any, non-local contract workers are needed for the mine construction projects, there could be a very minor increase in the need for law enforcement efforts for low level criminal behavior. Any increase would be expected to be readily accommodated by the existing capabilities of the County Sheriffs and community police forces, particularly in Humboldt County and Winnemucca.

The very minor increase in demand for other public facilities and services, such as the hospital and the water and sewer systems, should be well within the existing capacities of the systems to accommodate them. It is unlikely that measurable numbers of additional school age children would join the community as a result of contract construction activity.

Public Finance

Developing the proposed project would extend the life of the mine for 20 years. As such, it would continue and expand the provision of revenues to local governments, school districts, and certain other taxing jurisdictions, and to the State of Nevada for the duration of the additional mine life. In 2009, RCG generated $552,196 in net proceeds taxes, $855,728 in sales and use taxes, and $127,295 from ad valorem property taxes. These levels of tax payments are likely to increase for the additional 20 years of mine life, particularly from net proceeds taxes as production increases from the current levels produced by the bulk sampling efforts. Net proceeds may vary considerably, however, depending on gold prices and production costs.

Social Conditions

With a minor increase in permanent employment or population expected from the proposed project, it is not expected to cause adverse changes in the social structure or traditional lifestyles of study area communities. A possible influx of a small number of contract workers would not noticeably affect the quality of life of people currently living in the area. Transitioning of the Hollister operations from exploration and sampling to production mining activity and retaining the jobs of current employees for an additional 20 years would be expected to sustain their individual lifestyles, but would have little or no effect on the social structure of the community as a whole. Extending the life of the Hollister operations, however, could be beneficial to the long-term sustainability of the community as it would provide additional time for local economic diversification efforts to be realized.

3.20.2.2 Mud Springs Road Transmission Line Alternative

Social and economic effects of both options of this alternative would be essentially the same as described for the Proposed Action. This alternative would be the same as described for the Proposed Action except 9.5 (North Option) and 15.2 (South Option) fewer acres of disturbance. As a result, it would likely be completed in less time and would require employment of the contract line construction crews for approximately 20 percent less time than the Proposed Action. No other differences from the Proposed Action have been identified.

3.20.2.3 Mud Springs Waste Rock Storage Facility Alternative

The social and economic effects of the Mud Springs Waste Rock Storage Facility (WRSF) Alternative would be the same as the Proposed Action with the following exception. Development of the Mud Springs WRSF Alternative would result in temporary employment of a small crew of heavy equipment operators contracted to haul waste rock temporarily stored in the existing WRSF in the East Pit and place waste rock at the alternative site 4 to 6 times per year. The number of workers needed is uncertain, but it is assumed that no more than 6 would be required. For purposes of analysis, the duration of employment was assumed to be up to 2 weeks each time the activity would occur. Based on these assumptions, this alternative would result in from 12 to 18 man-months of additional employment per year for the life of the project. Considering the nature and timing of the activity, it is likely that the workers would be local residents.

Based on the scenario described above, it is expected that the Mud Springs WRSF Alternative would have no effect on population in the study area. It would add a small positive increment to the local economy through increased employment and income, most of which would remain in the study area. Potential effects on housing, community facilities and services and social conditions would be minimal to slightly positive. There would be a small positive contribution to local and state public fiscal conditions through increased taxes from workers and from purchases of fuel and other materials and services associated with the waste rock hauling.

3.20.2.4 Backfill Alternative

Under this alternative, a small increment – less than 2 percent – of the waste rock from the proposed West Pit WRSF or the existing WRSF would be transported to the HPS and the East and West raises to backfill the shafts as part of the reclamation and closure process. No additional employees would be required for this activity and no additional equipment would be purchased. There may be additional fuel required, although the amount is uncertain, it would be expected to be a very small increase over the Proposed Action. Social and economic effects of this alternative would be essentially the same as for the Proposed Action.

3.20.2.5 No Action Alternative

Under the No Action Alternative, the BLM would not approve the proposed project. RCG would continue to conduct surface and underground exploration and bulk sampling under the current exploration permits and approvals as authorized by the BLM and the State of Nevada. Reclamation and closure of the existing facilities would proceed under the current schedule.

Population and Demography

The specific effect on study area population is uncertain. With an average family size of 2.77 people in Humboldt County, where 70.3 percent of RCG's Hollister workers live, approximately 312 county residents (2.2 percent of the county population) are currently directly supported by the mine. An additional increment of the population, perhaps as many as 265 people based on the multiplier effect addressed below, is indirectly supported by the site as well. A potentially affected total of 577 people in Humboldt County would be approximately 3.3 percent of the county population. Percentage effects on

other study area counties would be smaller, ranging from zero in Eureka County, where no project workers claim residence, to 0.2 percent for Elko County, and 0.6 percent for Lander County.

It is assumed that layoffs would begin at the end of the current authorization, if not before, and that nearly all employees would be gone at the time of final closure, although the actual pace of layoffs is unknown. The unemployment rates in study area counties are currently near the highest they have been in recent years, though still lower than the statewide average rate. Depending on whether unemployment rates remain at current levels and on the status of other mining projects in the area, it is possible that many laid off RCG workers would remain in the community to search for new jobs, at least initially, which would result in a lessening of population losses in the study area. However, the availability of alternative employment in the area in the future is difficult to predict. Ultimately, it is expected that a substantial number of current workers and their families may have to leave the area to find employment.

It is assumed that the workers at the Hollister Site approximately reflect the ethnic and racial pattern of the study area. As such, it is unlikely that any population change related to early termination of exploration and sampling activities at the site would alter the demography of the study area.

Income, Economy, and Employment

Closure of the Hollister Site after existing permits expire would result in reduction of the work force. There are currently approximately 160 workers employed at the site, representing approximately 6.5 percent of the "natural resources and mining" workers and 0.8 percent of all workers in Elko County (**Table 3.20-4**). It is not known how many, if any, of these jobs would be lost prior to closure or how rapidly layoffs would occur after closure, although it is reasonable to assume that nearly all would be terminated before final reclamation and closure of the project. If large numbers of workers were terminated simultaneously, the unemployment rate for Elko County would increase from the estimated current 8.1 percent rate to 8.7 percent (see **Table 3.20-5**).

Any loss of jobs also would reduce the dollars flowing into the local and state economy. The Hollister operations provided approximately $18.4 million in wages and salaries in 2009, including benefits. The facility also purchased supplies, services and commodities worth an estimated $12.5 million in the state. Under the No Action Alternative, the combined $30.9 million per year of annual labor and materials currently flowing into the Nevada economy would decline when current authorizations expire.

In addition to the direct employment and income provided by the Hollister operations, the economic activity spawns indirect and induced employment and income in the local economy. Employees of the mine spend their income in the local area for goods and services, which provides opportunities for other businesses selling cars, groceries, and fuel to hire workers and for service providers such as the school district to hire teachers. It has been estimated that each direct employee in the hard rock mining industry generates demand for an additional 0.85 indirect and induced employees in the Elko/Eureka counties economy (Price and Harris 2007), which is probably comparable to other counties with relevant mining sectors. Also, each dollar of direct labor income ("labor income" includes the sum of employee compensation and proprietor income) from the hard rock mining sector generates an additional $0.38 of indirect and induced labor income (Price and Harris 2007). Assuming these multipliers are applicable, the loss of 160 jobs from the Hollister operations would result in the loss of an additional 136 jobs in the rest of the study area counties' economies. In addition, it would result in a loss of approximately $18.4 million in direct labor income plus approximately $7.0 million in indirect and induced labor income.

The timing of the job losses is not precisely known. The actual effects on the study area economy would depend on both the timing of layoffs and the type and availability of other employment that may be available in the area when the layoffs occur. Some laid off workers would be expected to find

replacement employment in the area, although it is uncertain whether they would find jobs at wage levels comparable to what they currently have.

Housing

Effects on the local housing market from the No Action Alternative would depend on the capacity of the local economy to absorb workers into new jobs. If a majority of the workers find new jobs in or near their current residence counties in a reasonable period of time, it is expected that housing market effects would be minor. There could be a short term, minor downward influence on demand and prices. Under current conditions, with low vacancy rates in the homeowner segment of the market. This would be a minor source of irritation in the market. If the housing market were in more of a downturn, at the time, comparable to other parts of Nevada, the adverse effect would be more detrimental. Rental vacancy rates are currently much higher than homeowner rates so that sector of the market could be further impacted (see **Table 3.20-6**).

The size of the Hollister work force is modest, but not insignificant. If, ultimately, many laid off workers could not find new local employment or had to settle for new jobs at lower wage rates, the effects on the housing market would be worse. Some families might leave the area. Others might have difficulty maintaining mortgages obtained with higher incomes. The adverse effects could be moderate to substantial.

Community Facilities and Services

The No Action Alternative would not be expected to adversely affect most public facilities and services in the study area in the short term. Over time, as all of the project employment was eliminated, some community facilities may be underutilized. Assuming some portion of the population would depart the area, service demands would decline and the need for services would be reduced (possibly resulting in loss of service jobs, which are part of the induced employment noted above). Some families might have difficulties making payments for services until and unless they were able to find new employment in the area. Growth pressure on public services and facilities would be reduced, at least for a period of time. The greatest effect could be on the school districts if some families were forced to leave the area to find new employment. As noted in **Table 3.20-7**, three of the four study area county school districts have already been losing students over the last 5 years. A loss of school-aged children would result in additional enrollment declines and, perhaps, underutilization of school facilities.

Public Finance

In addition to wages, salaries, and purchases, the Hollister operations annually pays taxes and fees to local and state agencies. RCG paid $1.1 million in local and state taxes in 2008 and $1.5 million in 2009, including $0.6 million in net proceeds taxes and $0.9 million in sales and use taxes and $0.1 million in ad valorem property taxes (RCG 2010b). These tax payments would likely continue at similar levels through the end of the current project, and would then decline when current authorizations expire.

Social Conditions

The No Action Alternative, which would result in job losses for approximately 160 mine workers and, potentially, nearly 136 others from secondary jobs, would be expected to increase stress on the individuals and families involved. Their quality of life would be adversely affected for at least the period of time they were unemployed, and longer if replacement jobs resulted in a reduced standard of living. The proportion of the total local population affected would not be large enough to dramatically alter the social structure of the community, but closure of any business in the study area during difficult economic times could be expected to adversely affect the security and confidence of people beyond those personally affected by a downsizing.

3.20.3 Cumulative Impacts

The CESA for social and economic resources is the same four-county area as the direct effects study area (**Figure 3.20-1**). The past, present, and RFFAs for mining and mineral exploration are identified in **Table 3.2-1**, and their locations are shown in **Figure 3.2-1**. Social and economic effects of past and present actions are reflected in the affected environment information presented in Section 3.20.1. As a result, any potential cumulative effects for past and present actions are included in the discussion of environmental consequences in Section 3.20.2.

Employment from mining activity in the Carlin Trend is a major contributor to economic activity in the CESA. Much of the work force associated with this employment and related mining support activities resides in the Elko Micropolitan Statistical Area (MSA). The Elko MSA is the closest to the proposed project area. **Table 3.20-10** lists past, existing actual, and projected employment for the major projects in the Carlin Trend along with the portion of that employment that resides in the Elko MSA. As noted above, the proposed project would not greatly expand employment, although it would extend employment for the existing Hollister work force by an estimated 20 years. This extension would provide a positive contribution to the area's economy, but, as shown in the table, the Hollister Site represents a relatively modest portion of the total mining related employment in the area (less than 5 percent until 2020 and beyond when several other projects are projected to end) and a very small percentage of the employees residing in the Elko MSA because access to the Winnemucca area is easier for workers. Buses are provided from Winnemucca to the Hollister Site.

The extension of employment for the Hollister Underground Mine Project also would continue the infusion of mining-related income into the study area economy.

The four CESA counties are consistently among the top five producers of minerals in Nevada, primarily from gold production. Taxes on net proceeds of minerals produce substantial revenues for the state and for counties where the minerals are produced. In calendar year 2010, Lander, Eureka, Humboldt and Elko counties ranked #1 through #4, respectively, in net proceeds of minerals, contributing 84.4 percent of the more than $3.0 billion statewide total. "The tax rate applied to net proceeds is based on a sliding scale between 2 percent and 5 percent, depending on the ratio of net proceeds to gross proceeds" (Nevada Department of Taxation 2010). **Table 3.20-11** illustrates the total tax revenue collected from the net proceeds of minerals tax over the past 5 fiscal years. Although the exact percentage varies somewhat from year to year, the state has received approximately half of the revenue from the net proceeds of minerals tax in recent years, most of which goes to the general fund. The rest of the revenue is distributed among the counties. In fiscal year 2009-10, recipient agencies received $7.3 million in Elko County, $19.3 million in Eureka County, $8.3 million in Humboldt County and $31.7 million in Lander County.

In addition to net proceeds of minerals taxes, mining projects pay ad valorem taxes on the assessed value of land, equipment, buildings and other improvements based on local tax rates. They pay sales taxes on locally purchased materials, use taxes on materials and equipment purchased elsewhere and excise taxes on fuel.

Additional details on the cumulative effects for social and economic resources from past, present, and RFFAs can be found in the Final Leeville and SOAPA Cumulative Impact Analyses (BLM 2010d,e), which are incorporated here by reference.

No adverse social or economic effects have been identified for the Proposed Action, Mud Springs Road Transmission Line Alternative, the Mud Springs Waste Rock Alternative, or the Backfill Alternative. Consequently, there would be no cumulative adverse social or economic effects.

3.20.4 Potential Monitoring and Mitigation Measures

Based on the conclusions of the analysis that there are no negative impacts, no monitoring or mitigation measures for social or economic values effects are recommended.

3.20.5 Residual Impacts

For the most part, social and economic effects from the proposed project would end after the project is completed. There would be public and private investment in infrastructure, homes and businesses from revenues generated by the project that would have economic life beyond the life of the project. The minerals produced by the proposed project also would continue to have value after the project is completed.

Table 3.20-10 Actual and Projected Total Employment and Employment for Residents of Elko MSA at Mine Facilities and TS Power Plant

Mine	Year of Operation																	
	2001		2007		2008		2009		2010		2011/2012		2015		2020		2025	
	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA
Newmont Carlin Trend (less Midas with Genesis)	1,455	1,455	1,907	1,907	2,374	2,374	2,289	2,289	2,061	2,061	2,011	2,011	1,722	1,722	788	788	71	71
Barrick Betze Pit	1,127	1,082	1,131	1,082	597	573	597	573	601	577	599	575	333	320	114	109	14	13
Barrick Meikle	607	583	919	882	526	505	526	505	548	526	603	579	450	432	0	0	0	0
Barrick Overhead & Processing	IA	IA	IA	IA	549	527	549	527	336	323	329	316	289	277	218	207	162	155
Barrick Contractor Employees	IA	IA	IA	IA	400	384	400	384	400	384	400	384	400	384	200	192	75	72
Barrick Cortez	394	299	550	418	985	749	885	673	885	673	885	673	685	521	155	118	0	0
Newmont Midas	233	0	220	0	225	0	225	0	202	4	171	0	0	0	0	0	0	0
Barrick Arturo	0	0	0	0	0	0	0	0	0	0	0	0	358	358	50	50	0	0
Barrick Arturo Contractor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RCG Hollister - Existing	0	0	144	10	144	10	144	10	160	11	160	11	0	0	0	0	0	0
RCG Hollister - Proposed	0	0	0	0	0	0	0	0	0	0	0	0	175	11	175	12	175	12
RCG Hollister Proposed Contractors	0	0	0	0	0	0	0	0	0	0	45	3	0	0	0	0	0	0

Table 3.20-10 Actual and Projected Total Employment and Employment for Residents of Elko MSA at Mine Facilities and TS Power Plant

Mine	Year of Operation																	
	2001		2007		2008		2009		2010		2011/2012		2015		2020		2025	
	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA	Total	Elko MSA
Barrick Bald Mountain	107	68	196	125	205	131	285	179	295	186	325	208	260	166	25	16	0	0
Jerritt Canyon	411	370	357	321	400	360	30	27	150	135	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk
TS Power Plant	0	0	UC	UC	Unk	Unk	65	46	65	46	65	46	65	46	65	46	65	46
Totals with Proposed RCG Hollister	4334	3,857	5,424	4,745	6,405	5,613	5,995	5,213	5,703	4,926	5,593	4,806	4,737	4,237	1,790	1,538	562	369
Totals without Proposed RCG Hollister	4,334	3,857	5,424	4,745	6,405	5,613	5,995	5,213	5,703	4,926	5,548	4,803	4,562	4,226	1,615	1,526	387	357
Net due to Proposed RCG Hollister	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	45	3	175	11	175	12	175	12

NA = Not Applicable; IA = Included above; Unk = unknown; UC = under construction for 27 months with employment at a maximum of 900 workers - most from out of the area.

Elko MSA = encompasses Elko, Spring Creek, Carlin, and the adjacent unincorporated communities in Elko County, Nevada.

Source: BLM 2010f; RCG 2010b.

Table 3.20-11 Statewide Net Proceeds of Minerals Tax Collection

Fiscal Year	Tax Revenue
2005-06	$44,524,830
2006-07	$62,178,511
2007-08	$74,129,804
2008-09	$145,449,950
2009-10	$168,695,319

Source: Nevada Department of Taxation 2011.

3.21 Environmental Justice

The environmental justice analysis addresses the potential for the proposed project or alternatives to adversely affect minority or low income populations to a disproportionate degree, relative to their representation in the larger population.

The environmental justice direct and indirect study area and cumulative effects study area (CESA) includes Elko, Eureka, Humboldt, and Lander counties (**Figure 3.20-1**). The study area is large because the Hollister Site is located in Elko County, within approximately 7 miles of the Eureka and Lander county lines. However, most of the work force lives in Humboldt County because the Winnemucca area is the most readily accessible community providing a range of housing, community, and commercial services. Past, present, and reasonably foreseeable future actions (RFFAs) that may occur within the CESA are described in Section 3.2.

3.21.1 Affected Environment

Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" was issued February 11, 1994 (59 Federal Register 7629). EO 12898 "is intended to promote nondiscrimination in Federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment." It requires each federal agency to achieve environmental justice as part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects, including social and economic effects, of its programs, policies, and activities on minority and low-income populations.

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The CEQ guidance states that population groups defined as minorities include: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic/Latino origin; or Hispanic/Latino. CEQ guidelines for evaluating potential adverse environmental justice effects indicate minority populations should be identified when either: 1) a minority population exceeds 50 percent of the population of the affected area, or 2) a minority population represents a "meaningfully greater increment" of the affected area population than the population of some appropriate larger geographic unit, as a whole.

Low-income populations are those communities or sets of individuals whose median income is below the current poverty level of the general population. According to the guidance, low-income populations in an affected area should be identified using the "annual statistical poverty thresholds from the Bureau of the Census' Current Population Reports, Series P-60 on Income and Poverty." In identifying low-income populations, (federal) agencies may consider as a community either a group of individuals living in geographic proximity to one another or a set of individuals (such as migrant workers or Native Americans) where either type of group experiences common conditions of environmental exposure or effect" (CEQ 1997b).

3.21.1.1 Minority Population

All four of the study area counties have notably higher percentages of white, non-Hispanic residents than the state as a whole. Eureka County, in particular, is over 84 percent white, non-Hispanic, compared with approximately 54 percent for Nevada (**Table 3.21-1**). All four counties have fewer than 1 percent blacks and 1 percent or fewer Asians, compared with nearly 8 percent for both groups state-wide. All four counties also have lower percentages of Hispanics than the state. All four counties have higher

percentages of American Indian and Alaska Native population, compared with the state's 0.9 percent, with Eureka County the closest at 2.1 percent.

Table 3.21-1 2010 Race and Ethnicity by Study Area County and Census Tract

Race/Ethnic Origin	Census Tract 9517	Elko County	Eureka County	Humboldt County	Lander County	State of Nevada
White Not of Hispanic Origin	35.8	69.1	83.6	68.9	73.7	54.1
Black Not of Hispanic Origin	0.6	0.7	0.1	0.5	0.3	7.7
American Indian and Alaska Native	32.3	4.7	2.1	3.8	3.4	0.9
Asian or Pacific Islander, Non-Hispanic	0.3	1.0	0.9	0.8	0.3	7.7
Other and Two or More Races	1.1	1.7	1.3	1.6	1.1	3.1
Hispanic Origin of Any Race	29.9	22.9	12.0	24.4	21.1	26.5

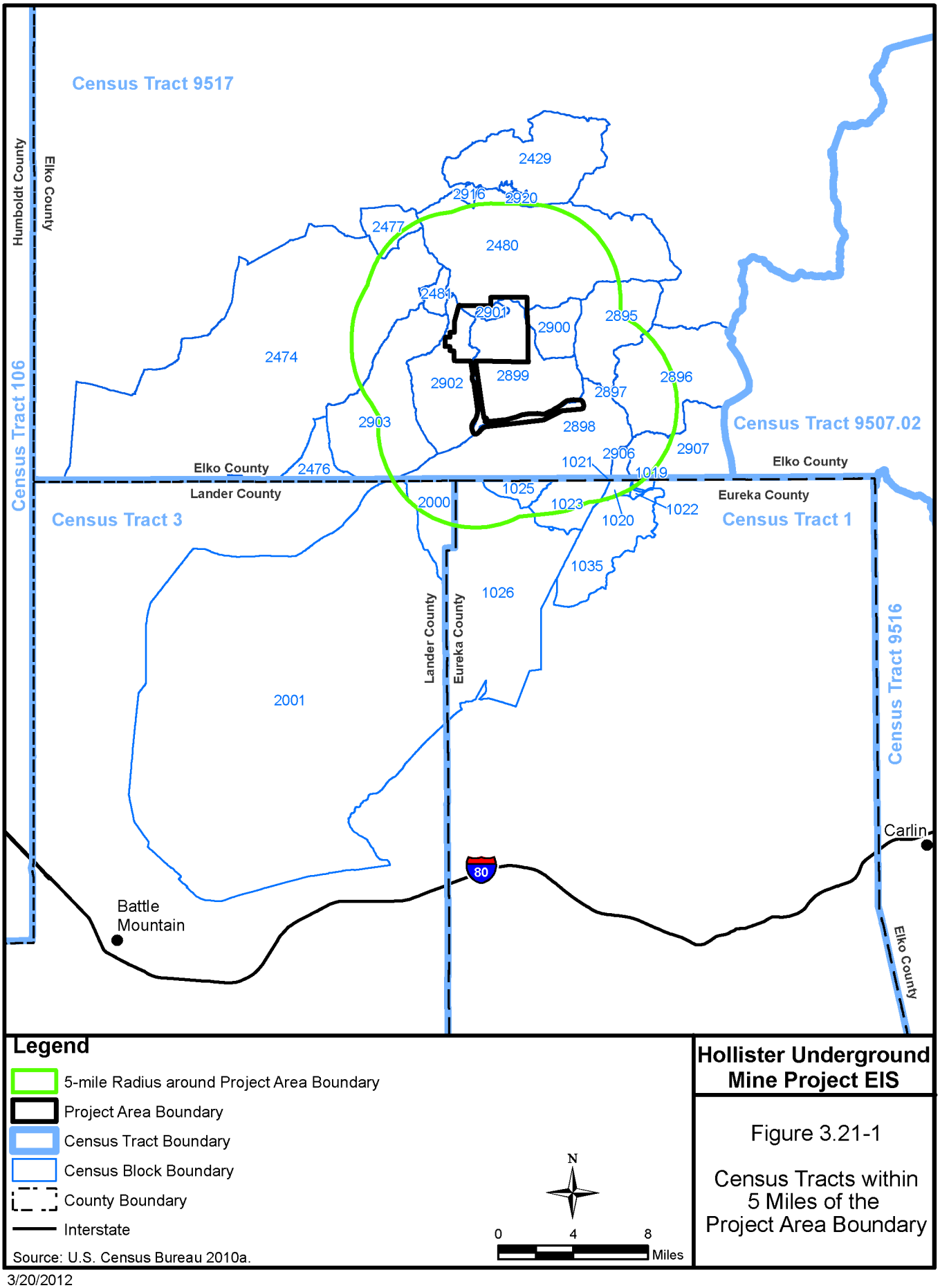
Source: United States [U.S.] Census Bureau 2010a.

Census Tract 9517 encompasses much of the rural area of northern Elko County from Humboldt County on the west to the Utah state line on the east (**Figure 3.21-1**). Portions of 13 Census Blocks in Block Group 2 of Census Tract 9517 lie within a five-mile radius of the Project Area. Most of the proposed surface disturbance would be located in Block 2899. There is no resident population in 12 of the 13 census blocks. There are five residents in Block 2474, although they are approximately 10 miles west of the project area. The total population of Tract 9517 was just 2,669 in 2010, scattered among several small communities, ranches, and rural residences. The population was 32.3 percent American Indian and Alaska Native; 29.9 percent claimed Hispanic ethnicity. All other minority race categories were very small.

In accordance with the guidance, minority populations should be identified when either:

- "The minority population of the affected area exceeds 50 percent; or
- "The minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis."

The CEQ guidelines do not define an "affected area" for Environmental Justice purposes, however, the U.S. Environmental Protection Agency (USEPA) indicates that the "affected area" is "that area which the proposed project will or may have an effect on" (USEPA 1998a). In this case, it is interpreted to mean the study area as a whole or a component thereof, such as an individual county or Census Tract 9517. No racial or ethnic group exceeds 50 percent of the population of any of the study area counties nor in Census Tract 9517. Although not greater than 50 percent, the population percentages of American Indians in three of the four study area counties and in Census Tract 9517 would be considered "meaningfully greater" than for the state as a whole. The percentages are all more than three times greater than the statewide percentage. Therefore, for the purpose of identifying environmental justice concerns, a minority population, as defined by the guidance, exists in the study area. It is notable, however, that the American Indian populations in Census Tract 9517, and in the remainder of Elko County, are concentrated on several Indian Reservations and Colonies, including the Duck Valley and South Fork Indian Reservations, respectively, both of which are over 50 miles from the project area, and


Census Tract 9517
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Census Tract 9507.02
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1021
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Elko County
Elko County
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Eureka County
Census Tract 3
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Census Tract 1
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Lander County
Eureka County
Census Tract 106
Census Tract 9516
2001
Carlin
80
Battle
Mountain
Elko County
Legend
5-mile Radius around Project Area Boundary
Project Area Boundary
Census Tract Boundary
Census Block Boundary
County Boundary
Interstate
Source: U.S. Census Bureau 2010a.
N
0
4
8
Miles
Hollister Underground Mine Project EIS
Figure 3.21-1
Census Tracts within 5 Miles of the Project Area Boundary

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the Elko Colony, which is approximately 40 miles from the project area (straight line distances). Most of the population of the Duck Valley Reservation resides in Nevada in Census Tract 9517, which accounts for the high percentage of American Indians in that very large and otherwise very rural and sparsely populated tract. There also are a reservation in Battle Mountain (Lander County) and a colony in Winnemucca (Humboldt County), which are approximately 35 miles and 60 miles, respectively, from the project area.

3.21.1.2 Low-Income Population

Although mining is a dominant industry in much of the study area, and mining wages and salaries are typically higher than average, per capita personal income (PCPI) in the study area continues to lag slightly behind the state level. Data from 2000 (Bureau of Economic Analysis [BEA] 2010) indicated a state PCPI average of $30,986 (**Table 3.21-2**). Average PCPI for study area counties ranged from $23,757 in Eureka County (76.7 percent of the state level) to $26,250 in Lander County (84.7 percent of the state level) (BEA 2010). In 2008, the state PCPI had risen to $40,936, an increase of 32 percent. The PCPI for study area counties increased at comparable or faster rates, but three of the four counties remained below the state average (**Table 3.21-2**). In contrast to PCPI, estimated median household incomes tell a different story. The median household income for the state for 2009 was estimated at $53,310. All four study area counties had higher median household incomes than the state: Elko County ($62,091); Eureka County ($56,815); Humboldt County ($57,309); and Lander County ($62,329) (U.S. Census Bureau 2010b).

Table 3.21-2 Per Capita Personal Income – Nevada and Counties

Area Name	2000	2008	% Change	% of Nevada State Total (2000)	% of Nevada State Total (2008)
Nevada State Total	$30,986	$40,936	+32.1	100.0	100.0
Elko County	$25,418	$37,300	+46.7	82.0	91.1
Eureka County	$23,757	$40,674	+71.2	76.7	99.4
Humboldt County	$25,244	$33,249	+31.7	81.5	81.2
Lander County	$26,250	$41,812	+59.3	84.7	102.1

Note: Per capita personal income was computed using Census Bureau mid-year population estimates. Estimates for 2000-2008 reflect county population estimates available as of April 2010.

Source: BEA 2010.

Poverty status is determined by comparing annual income to poverty thresholds, which vary by family size, number of children, and age of the householder, although not geographically. Poverty thresholds are updated annually based on changes in the Consumer Price Index (CPI-U). Weighted average poverty thresholds for 2009 ranged from $10,289 for a single individual 65 years and over to $44,366 for a household of nine or more people. Census estimates indicated 12.4 percent of the people in Nevada had incomes below the poverty level in 2009 (U.S. Census Bureau 2010b). All four study area counties had lower percentages of people with incomes below the poverty thresholds than the state: Elko County was 8.2 percent, Eureka County was at 10.4 percent, Humboldt County was 11.5 percent, and Lander County was 10.0 percent. Estimates of the percent of young people under age 18 in poverty were higher for all five jurisdictions, but the percentages for the four study area counties were all below the statewide 17.6 percent. Based on this information, none of the study area counties would be considered to have low-income populations under EO 12898.

3.21.2 Environmental Consequences

Primary issues related to environmental justice are guided by EO 12898 that initiated consideration of environmental justice in federal actions. The basic question is whether any potential adverse human health or environmental effects of the Proposed Action or alternatives would fall disproportionately on minority or low income members of the affected community.

According to the CEQ guidance, "when determining whether human health effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and

(b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

(c) Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards."(CEQ 1997b)

"When determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether there is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and

(b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

(c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards." (CEQ 1997b)

In order to assess the potential for environmental justice impacts, the socioeconomic characteristics of the study area counties and communities are first analyzed for the presence of minority and/or low-income populations. Second, if minority and/or low-income populations are identified based on the CEQ Guidance, the proposed project and alternatives are evaluated for potential effects, which may be expected to disproportionately impact any such populations.

3.21.2.1 Proposed Action

The analysis indicates that the potential effects of the Proposed Action would not be expected to disproportionately affect any particular population. The area in the immediate vicinity of the proposed project has no resident population. The nearest residences are a few remote ranches located several miles from the project area, the nearest of which has no resident minority population and has not been identified as low-income in nature. The nearest residential area is over 15 miles away in the small community of Midas. Larger communities are all more than 30 miles from the project area. Concentrations of American Indian populations are all located at considerable distances from the project

area. The community of Owyhee, on the Duck Valley Indian Reservation in Elko County, is 60 miles north of the project area and the South Fork Indian Reservation, also in Elko County, is over 50 miles southeast of the project area. The Fort McDermitt Indian Reservation, in Humboldt County, is over 75 miles northwest of the project area. American Indian colonies at Elko and Battle Mountain are closer to the project area, but are in or near larger communities where they represent small percentages of the population. The relatively high proportion of Hispanic or Latino population in Census Tract 9517 is assumed to reside a substantial distance from the project area as well, because there are no residences in the project vicinity. No concentrations of low income populations have been identified near the project area.

Environmental effects that may occur at such distances from the proposed project area, such as air quality or traffic effects, would affect the study area's population essentially equally without regard to race, ethnicity or income level. Ore truck traffic to Midas Mill would not travel through populated communities.

Although the CEQ Guidance does not include this statement, USEPA Environmental Justice guidance states, "impacts that may affect a cultural, historical, or protected resource of value to an Indian tribe or a minority population (should be considered), even when the population is not concentrated in the vicinity" (USEPA 1998a). As noted in Section 3.17, Native American Traditional Values, issues identified by tribal governments and individuals and analyzed for the Proposed Action include potential effects to cultural resources, subsurface chert deposits, and burials, as well as groundwater pumping impacts to springs, impacts associated with road improvements, and increased development due to installation of the electric power transmission line (transmission line). No effects were identified to archaeological sites (other than residual impacts to affected archaeological sites because data recovery ultimately destroys the site), chert deposits, burials, Antelope and Ivanhoe-Buttercup springs, road maintenance, and installation of the transmission line as described in Section 3.17, Native American Traditional Values. Because the proposed project occurs within the Tosawihi Quarries Archaeological District (Tosawihi Quarries) and its importance to the Western Shoshone people, especially the descendents of the Native Americans who utilize the Tosawihi Quarries for cultural and traditional activities, some of the Native Americans have stated they feel disproportionately adverse environmental justice effects from the activities that have occurred and are occurring in the Tosawihi Quarries. The Native Americans have provided no information regarding the nature of the disproportionate, adverse environmental justice effects.

The proposed mine site is located within the current boundaries of the Tosawihi Quarries. The traditional cultural properties (see Section 3.17, Native American Traditional Values) are located outside of the proposed mining area. Native Americans would continue to have access to the Tosawihi Quarries. The fenced industrial area of the proposed mine would be open to public access except for the core mining area, which would require a Rodeo Creek Gold Inc (RCG) escort due to Mine Safety and Health Administration regulations. Ivanhoe Road would still provide access through the proposed mine site and adjacent areas.

Regarding whether "communities have been sufficiently involved in the decision making process," the Bureau of Land Management (BLM) held five public meetings and distributed public notices about the proposed project through mailings and notices in area newspapers in addition to the formal notice in the *Federal Register*. Extensive effort has been made to involve the Native American communities in the EIS process through both the NEPA public process and formal consultation specific to the proposed project (documented in Section 3.17.1.3, Native American Consultation). In addition, more generic discussions about resources and sites related to the Tosawihi Quarries have taken place over the last 30 years. Based on this analysis, the Proposed Action would not have a disproportionate impact on any minority group, low income population, or Native American tribes.

3.21.2.2 Mud Springs Road Transmission Line Alternative

Environmental justice concerns under the Mud Springs Road Transmission Line Alternative would be the same as those discussed for the Proposed Action.

3.21.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under the Mud Springs Waste Rock Storage Facility Alternative, environmental justice concerns would be the same as those discussed for the Proposed Action.

3.21.2.4 Backfill Alternative

Environmental Justice concerns under the Backfill Alternative would be the same as described for the Proposed Action.

3.21.2.5 No Action Alternative

Under the No Action Alternative, BLM would not approve the proposed project. RCG would continue to conduct surface and underground exploration and bulk sampling under the current exploration permits and approvals as authorized by the BLM and State of Nevada. Reclamation and closure of the existing exploration facilities would proceed under the current schedule. No environmental justice effects were previously identified in the permitting process for the existing activities.

3.21.3 Cumulative Impacts

The CESA for environmental justice is the same four-county area as the direct and indirect effects study area. The past, present, and RFFAs for mining and mineral exploration activities within the Carlin Trend are identified in **Table 3.2-1**, and their locations are shown in **Figure 3.2-2**. The environmental justice analysis did not identify any direct disproportionate adverse effects on minority or low income populations in the study area from the Proposed Action, and an extensive effort to involve all communities in the decision-making process was documented. Therefore, no direct cumulative effects to these populations would occur as a result of the Proposed Action. Some Native Americans' have stated that they feel disproportionately adverse environmental justice effects from impacts to the Tosawihi Quarries, but have provided no information regarding the nature of the environmental justice effects. These concerns relate to the Tosawihi Quarries, which is local to the immediate vicinity of the proposed project so there would be no cumulative effects from other activities which are not in close proximity to the quarries.

The cumulative impacts associated with the Mud Springs Road Transmission Line, Mud Springs Waste Rock Storage Facility, and Backfill alternatives, combined with past, present, and RFFAs, would be the same as described for the Proposed Action.

3.21.4 Potential Monitoring and Mitigation Measures

Mitigation measures recommended to minimize adverse effects on Native American Traditional Values would include the execution of a PA among BLM, the State Historic Preservation Office, Advisory Council on Historic Preservation, and RCG as described in Section 3.17, Native American Traditional Values.

3.21.5 Residual Impacts

No low-income populations are located in the study area. Minority (Native American) populations in the study area are located a considerable distance from the project area. Therefore, there would be no direct disproportionate adverse environmental justice effects on such populations. Residual adverse effects on Native American Traditional Values are addressed in Section 3.17, which also would address concerns expressed by Native American about potential disproportionate adverse effects on their culture or heritage.

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The environmental justice analysis addresses the potential for the proposed project or alternatives to adversely affect minority or low income populations to a disproportionate degree, relative to their representation in the larger population.

The environmental justice direct and indirect study area and cumulative effects study area (CESA) includes Elko, Eureka, Humboldt, and Lander counties (**Figure 3.20-1**). The study area is large because the Hollister Site is located in Elko County, within approximately 7 miles of the Eureka and Lander county lines. However, most of the work force lives in Humboldt County because the Winnemucca area is the most readily accessible community providing a range of housing, community, and commercial services. Past, present, and reasonably foreseeable future actions (RFFAs) that may occur within the CESA are described in Section 3.2.

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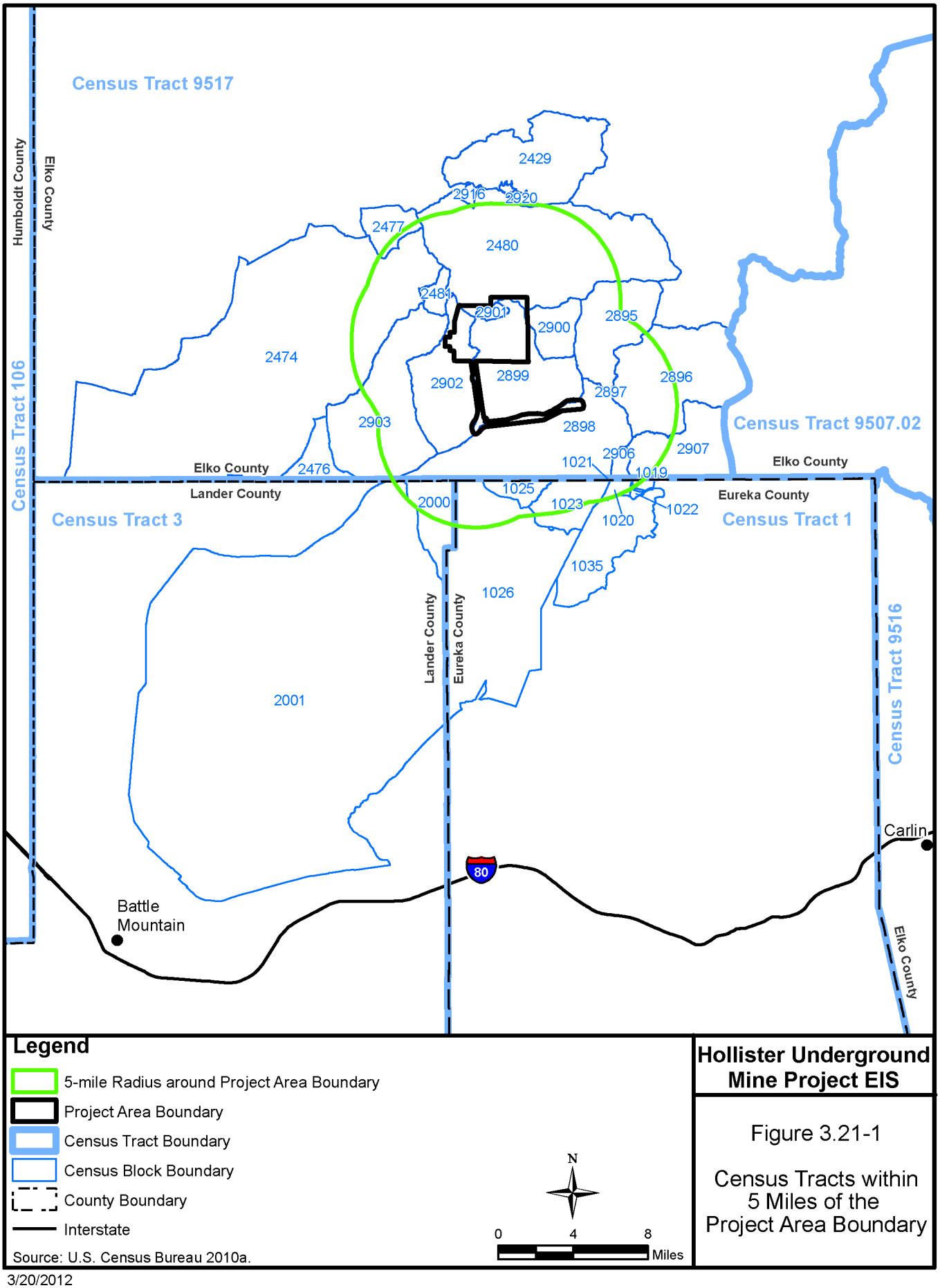
Census Tract 9517
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Nevada State Total	$30,986	$40,936	+32.1	100.0	100.0
Elko County	$25,418	$37,300	+46.7	82.0	91.1
Eureka County	$23,757	$40,674	+71.2	76.7	99.4
Humboldt County	$25,244	$33,249	+31.7	81.5	81.2
Lander County	$26,250	$41,812	+59.3	84.7	102.1

Note: Per capita personal income was computed using Census Bureau mid-year population estimates. Estimates for 2000-2008 reflect county population estimates available as of April 2010.

Source: BEA 2010.

Poverty status is determined by comparing annual income to poverty thresholds, which vary by family size, number of children, and age of the householder, although not geographically. Poverty thresholds are updated annually based on changes in the Consumer Price Index (CPI-U). Weighted average poverty thresholds for 2009 ranged from $10,289 for a single individual 65 years and over to $44,366 for a household of nine or more people. Census estimates indicated 12.4 percent of the people in Nevada had incomes below the poverty level in 2009 (U.S. Census Bureau 2010b). All four study area counties had lower percentages of people with incomes below the poverty thresholds than the state: Elko County was 8.2 percent, Eureka County was at 10.4 percent, Humboldt County was 11.5 percent, and Lander County was 10.0 percent. Estimates of the percent of young people under age 18 in poverty were higher for all five jurisdictions, but the percentages for the four study area counties were all below the statewide 17.6 percent. Based on this information, none of the study area counties would be considered to have low-income populations under EO 12898.

3.21.2 Environmental Consequences

Primary issues related to environmental justice are guided by EO 12898 that initiated consideration of environmental justice in federal actions. The basic question is whether any potential adverse human health or environmental effects of the Proposed Action or alternatives would fall disproportionately on minority or low income members of the affected community.

According to the CEQ guidance, "when determining whether human health effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether the health effects, which may be measured in risks and rates, are significant (as employed by NEPA), or above generally accepted norms. Adverse health effects may include bodily impairment, infirmity, illness, or death; and

(b) Whether the risk or rate of hazard exposure by a minority population, low-income population, or Indian tribe to an environmental hazard is significant (as employed by NEPA) and appreciably exceeds or is likely to appreciably exceed the risk or rate to the general population or other appropriate comparison group; and

(c) Whether health effects occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards."(CEQ 1997b)

"When determining whether environmental effects are disproportionately high and adverse, agencies are to consider the following three factors to the extent practicable:

(a) Whether there is or will be an impact on the natural or physical environment that significantly (as employed by NEPA) and adversely affects a minority population, low-income population, or Indian tribe. Such effects may include ecological, cultural, human health, economic, or social impacts on minority communities, low-income communities, or Indian tribes when those impacts are interrelated to impacts on the natural or physical environment; and

(b) Whether environmental effects are significant (as employed by NEPA) and are or may be having an adverse impact on minority populations, low income populations, or Indian tribes that appreciably exceeds or is likely to appreciably exceed those on the general population or other appropriate comparison group; and

(c) Whether the environmental effects occur or would occur in a minority population, low-income population, or Indian tribe affected by cumulative or multiple adverse exposures from environmental hazards." (CEQ 1997b)

In order to assess the potential for environmental justice impacts, the socioeconomic characteristics of the study area counties and communities are first analyzed for the presence of minority and/or low-income populations. Second, if minority and/or low-income populations are identified based on the CEQ Guidance, the proposed project and alternatives are evaluated for potential effects, which may be expected to disproportionately impact any such populations.

3.21.2.1 Proposed Action

The analysis indicates that the potential effects of the Proposed Action would not be expected to disproportionately affect any particular population. The area in the immediate vicinity of the proposed project has no resident population. The nearest residences are a few remote ranches located several miles from the project area, the nearest of which has no resident minority population and has not been identified as low-income in nature. The nearest residential area is over 15 miles away in the small community of Midas. Larger communities are all more than 30 miles from the project area. Concentrations of American Indian populations are all located at considerable distances from the project

area. The community of Owyhee, on the Duck Valley Indian Reservation in Elko County, is 60 miles north of the project area and the South Fork Indian Reservation, also in Elko County, is over 50 miles southeast of the project area. The Fort McDermitt Indian Reservation, in Humboldt County, is over 75 miles northwest of the project area. American Indian colonies at Elko and Battle Mountain are closer to the project area, but are in or near larger communities where they represent small percentages of the population. The relatively high proportion of Hispanic or Latino population in Census Tract 9517 is assumed to reside a substantial distance from the project area as well, because there are no residences in the project vicinity. No concentrations of low income populations have been identified near the project area.

Environmental effects that may occur at such distances from the proposed project area, such as air quality or traffic effects, would affect the study area's population essentially equally without regard to race, ethnicity or income level. Ore truck traffic to Midas Mill would not travel through populated communities.

Although the CEQ Guidance does not include this statement, USEPA Environmental Justice guidance states, "impacts that may affect a cultural, historical, or protected resource of value to an Indian tribe or a minority population (should be considered), even when the population is not concentrated in the vicinity" (USEPA 1998a). As noted in Section 3.17, Native American Traditional Values, issues identified by tribal governments and individuals and analyzed for the Proposed Action include potential effects to cultural resources, subsurface chert deposits, and burials, as well as groundwater pumping impacts to springs, impacts associated with road improvements, and increased development due to installation of the electric power transmission line (transmission line). No effects were identified to archaeological sites (other than residual impacts to affected archaeological sites because data recovery ultimately destroys the site), chert deposits, burials, Antelope and Ivanhoe-Buttercup springs, road maintenance, and installation of the transmission line as described in Section 3.17, Native American Traditional Values. Because the proposed project occurs within the Tosawihi Quarries Archaeological District (Tosawihi Quarries) and its importance to the Western Shoshone people, especially the descendents of the Native Americans who utilize the Tosawihi Quarries for cultural and traditional activities, some of the Native Americans have stated they feel disproportionately adverse environmental justice effects from the activities that have occurred and are occurring in the Tosawihi Quarries. The Native Americans have provided no information regarding the nature of the disproportionate, adverse environmental justice effects.

The proposed mine site is located within the current boundaries of the Tosawihi Quarries. The traditional cultural properties (see Section 3.17, Native American Traditional Values) are located outside of the proposed mining area. Native Americans would continue to have access to the Tosawihi Quarries. The fenced industrial area of the proposed mine would be open to public access except for the core mining area, which would require a Rodeo Creek Gold Inc (RCG) escort due to Mine Safety and Health Administration regulations. Ivanhoe Road would still provide access through the proposed mine site and adjacent areas.

Regarding whether "communities have been sufficiently involved in the decision making process," the Bureau of Land Management (BLM) held five public meetings and distributed public notices about the proposed project through mailings and notices in area newspapers in addition to the formal notice in the *Federal Register*. Extensive effort has been made to involve the Native American communities in the EIS process through both the NEPA public process and formal consultation specific to the proposed project (documented in Section 3.17.1.3, Native American Consultation). In addition, more generic discussions about resources and sites related to the Tosawihi Quarries have taken place over the last 30 years. Based on this analysis, the Proposed Action would not have a disproportionate impact on any minority group, low income population, or Native American tribes.

3.21.2.2 Mud Springs Road Transmission Line Alternative

Environmental justice concerns under the Mud Springs Road Transmission Line Alternative would be the same as those discussed for the Proposed Action.

3.21.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under the Mud Springs Waste Rock Storage Facility Alternative, environmental justice concerns would be the same as those discussed for the Proposed Action.

3.21.2.4 Backfill Alternative

Environmental Justice concerns under the Backfill Alternative would be the same as described for the Proposed Action.

3.21.2.5 No Action Alternative

Under the No Action Alternative, BLM would not approve the proposed project. RCG would continue to conduct surface and underground exploration and bulk sampling under the current exploration permits and approvals as authorized by the BLM and State of Nevada. Reclamation and closure of the existing exploration facilities would proceed under the current schedule. No environmental justice effects were previously identified in the permitting process for the existing activities.

3.21.3 Cumulative Impacts

The CESA for environmental justice is the same four-county area as the direct and indirect effects study area. The past, present, and RFFAs for mining and mineral exploration activities within the Carlin Trend are identified in **Table 3.2-1**, and their locations are shown in **Figure 3.2-2**. The environmental justice analysis did not identify any direct disproportionate adverse effects on minority or low income populations in the study area from the Proposed Action, and an extensive effort to involve all communities in the decision-making process was documented. Therefore, no direct cumulative effects to these populations would occur as a result of the Proposed Action. Some Native Americans' have stated that they feel disproportionately adverse environmental justice effects from impacts to the Tosawihi Quarries, but have provided no information regarding the nature of the environmental justice effects. These concerns relate to the Tosawihi Quarries, which is local to the immediate vicinity of the proposed project so there would be no cumulative effects from other activities which are not in close proximity to the quarries.

The cumulative impacts associated with the Mud Springs Road Transmission Line, Mud Springs Waste Rock Storage Facility, and Backfill alternatives, combined with past, present, and RFFAs, would be the same as described for the Proposed Action.

3.21.4 Potential Monitoring and Mitigation Measures

Mitigation measures recommended to minimize adverse effects on Native American Traditional Values would include the execution of a PA among BLM, the State Historic Preservation Office, Advisory Council on Historic Preservation, and RCG as described in Section 3.17, Native American Traditional Values.

3.21.5 Residual Impacts

No low-income populations are located in the study area. Minority (Native American) populations in the study area are located a considerable distance from the project area. Therefore, there would be no direct disproportionate adverse environmental justice effects on such populations. Residual adverse effects on Native American Traditional Values are addressed in Section 3.17, which also would address concerns expressed by Native American about potential disproportionate adverse effects on their culture or heritage.

3.22 Visual Resources

The visual resources study area for direct and indirect impacts encompasses the project area as seen from the four key observation points (KOPs) identified for the proposed project (**Figure 3.22-1**). KOP selection is based on the standard Visual Resource Management (VRM) system requirements for public viewing locations with immediate visibility of the project. The study area and cumulative effects study area (CESA) are based upon the viewshed of the proposed project (**Figure 3.22-2**). Past, present, and reasonably foreseeable future actions (RFFAs) are summarized in Section 3.2.

The Bureau of Land Management (BLM) is responsible for identifying and protecting scenic values on public lands under several provisions of the Federal Land Policy and Management Act of 1976 and the National Environmental Policy Act. The BLM VRM system was developed to facilitate that responsibility in a systematic interdisciplinary manner. The VRM system includes an inventory process based on scenic quality, viewer sensitivity to visual change, and viewing distances, which leads to classification of public lands and assignment of visual management objectives. The four VRM classes serve to document the relative value of existing visual resources, to describe visual management objectives for land use planning, and establish thresholds for allowable change to the visual environment. The management objectives of the VRM classes are described in **Table 3.22-1**.

Table 3.22-1 BLM Visual Resource Management Class Objectives

Class I Objective	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
Class II Objective	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic (design) elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III Objective	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV Objective	The objective of this class is to provide for management activities, 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. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic (design) elements.

Source: BLM 1986b.

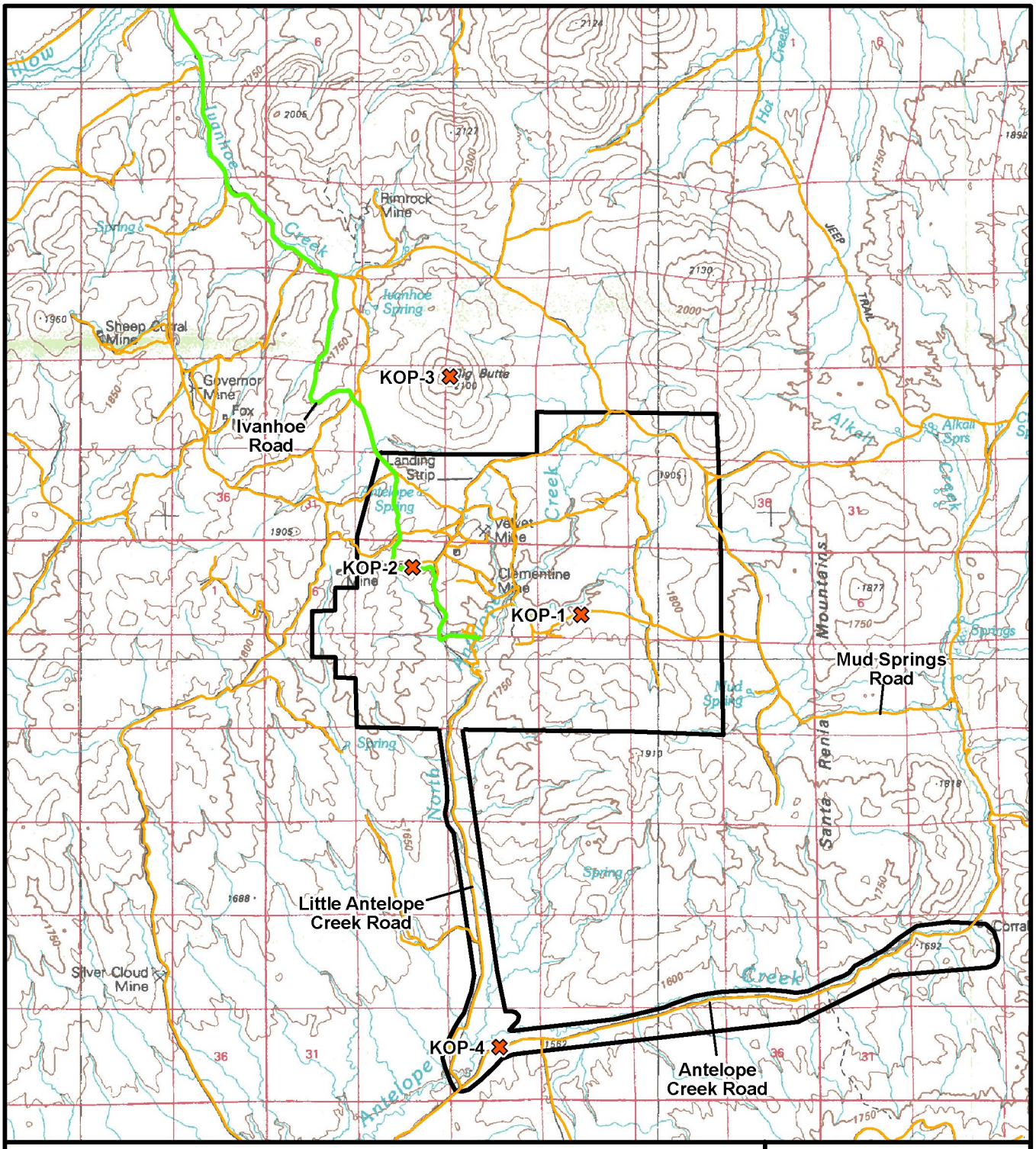
KOP-3
KOP-2
KOP-1
KOP-4
Ivanhoe Road
Mud Springs Road
Little Antelope Creek Road
Antelope Creek Road
Landing Strip
Rimrock Mine
Sheep Corral Mine
Governor Mine
Fox Mine
Velvet Mine
Clementine Mine
Silver Cloud Mine
Ivanhoe Creek
Ivanhoe Spring
Antelope Spring
Mud Spring
Alkali Spring
Alkali Creek
Hot Creek
North Antelope Creek
Antelope Creek
Santa Rosa Mountains
Jeep Trail
Big Butte
Corral
Legend
Project Area Boundary
Key Observation Point
Existing Roads
Ivanhoe Road
Note: Entire map area is designated Class IV for Visual Resource Modeling.
Source: BLM 2010k.
N
0
1
2
Miles
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Figure 3.22-1
Visual Resources Study Area

3/20/2012

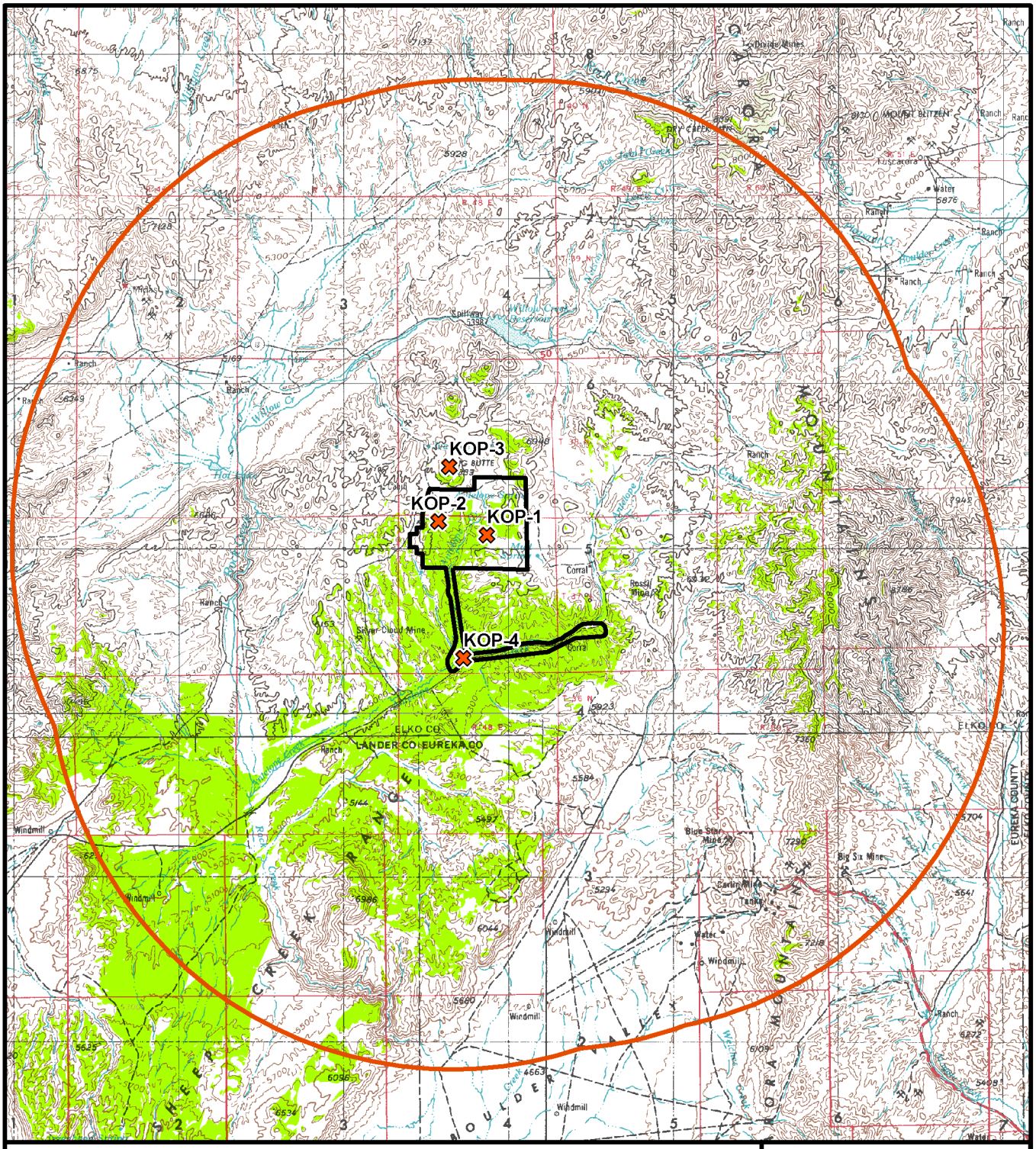

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Figure 3.22-2

Viewshed Area for the Study Area and Cumulative Effects Study Area

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The VRM system also includes a “contrast rating” procedure for evaluating the potential visual effects of a proposed project or management activity. The VRM system was used to evaluate the visual impact of the proposed project as well as the potential cumulative visual effects of the proposed project in the context of other activities that have taken place or may take place in the area in the reasonably foreseeable future.

3.22.1 Affected Environment

The extent of the viewshed is based upon an approximately 15-mile-limit of visibility. Beyond 15 miles, it becomes difficult to distinguish specific features in the landscape. The viewshed for the proposed project contains the area within the general triangle formed by Big Butte, Santa Renia Mountains, and Sheep Creek Range (**Figure 3.22-2**). Landscape characteristics contributing to the inventory process for the proposed project are described below, followed by VRM class designations for the visual area of influence (**Figure 3.22-3**).

The proposed project is located in the Basin and Range physiographic province as defined by Fenneman (1931). The province is characterized by alternating valleys and low mountain ridges common to northern Nevada. Topography within the project vicinity is rounded, angular, and irregular. The prominent landform in the project vicinity is Big Butte, a Native American Traditional Cultural Property (TCP) from the 5,600-foot elevation contour and above. The lower end of Antelope Creek is at an elevation of approximately 5,100 feet, while the upper end near the proposed electric power transmission line (transmission line) origin is approximately 5,280 feet. The high points to the southeast of the project area are approximately 6,300 feet. The Sheep Creek Range reaches approximately 5,700 feet elevation, dropping gradually to the north and south.

Native soils are light beige to pale whitish gray with rock outcrops adding generally muted browns, oranges, and some mauve to purple hues. Vegetation in the project area tends to be sparse and dominated by small- to medium-sized mixed shrubs. Vegetation colors range from silvery gray-green to light and medium olive. Grasses are short and typically sparse, reflecting the desert conditions of the region. Somewhat brighter greens are evident for periods in the spring with beige, tans, and muted gold during the drier and colder months.

Color differences, though generally not sharply contrasting, can be easily distinguished at ranges of less than 1 mile, especially with early morning or late afternoon sun at the viewer's back. Colors blend together and become very subtle or undistinguishable at greater distances and under different light conditions, such as high mid-day sun or the light haze often seen in this part of Nevada.

The proposed project is located in a region that has been mined for over a century. The nearest historic mines are Clementine Mine, Old Timer Mine, Butte 1 and 2, and Velvet Mine, all less than 1 mile away. The Santa Renia Mountains to the east contain numerous exploration roads; some of which have been reclaimed. Other active mines are located in the Tuscarora Mountains located south-southeast of the project area.

Views in the vicinity of the proposed Hollister Mine include legacy mining landforms from historical surface mining operations. The East and West pits and current operations exhibit strong color contrast with the natural surroundings and moderate to strong line, landform, and surface texture contrast. The darker colors of the existing Rodeo Creek Gold Inc (RCG) waste rock storage facility (WRSF) stand out from the natural background in conditions of direct sunlight. They produce less contrast in overcast sky conditions when the light angle or intensity does not emphasize the color differences between introduced and natural vegetation and soils. The reclaimed leach pad and Newmont reclaimed WRSFs appear as regular, geometric shaped mounds, predominantly horizontal in character. They generally are smoother textured than the surrounding landscape.

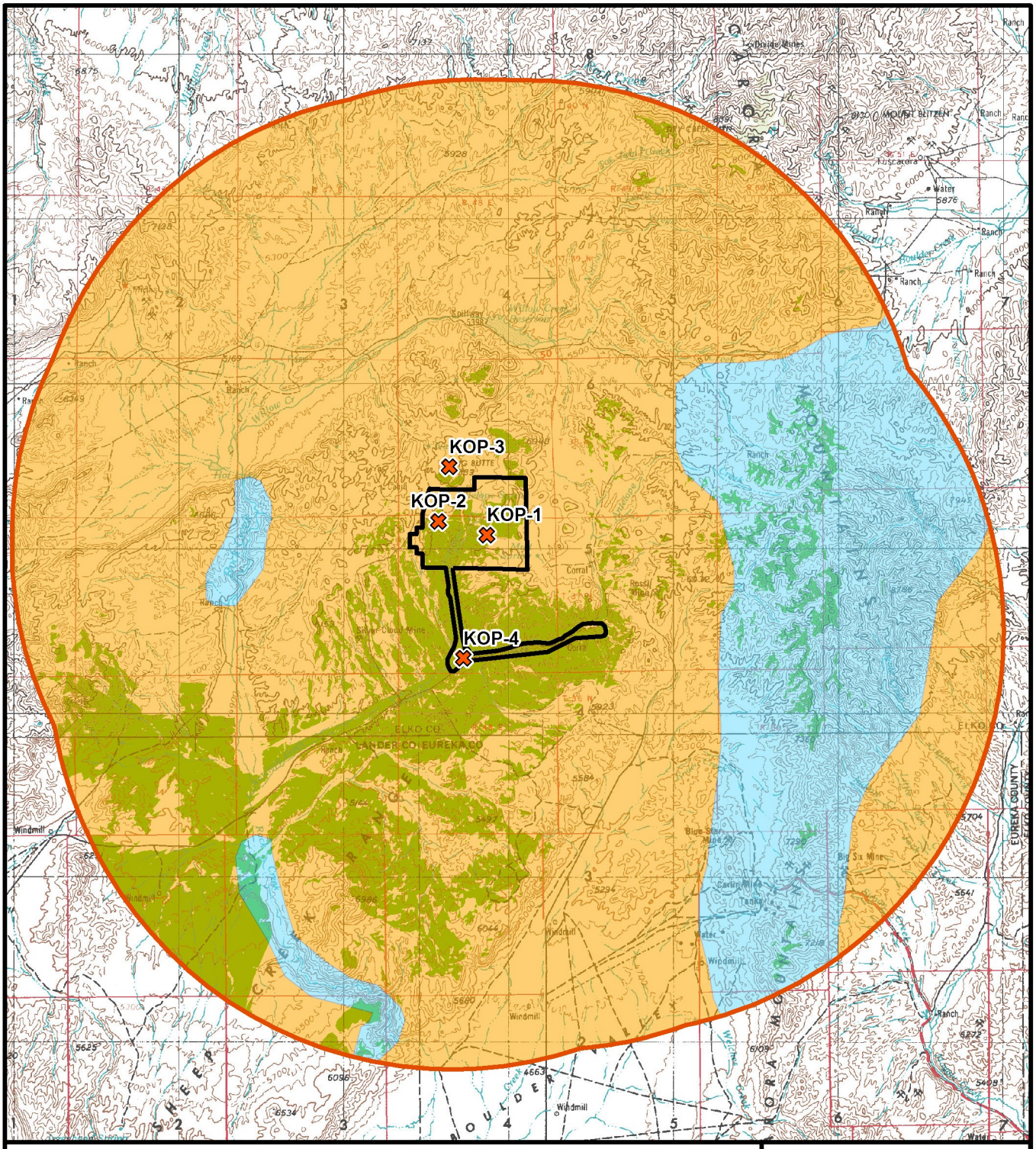

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Figure 3.22-3

VRM Classes for the Study Area and Cumulative Effects Study Area

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Areas that have been reclaimed show substantial mitigating effects that the reclamation has had on the visual environment. The irregular softening and rounding of the slopes is more like the natural terrain of the foothills than the angle of repose from dumping on the existing RCG WRSF. This reclamation reduces the landform and line contrast to a relatively low level. Although shrub growth has not yet reached a level to mimic the vegetation of the surrounding valley, and the grasses are characteristically sparse, this early stage of revegetation substantially reduces the color contrast.

Structures in the visual analysis area are geometric in form and limited mainly to mining structures. There also are a few fence lines and a 345-kilovolt (kV) transmission line traversing the area. The fences and utility line have both a linear and structural character in the large, open landscape. Road scars are prominent linear man-made features in the study area, most apparent in the valleys and side slopes. The existing 345-kV transmission line is constructed of metal galvanized single pole framework. The proposed 120-kV transmission line would be located parallel to the existing 345-kV transmission line and constructed in an H-frame or double wood pole structures and shorter in height than the higher voltage line. The proposed 24.9-kV transmission line located along Little Antelope Creek would be constructed of a single wood pole with two crossbar structures.

The project vicinity is visible from Big Butte and the Mud Springs, Antelope Creek, and Little Antelope Creek roads. None of these roads are highly traveled.

The BLM established one VRM class in the study area, VRM Class IV, based on the Elko Resource Management Plan Visual Resource Management Classes (BLM 1987). The management objectives for this class are described in **Table 3.22-1**. In the CESA, there are areas designated Class III and Class IV. The Visual Resource Inventory for the Elko District is in progress.

3.22.2 Environmental Consequences

Potential visual impacts associated with the proposed project were analyzed using the procedures outlined in the BLM Visual Resource Inventory Handbook H-8410-1 (BLM 1986b). Visual impacts were determined by comparing visual contrast ratings for the proposed project facilities with the VRM class objective (**Table 3.22-1**) for the project study area, VRM Class IV. The process involves comparing the degree of visual contrast from the proposed facilities and activities with the existing landscape character both during active mining and after reclamation is completed. The contrast rating process used four KOPs (**Figure 3.22-1**) as the viewpoints for conducting the impact analysis.

KOP-1, located on Mud Springs Road, was selected to represent the view for travelers approaching from the east. KOP-2 is located on the Ivanhoe Road and represents the view for travelers approaching from the northwest. KOP-3, located at the top of Big Butte approximately 2 miles north of the Hollister Site, is different than the other three KOPs in that it represents a sensitive, but infrequently used, viewpoint. Native Americans consider Big Butte to be a sacred site and it is a known TCP. KOP-4, located on the Antelope Creek Road, represents the view for travelers approaching from the southwest in the vicinity of the proposed Rodeo Creek Substation and transmission lines. All of the approach routes are lightly traveled, and are the only improved routes to and through the area. Most traffic in the area is generated by local mineral development or ranching activity. However, there also is some traffic associated with recreational hunting and camping activities.

3.22.2.1 Proposed Action

Development of the proposed project would expand the amount of visual contrast that currently exists between existing and previously approved exploration-related facilities and the natural character of the landscape. The primary change in visual effects from the currently approved levels would be the addition of the proposed Hatter production shaft, raise, or ramp, new mine facilities buildings, and the transmission lines and Rodeo Creek Substation. For the purposes of this visual analysis, the production shaft was analyzed for potential impacts because it is taller and would cause the most

visual impact and greatest surface disturbance compared with a ramp or raise. The proposed project also would extend visual effects through the use of the area and proposed mining activity. As noted in Section 3.22.1, Affected Environment, prior to completion of reclamation, the existing mine features exhibit strong color contrast, especially under bright, clear light conditions. In addition, there are moderate to strong line and landform contrasts generated to a large extent by the shapes of the existing RCG WRSF. Finally, there is moderate texture contrast between the bare surfaces of the mine features and the vegetation textures and patterns in the natural landscape. The proposed project primarily would expand the visual effects in the vicinity of the existing mine area, and would be most prominent during active mining. The visual contrast effects gradually would become less prominent with reclamation.

Under the Proposed Action, the West Pit would be partially backfilled with waste rock and reclaimed. Reclamation of the West Pit WRSF would result in reduced visual contrast effects compared with the visual effects of the existing West Pit.

The proposed facilities would have visual characteristics during active mining that would be similar to existing facilities, notably a geometric form and exposed earth surfaces. As a result, the proposed project would have similar, but expanded, visual effects to those already occurring from the existing facilities, including moderate color contrast, weak to moderate line contrast, and weak texture contrast. The key considerations, therefore, are the degree of expansion of the visual impacts, and the amount of contrast permissible under the VRM Class IV objective.

Visual contrasts from the proposed project would be greatest at KOP-1 and KOP-2. The existing disturbance in the vicinity of the proposed production shaft has been successfully reclaimed and revegetated. The proposed production shaft would rise approximately 120 feet above the ground, and the mine office complex buildings would be approximately 40 feet tall. Lighting used to facilitate around-the-clock mining would increase the visual contrast at night. All of the area proposed for disturbance is rated VRM Class IV. The objective for Class IV states, “the level of change to the characteristic landscape can be high.” Due to the scale of the structure, and the weak color contrast combined with moderate to strong line contrast, it is expected that the proposed production shaft would achieve the requisite level of landscape change in the short term, during active mining. **Figure 3.22-4** illustrates a simulation of the visual effects as seen from KOP-1.

The proposed mine office complex on the western side of the mine area would be constructed on previously disturbed land. The visual effects would be relatively minor, because the complex size is small and would be seen as extensions of the existing and previously approved activities. In addition, as described in Section 2.4.9, Applicant-committed Environmental Protection Measures, structures at the Hollister Mine would be painted in colors that match the natural surroundings. The mine office complex is behind a ridge and is not visible from KOP-2 (**Figure 3.22-5**). The proposed production shaft would be partially seen from view from KOP-2. **Figure 3.22-6** illustrates a simulation of the visual effects as seen from KOP-2.

Recent past and on-going reclamation efforts have been effective at mimicking natural landforms in the project vicinity. The same reclamation standards would be implemented for the proposed project. As a result, it would be expected that the visual contrasts from proposed facilities would be reduced after reclamation. As a result, the residual visual effects (as seen from KOP-1) would be expected to achieve the VRM Class IV objective.

The proposed project would be visible from KOP-2; however, the effects would be less visually dominant than from KOP-1. Upper portions of the proposed facilities would be screened from view at this KOP by existing terrain. With this degree of screening, it is anticipated that the visual contrast effects at KOP-2 would be moderate even during the peak of active mining. As a result, the VRM Class IV objective would be met from this viewpoint. After completion of reclamation, it is anticipated that the visual contrast would be reduced to low levels.

The majority of the proposed project facilities would not be visible from KOP-3, because the land slopes away from viewers. The most prominent feature that would be visible would be the proposed production shaft, which would be slightly over 2 miles from the KOP and would rise approximately 120 feet above the natural ground surface. Other facilities would be entirely screened by intervening terrain. **Figures 3.22-7** and **3.22-8** illustrate simulations of the daytime and nighttime visual effects as seen from KOP-3 during daytime and nighttime, respectively. Given the terrain and existing facilities located in the East Pit, visual impacts during daytime and nighttime would be minor. The weak color contrast facility would achieve the Class IV objective during its active life. After successful completion of reclamation, it would comply with the objective in the long term.

The top of Big Butte is the highest point in the immediate vicinity. From this perspective, a viewer would be able to experience broad vistas of north-central Nevada. The proposed facilities would not dominate the viewer's attention and the existing, natural character of the landscape would be "partially retained." This degree of visual contrast would be further lessened with completion of reclamation.

The moderate color and line contrasts of the transmission line and substation as seen from KOP-4 would achieve the Class IV objective during the project's active life. After successful completion of reclamation, it would comply with the objective in the long term. **Figure 3.22-9** illustrates a simulation of the visual effects as seen from KOP-4. **Figure 3.22-2** illustrates the spatial extent (188,756 acres) of visual impact of the Proposed Action within the foreground-middleground and background distance zones (15 miles).

Visual contrasts from the surface exploration disturbances, including drill sites, storage areas, and roads, would be visible in the immediate foregrounds and middle grounds from KOP-1, KOP-2, and KOP-3, and in the middle ground from KOP-4. Contrasts would range from weak to moderate for form, line, and color, and none to weak for textures. Safety lighting would increase the visual contrast at night. The area of disturbance is rated VRM Class IV. The scales of the disturbances and the weak to moderate form, line, and color contrasts would achieve the requisite "moderate" level of landscape change for Class IV areas during active exploration. All visual contrasts would gradually become less prominent with reclamation.

The proposed project would comply with the Class IV objective during active mining and after reclamation because the color contrast and landform contrast would be weak.

3.22.2.2 Mud Springs Road Transmission Line Alternative

Under this alternative, the transmission line route would originate at a new substation constructed immediately adjacent to (North Option) or southwest of (South Option) the Coyote Creek substation and then parallel the Mud Springs Road to the mine complex. The visual impacts of this alternative including the North and South options, would be similar to the impacts of the Proposed Action in that all facilities except for the transmission line route and substation would be in the same location as for the Proposed Action. None of the project elements would be visible from KOP-4. **Figures 3.22-10** and **3.22-11** illustrate the spatial extent (North Option – 222,675 acres; South Option – 192,484 acres) of visual impact of this alternative within the foreground-middleground and background distance zones (15 miles).

3.22.2.3 Mud Springs Waste Rock Storage Facility Alternative

Visual contrasts from the Mud Spring WRSF would be greatest at KOP-1 where it is visible in the immediate foreground. It also would be visible from KOP-3 at a distance of 2.9 miles. It would not be visible from KOP-2 and KOP-4. The crest of the Mud Spring WRSF would be approximately 100 feet above the ground. Lighting would increase the visual contrast at night. The area of disturbance is rated

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Figure 3.22-4
Key Observation Point 1

Visual Simulations

3.22-9

Note: All dimensions shown are approximate and not to scale.

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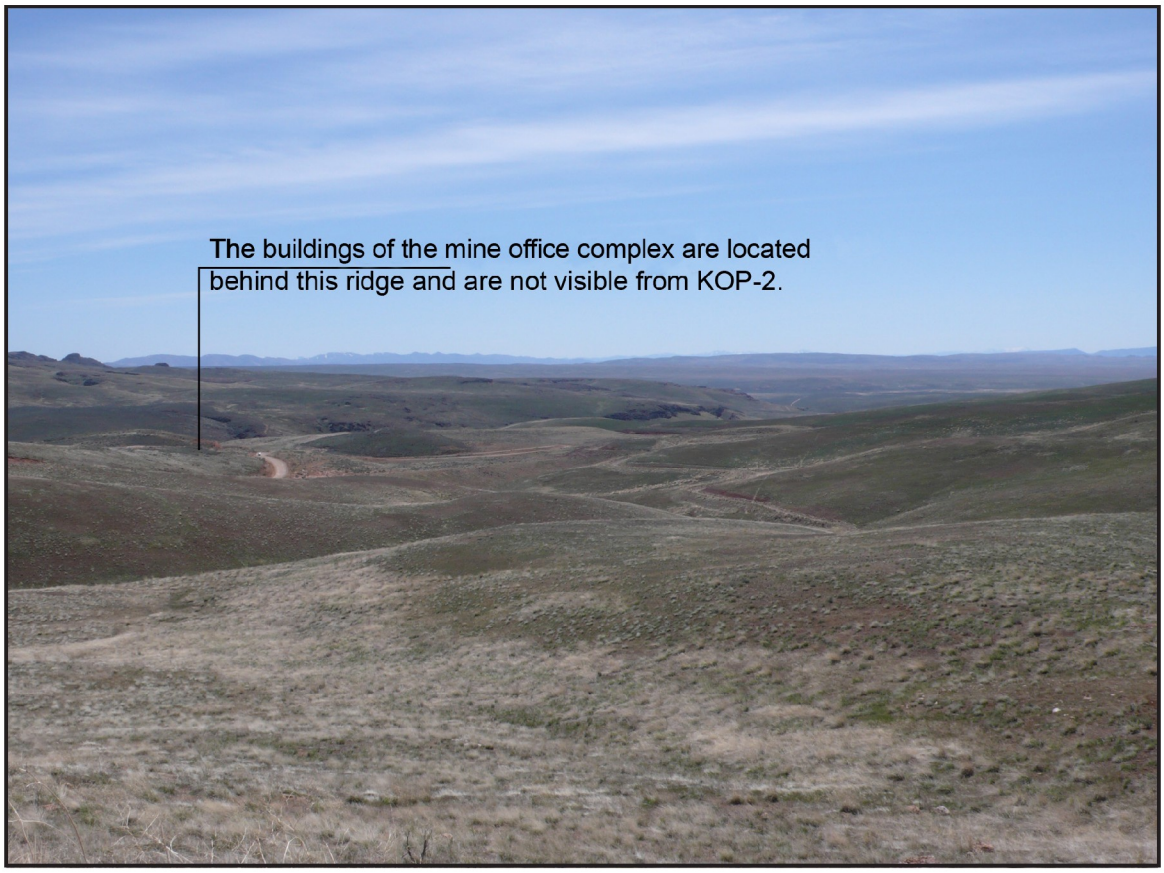

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Figure 3.22-5

View from KOP-2 of the Mine Office Complex Area

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Figure 3.22-6
Key Observation Point 2

Visual Simulations

3.22-11

Note: All dimensions shown are approximate and not to scale.

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Figure 3.22-7
Key Observation Point 3

Visual Simulations

3.22-12

Note: All dimensions shown are approximate and not to scale.

03/12/2012

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Figure 3.22-8

Key Observation Point 3 Nighttime Visual Simulations

3.22-13

Note: All dimensions shown are approximate and not to scale.

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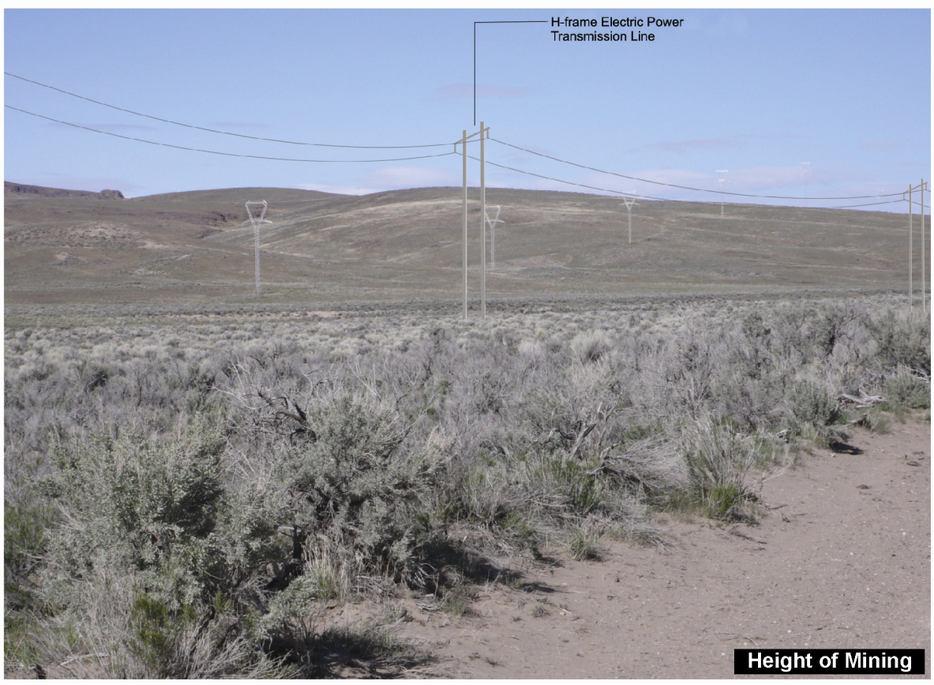

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Figure 3.22-9
Key Observation Point 4

Visual Simulations

3.22-14

Note: All dimensions shown are approximate and not to scale.

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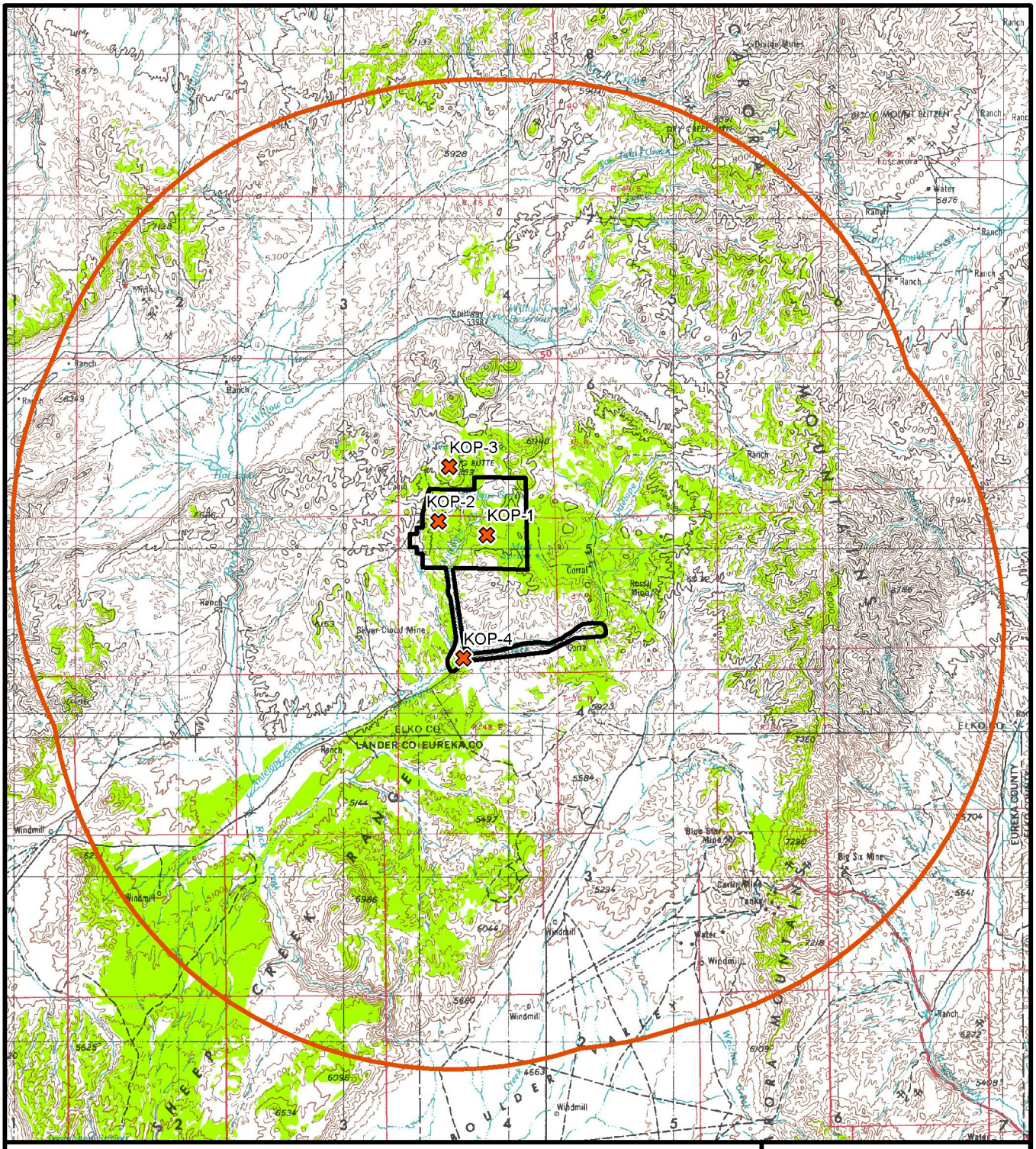

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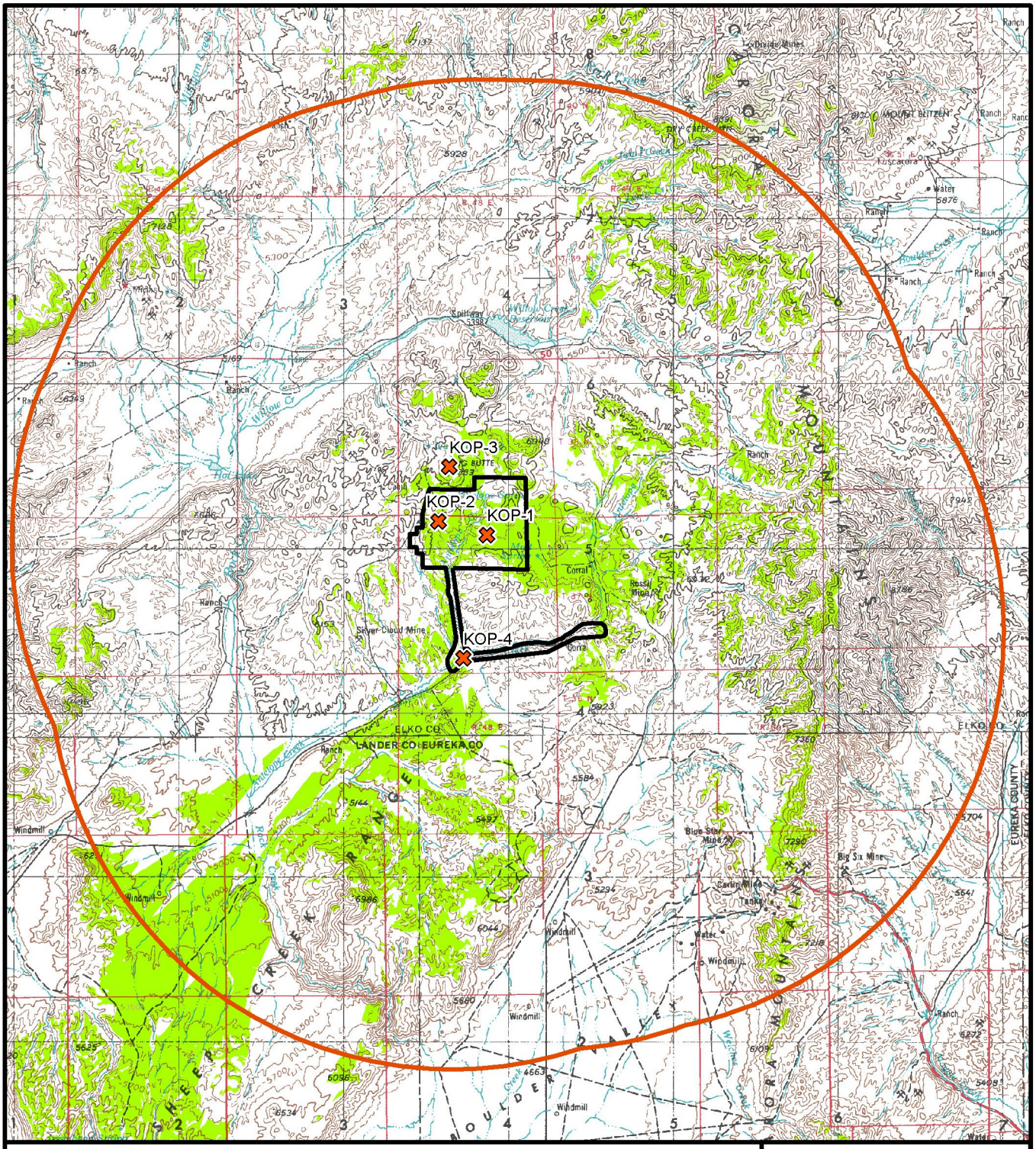
Figure 3.22-10

Viewshed Area for the Mud Springs Road Electric Power Transmission Line Alternative (North Option)

3/20/2012



Legend

- Key Observation Point
- Project Area Boundary
- Not Visible
- Visible
- 15-mile Buffer and CESA Boundary

Hollister Underground Mine Project EIS

Figure 3.22-11

Viewshed Area for the Mud Springs Road Electric Power Transmission Line Alternative (South Option)

3/20/2012

VRM Class IV. In the view from KOP-1, the existing landform disturbance behind and above this alternative has been successfully reclaimed and revegetated. The scale of the structure and the moderate form, line, color and texture contrasts would achieve the requisite "high" level of landscape change during active mining. In the view from KOP-3, visual contrasts would be weak for form, line, color, and texture. All visual contrasts from KOP-1 and KOP-3 would gradually become less prominent with reclamation.

3.22.2.4 Backfill Alternative

Visual contrasts from the Backfill Alternative would be weak for form, line, color and texture in the view from KOP-1 where it is visible in the immediate foreground. It would not be noticeable from KOP-2, KOP-3 or KOP-4. The area of disturbance is rated VRM Class IV. In the view from KOP-1, the scale of the disturbance and the weak contrasts would achieve the Class IV objectives for permissible landscape change during active mining. All visual contrasts would gradually become less prominent with reclamation.

3.22.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be constructed. As a result, there would be no additional disturbance beyond what currently exists or is currently permitted. Exploration activities permitted under current authorizations would continue, including reclamation of disturbance areas, which ultimately would reduce the visual contrast from exploration-related activities. The visual effects of the existing project were considered to be "less than significant" (BLM 2004a).

3.22.3 Cumulative Impacts

The CESA for visual resources is shown in **Figure 3.22-2**. Past and present actions and RFFAs are identified in **Table 3.2-1** and shown in **Figures 3.2-1** and **3.2-2**.

Visual effects of past and present actions are included in the description of the Affected Environment (Section 3.22.1). The future actions that would create visual effects are predominantly mine and mineral exploration activities. There also would be a potential increase in the number and extent of dirt roads. Among these actions, the mining projects would be the most likely to introduce visual contrast in the CESA. However, all of the identified future actions would be located in VRM Class III and VRM Class IV areas, so it is anticipated that the visual disturbance would meet the standards of the VRM Class III objective, which provide for "moderate change" in the landscape and VRM Class IV objective, which provide for major change in the landscape. Based on the project's proposed reclamation plan and the assumption that standard reclamation requirements would be required for permitting of future projects, the cumulative visual effects would be minimized to the degree possible after completion of the projects and successful reclamation is accomplished.

Cumulative visual effects associated with the alternatives would be similar to the cumulative visual effects associated with the Proposed Action. As previously described, the visual effects of past and present actions are included in the description of the Affected Environment (Section 3.22.1).

3.22.4 Potential Monitoring and Mitigation Measures

Applicant-committed Environmental Protection Measures, described in Section 2.4.9.7, would consist of painting the buildings to blend into the surrounding terrain, either a tan or sage green color; completed reclamation and closure at the end of mine life with concurrent reclamation where possible; and contoured WRSFs to provide a natural looking post-reclamation landform. No monitoring or additional mitigation would be necessary.

3.22.5 Residual Impacts

Residual adverse visual effects would result from the long-term changes in landform and color contrasts associated with construction of facilities such as the production shaft and transmission lines. The visual contrast effects would be eliminated after reclamation and closure of the mine site, when the vegetation in the area either reaches maturity, or the area burns and vegetation re-establishes at the same time.

3.23 Noise

The direct effects study area and cumulative effects study area (CESA) for noise effects encompasses an area within a 5-mile radius of the existing East Pit area (**Figure 3.23-1**). Past and present actions, and reasonably foreseeable future actions (RFFAs) are discussed in Section 3.2. Noise from the mine is unlikely to be problematic beyond 2 to 3 miles from the pit, but the potential sensitivity of sage-grouse lek activity in the area led to expanding the study area to a 5-mile radius.

3.23.1 Affected Environment

Noise-sensitive receptors and existing noise sources in the project vicinity are described below. Terrain features that may affect noise transmission are characterized and existing noise levels are presented.

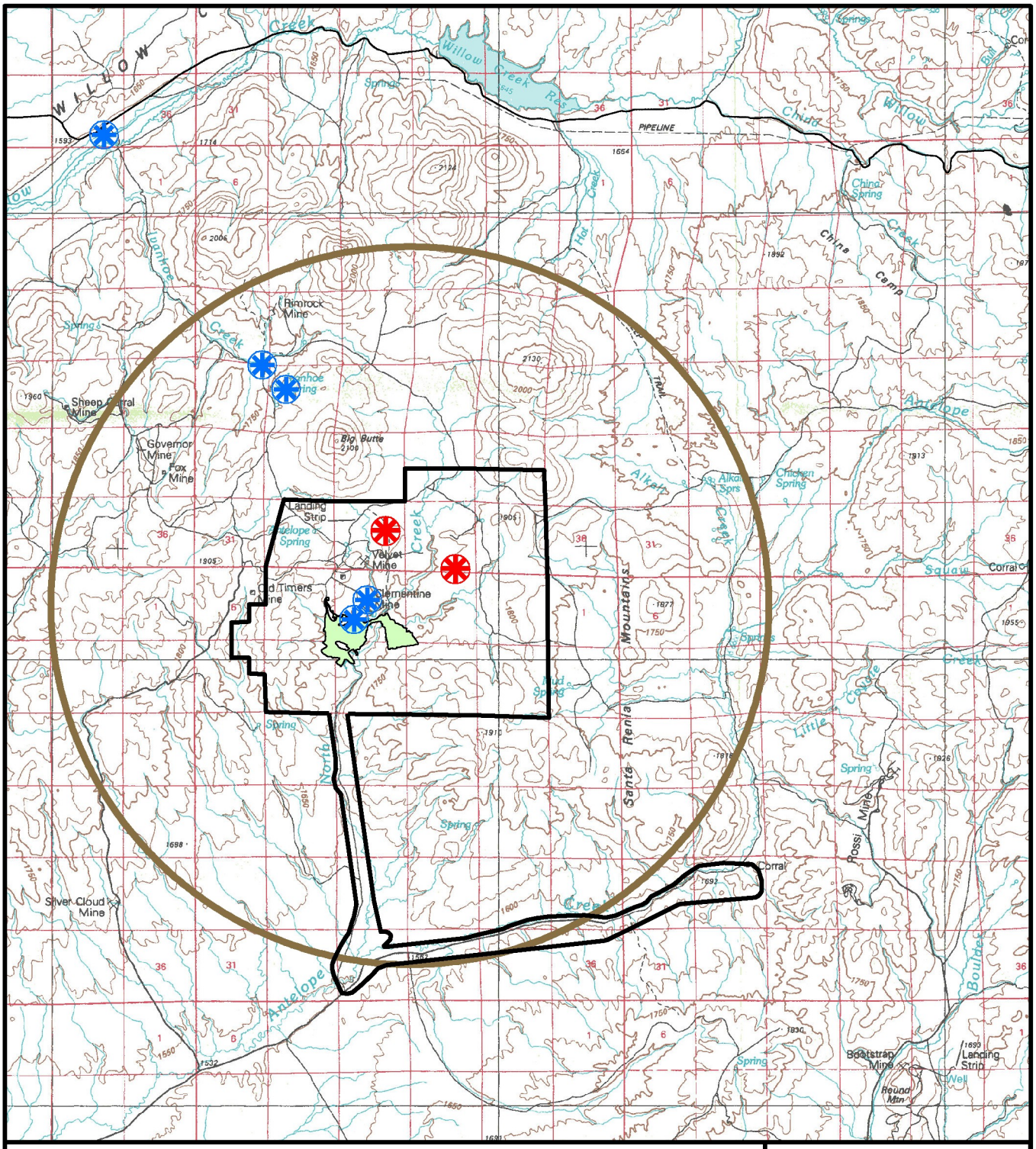
The project area is located in a relatively remote area where the only signs of development are the remnants of historic mining projects and active mineral exploration. There are no occupied ranches in the study area. The nearest ranch is the Squaw Valley Ranch, more than 10 miles to the northwest. For the proposed project, the potential noise sensitive receptors include traditional cultural properties (TCPs) associated with Big Butte and the Ivanhoe and Buttercup Springs complex and two active greater sage-grouse leks (East Velvet lek and East Clementine lek), which are considered sensitive because the greater sage-grouse is a federal candidate and Bureau of Land Management (BLM)-sensitive species (see Section 3.14, Special Status Species).

Natural sounds, including wind, insects, and birds, are the principal contributors to ambient noise in most portions of the study area. Variations in wind speeds can have a dramatic effect on noise levels in the area. Traffic from the Hollister operations generates periodic vehicular noise, although the traffic is very light. There also is a very small amount of ranch-related and dispersed recreation-related traffic in the area on an occasional basis. The principal sources of noise in the project area are the two diesel generators currently operating in the East Pit and, to a lesser degree, other Hollister operations equipment, most of which also is within the East Pit.

Terrain in the study area is very irregular. The tops of the existing pit walls are at approximately 5,740 feet above mean sea level (amsl) in elevation, which is 225 feet above the floor of the East Pit at 5,515 feet amsl. The terrain rises in elevation to a row of low hills (between 5,900 feet and 6,100 feet amsl) to the north, drops off moderately to approximately 5,825 feet amsl, and then rises dramatically to the top of Big Butte at 6,889 feet amsl. The rounded cone of Big Butte, which lies approximately 3 miles north of the East Pit, is the most prominent topographic feature in the study area.

Noise levels in the study area were determined from measurements taken at several locations in the project vicinity. Measurements were taken 24 hours per day over a period of 6 days at the two active lek sites nearest the proposed mine site: the East Velvet lek and the East Clementine lek. A series of shorter measurements were taken at a site near Ivanhoe Creek at the base of Big Butte and near the Ivanhoe and Buttercup Springs Complex (**Figure 3.23-1**).

In addition to the measurements of ambient conditions, noise levels from generators and other mine machinery were measured in the East Pit and from the top of the pit wall. Also, ore truck noise levels were measured at a site adjacent to Ivanhoe Road, near the Midas-Tuscarora Road, where trucks were operating at normal speeds on nearly level ground. A summary of noise measurement results are provided in the Noise Technical Report (Planera 2010).



Hollister Underground Mine Project EIS

Figure 3.23-1

Noise
Direct Effects and Cumulative Effects Study Area

1/20/2012

Noise levels in the study area were generally relatively low, as would be expected in a remote area. They tended to be quite consistent during the daytime hours, but were somewhat more variable at night, although the nighttime levels were notably lower, on average, than daytime levels. Identifiable noise sources at the lek sites were wind, insects and birds. Identifiable sources near the springs complex included occasional vehicle traffic on Ivanhoe Road, in addition to wind, insect and bird sounds. There also was a low level sound from flowing water in close proximity to the springs.

Because of the concern for effects on greater sage-grouse, hourly noise data were aggregated for three time periods: 6:00 a.m. to 10:00 a.m., 10:00 a.m. to 6:00 p.m., and 6:00 p.m. to 6:00 a.m. The 6-day hourly averages for the morning and afternoon time periods were very consistent at the lek sites. Measured levels for those time periods were 45.6 decibels on the A-weighted scale (dBA) and 46.5 dBA, respectively, at the East Clementine lek and 44.3 dBA and 48.3 dBA, respectively, at the East Velvet lek. While there was some variability from day-to-day, the hourly averages fell in narrow ranges between 44 dBA and 47 dBA during the morning time block and between 44 dBA and 49 dBA during the afternoon time block. Levels were lower during the nighttime period, particularly from 9:00 p.m. to 5:00 a.m., but they also varied over a wider range. Single hourly equivalent continuous sound levels (L_{eq}) were measured as low as 17.5 dBA and as high as 55 dBA. Nighttime hourly average dBA over the 6-day period were typically in the mid-20s to low 30s at the lek sites.

The noise level was 38.1 dBA at the Ivanhoe and Buttercup Springs Complex, averaged for several short measurement periods in the mid to late afternoon. This is somewhat lower than the levels measured at the lek sites for comparable time periods. The area around the springs is somewhat more sheltered than the lek sites. It is not known whether this contributed to the difference in noise levels, or if the difference simply resulted from the short measurement times missing a broader range of noise sources. Ore trucks passing the spring complex on Ivanhoe Road were discernible for approximately 3 minutes each, although they only raised the measured sound level to slightly less than 50 dBA for a fraction of that time. Smaller vehicles were barely audible from the vicinity of the springs.

For comparison purposes, **Table 3.23-1** illustrates noise levels associated with several common indoor and outdoor activities, which is helpful for understanding noise emission levels from the proposed project.

Table 3.23-1 Typical Values of Sound Level of Common Noise Sources

Sound Pressure Level (dBA)	Common Indoor Noise Levels	Common Outdoor Noise Levels
110	Rock band	--
105	--	Jet flyover at 1,000 feet
100	Inside New York subway train	--
95	--	Gas lawn mower at 3 feet
90	Food blender at 3 feet	--
85	--	Heavy truck at 50 feet
80	Garbage disposal at 3 feet, or shouting at 3 feet	Noisy urban daytime
70	Vacuum cleaner at 10 feet	Gas lawn mower at 100 feet
65	Normal speech at 3 feet	Commercial area, heavy traffic at 300 feet
60	Large business office	--

Table 3.23-1 Typical Values of Sound Level of Common Noise Sources

Sound Pressure Level (dBA)	Common Indoor Noise Levels	Common Outdoor Noise Levels
50	Dishwasher in next room	Quiet urban daytime
45	Small town residence	--
40	Small theater, large conference room	Quiet urban nighttime
35	Soft whisper at 6 feet	Quiet suburban nighttime
33	Library	--
28	Bedroom at night	--
25	Concert hall (background)	Quiet rural nighttime
15	Broadcast and recording studio	--
5	Threshold of hearing	--

Sources: BLM 2000e; Harris 1979.

No noise measurements were taken for the Esmeralda or Midas mill locations or along the ore transport routes. Considering the location and operational status of the mill, it is assumed that noise levels greater than 1 mile from the mill would be in the range of low-to-mid-30s dBA at night to mid- to upper-40s dBA during the day. As with most remote areas in Nevada and throughout the West, wind conditions are a major determinant of actual levels at any particular time, with insect and bird noises being the most common sources of noise when wind speeds are low. Noise levels within 0.25 to 0.5 mile of the mill are likely dominated by mill activities and probably range upwards of 55 dBA, or higher, depending on proximity to the mill. Noise level estimates for the Esmeralda Mill vicinity are based on measurements and observations from other mining projects in Nevada. No particular noise sensitive receptors have been identified near the Esmeralda Mill.

Noise along the ore transportation route from the Hollister Mine to the Esmeralda Mill is generally dominated by traffic noise. Interstate 80 is one of the nation's major east-west truck routes, carrying between 7,000 and 8,000 vehicles per day (vpd) at high speeds with a high percentage of trucks in the traffic stream (Nevada Department of Transportation [NDOT] 2009) (see Section 3.3, Land Use and Access). U.S. Highway 95 (U.S. 95) is one of the few major north-south highways in Nevada, which carries relatively high traffic volumes ranging from 1,500 vpd to 3,100 vpd in rural areas and much higher volumes in Fallon and Hawthorne (NDOT 2009). Even State Route (SR) 359 carries over 2,000 vpd in Hawthorne (NDOT 2009). At the traffic levels carried by these major highways, noise levels would be relatively constant throughout the day and evening hours with somewhat more erratic levels in the late night and early morning hours, especially on U.S. 95 and SR 359. There are numerous residences and other noise sensitive land uses within hearing range of the traffic route from the Hollister Mine to the Esmeralda Mill.

3.23.2 Environmental Consequences

Noise impacts are commonly judged according to two general criteria: the extent to which a project would exceed federal, state, or local noise regulations, and the estimated degree of disturbance to people. In the case of the proposed project, there also is a concern about disturbance of the mating activities of sage-grouse at two leks in the vicinity. There are no specific federal, state, or local noise

regulations that would govern at the Hollister Mine. Neither the State of Nevada nor Elko County has noise regulations governing mining operations.

Without legislative guidance, the degree of disturbance becomes the key factor in evaluating noise effects. There are no residences or other common gathering places, such as schools or churches, in the study area. Consequently, the loci of concern for noise effects are the Ivanhoe and Buttercup Springs complex and Big Butte TCPs and the East Clementine and East Velvet sage-grouse leks. The concept of human disturbance is known to vary with a number of interrelated factors, including not only changes in noise levels, but the presence of other, non-project related noise sources in the project vicinity; peoples' attitudes toward the proposed project; the number of people exposed; and the type of human activity affected (e.g., sleep, quiet conversation or religious rituals as compared to physical work or active recreation). Little is known about the specifics of what type or level of noise would adversely affect greater sage-grouse mating behavior.

In the absence of applicable noise regulations or specific standards, the noise analysis used 65 dBA day-night (average sound) level (L_{dn}) as an absolute level criterion, and a 10–decibel increase above existing levels as a relative criterion, to evaluate projected project-related noise at TCP sites. The 65 dBA L_{dn} criterion is based on U.S. Department of Housing and Urban Development (HUD) noise guidelines, which identify levels in excess of 65 dBA L_{dn} as “normally unacceptable” for exterior noise for residential areas (HUD 1996). A 10 dBA increase is perceived as a doubling of sound and is considered a likely indicator of community annoyance. The 10 dBA figure is based on U.S. Environmental Protection Agency (USEPA) studies showing that an increase of 10 dBA over existing background noise levels has commonly caused nearby residents to vigorously complain (USEPA 1974).

3.23.2.1 Proposed Action

Hard rock mining commonly conducted above ground generates noise from two primary sources: operations of both stationary and mobile heavy equipment, and blasting to loosen overburden and ore from the bedrock for removal by truck and shovel operations. In the case of the proposed project, however, most blasting would occur underground and would not be audible on the surface, except perhaps for a brief period for surface construction of the Hatter production shaft, ramp, or raise (HPS). Consequently, equipment noise emissions would be the primary noise sources from the proposed project. The Proposed Action would not require additional equipment at the mine site. **Table 3.23-2** illustrates the roster of mobile equipment likely to be contributing to site noise levels both currently and under the Proposed Action. Additional equipment is in use underground, but it would only rarely depart from the portal for maintenance or repair and would not be a notable contributor to the project noise.

Under the Proposed Action, the generators would be replaced during normal operations by the proposed 24.9-kilovolt electric power transmission line (transmission line) and would be used only in the event of an emergency power outage. All other surface equipment at the mine site would remain the same as in current usage. The effect on noise from operations of the Proposed Action would be a reduction in mine site noise emissions, possibly by as much as 5 dBA at the top edge of the existing pit and by a lesser amount at locations farther removed from the pit. Based on measurements and observations, it is likely that this would have no measurable effect on noise levels at the sage-grouse lek sites. Noise levels at TCP sites would not be affected by removing the generators from regular use.

Construction of the HPS would generate surface noise for up to 12 months. Construction of the shaft, hoist house and headframe would occur on a previously disturbed 5-acre site (**Figure 2-11**). There may be some blasting required, although the amount that would occur at the surface would be minor and of short duration. Other construction activities would utilize some heavy equipment in addition to power saws, nailers and welders. Noise from construction would likely be audible, but at low levels at the East Clementine lek, which is approximately 1.0 mile from the proposed shaft site with little, if any,

potential for terrain barrier noise attenuation. The East Velvet lek is 1.25 miles from the shaft site and would benefit from an intervening ridge so construction noise at that location would be minimal.

Noise from trucks transporting ore is currently noticeable at the Ivanhoe and Buttercup springs. Measured noise levels at the springs averaged 38 dBA (equivalent sound level [L_{eq}]) without heavy truck traffic. Ore trucks climbing the grade inbound to the proposed mine on Ivanhoe Road were audible for approximately 3 minutes at relatively low levels. Truck noise raised the noise level to just over 50 dBA for a few seconds and averaged approximately 41 dBA. Ore trucks headed out to Golconda were headed downhill and generated less noise despite being loaded on the outbound trip. There are currently approximately 4 trucks per hour inbound past the Big Butte TCP for two 1.5-hour periods per day, generally between 4:00 p.m. and 10:00 p.m. Under the Proposed Action, ore truck traffic would increase to as many as 25 inbound trips to the mine site per day, which would likely increase the time frame of trucks passing the location of the springs to as much as 6 hours per day.

Table 3.23-2 Mobile Mining Equipment Roster for Surface Use[1] and Associated Noise Emissions

Equipment Type	Units	Estimated dBA[2]
Underground Equipment		
Truck (15-30 ton capacities)	1	71
Transmixer/Cement Truck	1	75
Personnel Tractors	1	65
Flatbed Truck	1	71
Lube Truck	1	71
Powder (Explosive-Delivery)Truck	1	71
Surface Equipment		
Backhoe	1	82
Dozer[3]	1	85
Motor Grader[3]	1	85
Crane	1	82
Fork Lift	1	70
Front End Loader (7 to 8 cubic yards)	1	85
Water Truck	1	83
Supply Truck (flatbed truck)	1	85
Light Vehicles (pickups)	10 to 20	65

[1] It is assumed the listed underground equipment would travel in and out of the mine on a regular basis.

[2] Sound pressure levels measured at a reference distance of 50 feet.

[3] This equipment would be contracted and used on an as-needed basis.

Source: RCG 2010b.

Noise effects from ore trucks were calculated for the top of Big Butte because it was identified as a TCP. Noise at the top of Big Butte from ore trucks would be lower than at the springs because the

crown of Big Butte is more than twice as far from the road. The maximum noise level from inbound ore trucks would likely be just over 40 dBA and the average would likely be in the low 30s dBA, which would be below the average ambient noise level on Big Butte. Truck noise may be discernible under quiet, low wind conditions, but would not be obtrusive.

Noise effects from ore transport to the Esmeralda Mill on residences and other sensitive receptors along the route would likely be minimal. The estimated maximum of 50 truck trips (26 more than the current number) would be a small fraction of either total traffic or truck traffic on the highways along the route. The resulting incremental increase in noise would not be quantifiable or noticeable to casual observers at noise sensitive areas along the route. Similarly, increasing the production at the Esmeralda Mill would have no measurable effect on noise levels in the area because the mill is currently fully equipped and operating. Increasing production may alter activity schedules, but the effects would be minimal and no specific noise sensitive receptors have been identified in the area.

Construction of the proposed Mine Office Complex would generate surface noise for approximately 12 months. Construction activities would utilize some heavy equipment in addition to a portable 200-kilowatt diesel generator, power saws, nailers, etc. Noise from construction would likely be audible at very low levels, if at all, at either the East Velvet lek or the East Clementine lek, which are 1.5 miles and 1.9 miles, respectively, from the proposed office site. Office construction noise would not be audible at the Ivanhoe Buttercup Spring Complex or at Big Butte.

Construction of the proposed transmission lines would be short-term and would move quite rapidly. Noise levels would be generally fairly low with heavy equipment limited to medium trucks, backhoes and truck mounted cranes. The entire length of the transmission lines would be a sufficient distant from any of the noise sensitive locations that the noise would not be audible.

The transmission line would emit humming noise occasionally, particularly in wet weather. The noise level of such emissions would be quite low, however, and the distance from the line to all identified active sage-grouse leks and TCPs is greater than 2 miles so the noise would not likely be audible at either type of noise-sensitive area.

Surface exploration activities would occur under the Proposed Action. Noise emissions from surface exploration would be generated by heavy equipment constructing drill sites, operating drill rigs, and drilling support equipment. Noise emission levels for both pad construction and drilling are estimated at approximately 87 dBA at a 50-foot reference distance. Resulting noise levels would be reduced to the 65 dBA threshold at a distance of approximately 630 feet from the drill site. However, with background levels of approximately 44 dBA measured at the sage-grouse lek sites during the day, noise levels would have to be reduced to 54 dBA to satisfy the “10 over” criterion. Noise levels from the surface exploration activities would be reduced to 54 dBA at a distance of approximately 2,235 feet from the drill site.

3.23.2.2 Mud Springs Road Transmission Line Alternative

Noise impacts under this alternative would be the same as described for the Proposed Action except the transmission lines would pass within approximately 1 mile of the East Clementine greater sage-grouse lek. As such, it is likely that some degree of construction noise would be audible at the lek, but at low levels and of short duration. The transmission line would emit humming noise occasionally, but the level of noise would be too low to be audible at a 1-mile distance.

3.23.2.3 Mud Springs Waste Rock Storage Facility Alternative

Development of the Mud Springs Waste Rock Storage Facility (WRSF) Alternative would result in heavy equipment activity at the alternative site an estimated 4 to 6 times per year for an undetermined length of time. This would employ large haul trucks and one or more track dozers on the WRSF, activity that would be largely confined to the existing pit areas under the Proposed Action. The site of

the Mud Springs WRSF would be at a base elevation of approximately 5,740 feet amsl, rising to an elevation of approximately 5,820 feet amsl over time. The only identified noise sensitive area likely to be affected by noise from this alternative would be the East Clementine sage-grouse lek. The site is approximately 6,200 feet southwest of the East Clementine lek with a direct line of sight and no intervening terrain barriers.

It is estimated that with 1 or 2 track dozers operating on the WSRF and a maximum of 2 to 3 large haul trucks present at the site at any given time, the Mud Springs WRSF Alternative would generate noise at a level of approximately 93 dBA at a reference distance of 50 feet from the center of activity. Assuming background noise at the East Clementine lek at the measured average daytime levels (45.6 dBA and 46.5 dBA), the Mud Springs WSRF Alternative would raise noise levels at the lek to approximately 52.4 dBA. This is not an unusually high level by human standards, but the effect on sage-grouse lek activity is uncertain. During windy periods, it is likely that background noise levels would be notably higher and the increment of increase in noise from the WRSF would be much smaller.

3.23.2.4 Backfill Alternative

Under the Backfill Alternative, the HPS and East and West raises would be backfilled with waste rock during reclamation and closure of the mine. Noise emissions would be generated from construction activities associated with this alternative: upgrading of the access roads to the East and West raises, loading of waste rock from a WRSF, transporting the waste rock in 20-ton capacity trucks, unloading of waste rock at the HPS and raises, and pushing the waste rock into the opening with a bulldozer or dumping the waste rock into the opening with a frontend loader. It is estimated that the HPS would require 1,536 truck loads of backfill material, the East raise would require 175 loads of material, and the West raise would require 234 loads of materials.

The nearest noise sensitive area likely to be affected by noise from this alternative would be the East Clementine sage-grouse lek for the HPS, and the East Velvet sage-grouse lek for the East and West raises. The East Clementine lek is located about 1 mile northeast of the HPS. The East Velvet lek is located approximately 1 mile northeast of the East raise and slightly more than 1 mile from the West raise. Given the location of the leks, it is likely that some degree of construction noise would be audible at the leks, but at low levels and of relatively short duration.

3.23.2.5 No Action Alternative

Under the No Action Alternative, the proposed project would not be constructed, and underground exploration and bulk sampling and testing activities would continue under current authorizations and permits. Two major sources of noise at the proposed Hollister Site currently are a pair of power generators and a set of large compressors used to ventilate the underground workings. Measurements taken in the existing East Pit at the Hollister Site registered 87.4 dBA at 50 feet from the generators and 84.0 dBA at 50 feet from the compressors (with some overlap due to proximity of the equipment). Measurements also were taken from the top of the East Pit wall, on the northwest side, with direct line of sight to the major equipment (both generators and compressor building), and also from a location 100 feet back from the edge of the pit. The measured level at the pit wall was 56.8 dBA, which when compared with the levels measured in the pit, indicates that the noise from the equipment is not projecting upward and, probably, that the pit is confining a major portion of the noise being emitted. The level measured 100 feet back from the pit wall was just 41.7 dBA, which was comparable to measured levels at the lek sites and demonstrated the added effect of “barrier attenuation” where the line of site to the noise sources was substantially interrupted.

3.23.3 Cumulative Impacts

The CESA for noise is shown in **Figure 3.23-1**. The past and present actions and RFFAs associated with mining and mineral exploration activities are identified in **Table 3.2-1**, and their locations are

shown in **Figures 3.2-1** and **3.2-2**. Past actions would have no effect on noise in the project area because noise emissions have terminated at the completion of a project or activity. Any potential cumulative noise effects from present actions are included in the measured background levels for the proposed project, although no such noise effects were observed at the time of the field monitoring. Noise from RFFAs would not be expected to cause cumulative effects with noise from the Proposed Action, because noise tends to be localized to an area within 2 to 5 miles of an activity, and there are no RFFAs that are both near enough to the identified sensitive receptors, and with sufficiently strong noise emissions, to create cumulative noise effects.

Cumulative noise impacts associated with the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives combined with past, present, and RFFAs, would be the same as described for the Proposed Action.

3.23.4 Potential Monitoring and Mitigation Measures

No further monitoring or mitigation measures are recommended for noise, other than the Applicant-committed Environmental Protection Measures, Section 2.4.9.

3.23.5 Residual Impacts

There would be no residual adverse effects on the environment from the noise generated during construction, mining, exploration, and reclamation activities. When mining and exploration activities cease, and reclamation activities are completed, man-made noise from the proposed project would cease. Removal and reclamation of the transmission line would terminate any occasional humming noise from that source.

3.24 Hazardous Materials and Solid Waste

3.24.1 Affected Environment

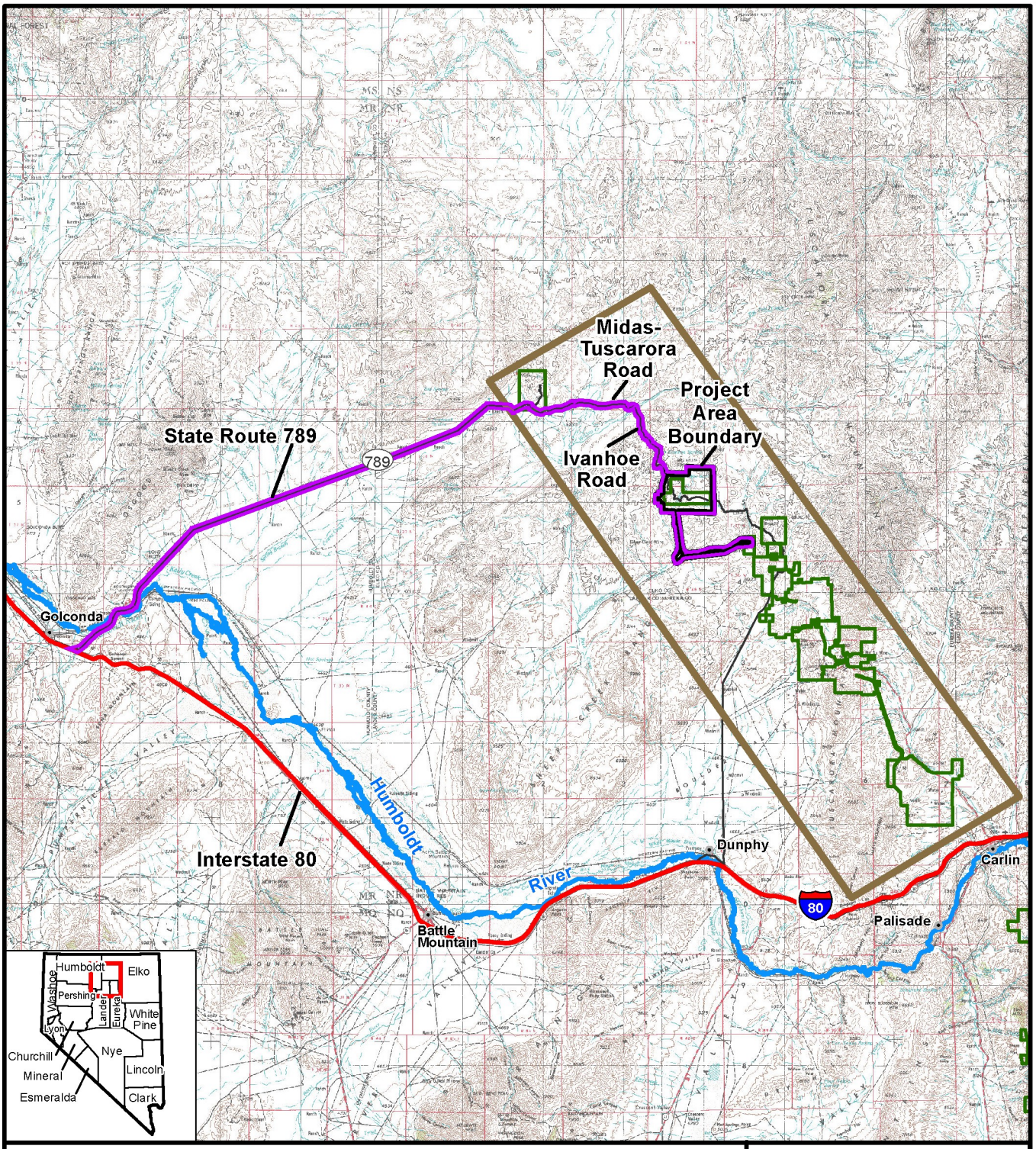
3.24.1.1 Introduction

The affected environment for hazardous materials includes air, water, soil, and biological resources that potentially could be affected by an accidental release of hazardous materials during transportation to and from the mine or during storage and use at the mine. The study area for direct and indirect impacts for hazardous materials and solid waste encompasses the project boundary and the transportation route for hazardous materials and wastes from Interstate 80 (I-80) and including State Route (SR) 789, the Midas-Tuscarora Road, and Ivanhoe Road (**Figure 3.24-1**). The cumulative effects study area (CESA) for hazardous materials and solid waste is shown in **Figure 3.24-1** and includes the aforementioned study area and the Carlin Trend north of I-80. The CESA extends from Newmont-Gold Quarry/South Operations Area Project in the south to the Midas Mine in the north to include mining and mineral exploration activity in the Carlin Trend. Past, present, and reasonably foreseeable future actions (RFFAs) in the CESA are described in Section 3.2. Mining and mineral exploration projects in the Carlin Trend are shown in **Figure 3.2-1**. The CESA chosen provides an adequate area of analysis in which to compare the relative effects of the Proposed Action to overall mining activity in the Carlin Trend. Within the CESA, there are projects and activities not related to mining such as community development, oil, gas, and geothermal leases, and wildfire management programs, as described in Sections 3.2.1, Paste and Present Actions, and 3.2.2, Reasonably Foreseeable Future Actions.

3.24.1.2 Regulatory Definitions of Hazardous Materials

“Hazardous materials,” which are defined in various ways under a number of regulatory programs, can represent potential risks to both human health and the environment when not properly managed. The term hazardous materials includes the following materials that may be utilized or disposed of in conjunction with mining operations:

- Substances covered under Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) Hazard Communication Standards (29 Code of Federal Regulations [CFR] 1910.1200 and 30 CFR 42): The types of materials that may be used in mining activities and that would be subject to these regulations would include almost all of the materials identified in Section 2.2.8, Hazardous Materials and Hazardous Waste Management.
- “Hazardous materials” as defined under United States Department of Transportation (USDOT) regulations at 49 CFR, Parts 170-177: The types of materials that may be used in mining activities and that would be subject to these regulations would include explosives, cement, fuels, some paints and coatings, and other chemical products.
- “Hazardous substances” as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and listed in 40 CFR Table 302.4. The types of materials that may contain hazardous substances that are used in mining activities and that would be subject to these requirements would include solvents; solvent-containing materials (e.g., paints, coatings, degreasers); acids; and other chemical products.
- “Hazardous wastes” as defined in the Resource Conservation and Recovery Act (RCRA) Procedures in 40 CFR 262 are used to determine whether a waste is a hazardous waste. The types of materials used in mining activities and that could be subject to these requirements could include liquid waste materials with a flash point of less than 140 degrees Fahrenheit, spent solvent containing wastes, corrosive liquids, and lab assay wastes. Hazardous wastes are regulated under Subtitle C of RCRA.



Legend

- Project Area Boundary
- Cumulative Effects Study Area
- Direct Effects Study Area
- Other Mine Plan Boundaries

N

0 5 10 Miles

Source: BLM 2009b.

Hollister Underground Mine Project EIS

Figure 3.24-1

Hazardous Materials Direct Effects Study Area and Cumulative Effects Study Area

08/26/2011

- Any “hazardous substances” or “extremely hazardous substances” as well as petroleum products such as gasoline, diesel, or propane, that are subject to reporting requirements if volumes on-hand exceed threshold planning quantities under Sections 311 and 312 of Superfund Amendments and Reauthorization Act (SARA): The types of materials that may be used in mining activities and that could be subject to these requirements would include fuels, coolants, acids, and solvent-containing products such as paints and coatings.
- Petroleum products defined as “oil” in the Oil Pollution Act of 1990: The types of materials used in mining activities and that would be subject to these requirements include fuels, lubricants, hydraulic oil, and transmission fluids.

In conjunction with the definitions noted above, the following lists provide information regarding management requirements during transportation, storage, and use of particular hazardous chemicals, substances, or materials:

- The SARA Title III List of Lists or the Consolidated List of Chemicals Subject to Emergency Planning and Community Right-to-Know Act and Section 112(r) of the Clean Air Act.
- The USDOT listing of hazardous materials in 49 CFR 172.101.

Certain types of materials, while they may contain potentially hazardous constituents, are specifically exempt from regulation as hazardous wastes. Used oil, for example, may contain toxic metals, but would not be considered a hazardous waste unless it meets certain criteria. Other wastes that might otherwise be classified as hazardous are managed as “universal wastes” and are exempted from hazardous waste regulation as long as those materials are handled in ways specifically defined by regulation. An example of a material that could be managed as a universal waste is used lead-acid batteries. As long as lead-acid batteries are recycled appropriately, requirements for hazardous waste do not apply.

Pursuant to regulations promulgated under CERCLA, as amended by SARA, release of a reportable quantity of a hazardous substance to the environment must be reported within 24 hours to the National Response Center (40 CFR Part 302). The Nevada Administrative Code (NAC) (445A.347) also requires immediate reporting of a release of a reportable quantity of a hazardous substance to the Nevada Division of Environmental Protection (NDEP). In addition, under the State of Nevada Water Pollution Control Permit program, all releases of a reportable quantity must be reported as soon as possible, but not later than 24 hours after the event, to the NDEP Bureau of Corrective Actions. Nevada regulates the storage and handling of certain defined “highly hazardous substances” under NAC 459.952-459.9542. The Nevada State Fire Marshall requires that storage of hazardous materials above certain specified thresholds requires a permit under NAC 459.9918 (Nevada State Fire Marshal and State Emergency Response Commission 2008).

3.24.1.3 Project-related Hazardous Materials

The hazardous materials to be used in the current exploration and proposed mining operations are described in Section 2.2.8, Hazardous Materials and Hazardous Waste, and in **Table 2-2**. The types of materials are briefly summarized below:

- Diesel fuel, gasoline, oils, greases, anti-freeze, and solvents used for equipment operation and maintenance;
- Sulfuric acid, calcium hydroxide, sulfuric acid, flocculants, lime, and antiscalants used for water treatment;
- Ammonium nitrate and high explosives used for blasting; and
- Wastes classified as hazardous waste.

3.24.1.4 Regulatory Definition of Solid Waste

Solid waste consists of a broad range of materials that include garbage, refuse, wastewater treatment plant sludge, non-hazardous industrial waste, and other materials (solid, liquid, or contained gaseous substances) resulting from industrial, commercial, mining, agricultural, and community activities (U.S. Environmental Protection Agency [USEPA] 2006). Solid wastes are regulated under different subtitles of RCRA and include hazardous waste (discussed in the previous section) and non-hazardous waste. Non-hazardous wastes are regulated under RCRA Subtitle D. In Nevada, solid waste rules are found in the NAC. Disposal of solid waste is regulated under NAC 444.570 444.7499; disposal of hazardous waste is regulated under NAC 444.850-444.8746.

3.24.1.5 Solid Wastes Generated from Mining Operations

The solid wastes at the Hollister Mine would include hazardous waste, solid non-hazardous waste, and sanitary waste. The facility generates hazardous waste in amounts to be considered a Conditionally Exempt Small Quantity Generator under the RCRA waste generator rules (less than 200 pounds per month) (Rodeo Creek Gold Inc [RCG] 2009a). Hazardous waste would consist of "universal wastes," which include florescent bulbs, aerosol paint can residue and filters, and used batteries including mine lights, NiCad and lithium types. Solid non-hazardous materials (for example, construction debris and trash) would be disposed at an off-site licensed facility. Appropriate materials (used oil, batteries, and antifreeze) would be recycled. Sanitary wastes would be dealt with by the existing septic system at the East Pit and new a septic system would be installed to service the proposed mine office, dry, and warehouse.

3.24.2 Environmental Consequences

3.24.2.1 Proposed Action

Under the Proposed Action the transport, storage, use, and disposal of hazardous materials for mine operations would continue for the life of mine (approximately 20 years) and for an additional 3 years for site closure and reclamation. If some of the chemicals identified for use during the life of the proposed expansion were to enter the environment in an uncontrolled manner, there could be associated direct or indirect adverse effects.

Transportation

All hazardous substances would be transported by commercial carriers or vendors in accordance with the requirements of Title 49 of the CFR. Carriers would be licensed and inspected as required by the Nevada DOT and USDOT. Tanker trucks would be inspected and would have a Certificate of Compliance issued by the Nevada Motor Vehicle Division. These permits, licenses, and certificates are the responsibility of the carrier. Title 49 of the CFR requires that all shipments of hazardous substances be properly identified and placarded. Shipping papers must be accessible and must include information describing the substance, immediate health hazards, fire and explosion risks, immediate precautions, firefighting information, procedures for handling leaks or spills, first aid measures, and emergency response telephone numbers.

A large-scale release of fuel or reagent would have implications for public health and safety. The location of the release would again be the primary factor in determining its importance. A release in a populated area could have effects ranging from simple inconvenience during cleanup to potential loss of life if an explosion and fire were involved. As shown in **Table 3.24-1**, the probability of a release anywhere along the transportation route is very small; the probability of a release within a populated area is smaller; and the probability of a release involving an injury or fatality is smaller still. The travel distance in **Table 3.24-1** is based on a 60-mile trip from I-80 near Golconda to SR 789 and the Midas-Tuscarora Road to Ivanhoe Road and then to the Hollister Site. Transportation along I-80 is not considered in the analysis because of the overwhelming number of loads being transported on the

interstate. Sulfuric acid is used in the analysis because it would be the hazardous material of greatest volume to be transported and used at the mine site. Diesel would initially be the most used hazardous material, but would be used in lesser (approximately 40 percent less) volumes than shown in **Table 2-2** when the largest existing diesel generators are replaced by utility-supplied electrical power. Blasting agents such as ammonium nitrate and high explosives use would increase approximately 50 percent over current usage.

Table 3.24-1 Probability of a Release of Sulfuric Acid

Material	Annual Use (gallons)	Shipment Quantity (gallons)	Number of Shipments[1]	Distance (miles)	Incident Rate per Mile[2]	Calculated Number of Incidents Over the 20-year Life-of-Mine[3]
Sulfuric Acid	38,400	4,000	200	12,000	.0000004	0.005

[1] 20-year life-of-mine (10 shipments per year X 20 years).

[2] Table 25, page 4-13 and Table 33, p. 5-4, Battelle (2001), includes accidents and en-route leaks, but not loading/unloading incidents.

[3] Number of incidents = (distance) X (incident rate).

Storage and Use

RCG has developed a Spill Prevention, Control, and Countermeasures (SPCC) Plan in accordance with 40 CFR Part 112, which describes the required level of containment and safety measures associated with storage, handling, and spill clean-up of oil (includes but not limited to petroleum, fuels, sludge, used oil, and mineral oil) (RCG 2009a, 2008a). Operations conducted in accordance with the SPCC Plan would ensure that impacts from spills would be minimized and the spilled materials contained and removed. Per the SPCC Plan, RCG also would have the necessary spill containment and cleanup equipment available at the site, and personnel would be able to quickly respond.

All hazardous substances would be handled in accordance with applicable MSHA regulations (Title 30 CFR). The hazardous materials to be used under the Proposed Action would be handled as recommended on the manufacturers' material safety data sheets. Based on the facility's design features and the operational practices in place, the probability of a major release occurring at the site during the life of the proposed mine expansion would be low.

Disposal

All hazardous waste generated at the mine would be transported to licensed disposal facilities in accordance with applicable federal and state regulations. Other solid wastes would be disposed of appropriately depending upon waste type.

Potential Effects of a Release

The environmental effects of a release would depend on the material released, the quantity released, and the location of the release. Potential releases could include a small amount of diesel fuel spilled during transfer operations at the mine site to the loss of several thousand gallons of diesel fuel or reagent into a riparian drainage.

The release of a hazardous material or waste into a sensitive area (such as stream, wetland, or populated area) is judged to be very unlikely. Depending on the material released, the amount released, and the location of the release, an accident resulting in a release could affect soils, water, biological resources, and human health.

Response to a Release

All spills, including transportation and loading/unloading spills occurring on site, would be cleaned up as soon as possible. If a spill exceeds the reportable quantity, it would be reported to the NDEP, USEPA, National Response Center, Bureau of Land Management (BLM), and the county Emergency Response Coordinator.

In the event of a release en-route to the mine site, the transportation company would be responsible for response and cleanup. Law enforcement and fire protection agencies also may be involved to initially secure the site and protect public safety. Hazardous material transporters are required to maintain an emergency response plan which details the appropriate response, treatment, and cleanup for a material spilled onto land or into water. For example, a release of sulfuric acid could require neutralizing the spill with lime, flushing the area with water, or removing contaminated soil.

For on-site spills, the procedures outlined in the SPCC Plan would be used to respond to petroleum and fuel spills. Specific procedures would be developed for other hazardous materials stored and used at the mine. Any cleanup would be followed by appropriate restoration of the disturbed area, which could include replacing removed soil, seeding the area to prevent erosion, and the return of the land to its previous use.

3.24.2.2 Mud Springs Road Transmission Line Alternative

There would be no difference in hazardous material use and transportation or solid waste generation under this alternative as compared to the Proposed Action. Therefore, the potential impacts would be the same as described for the Proposed Action.

3.24.2.3 Mud Springs Waste Rock Storage Facility Alternative

Under the Mud Springs Waste Rock Storage Facility (WRSF) Alternative, there would be no difference in hazardous materials use and transportation or solid waste generation under this alternative as compared to the Proposed Action. Therefore, the potential impacts would be the same as described for the Proposed Action.

3.24.2.4 Backfill Alternative

The Backfill Alternative would result in a slight increase (600 gallons) in overall fuel use. The potential impacts would be the same as described for the Proposed Action.

3.24.2.5 No Action Alternative

The present transportation and use of hazardous material and generation and disposal of solid waste would continue as a result of exploration activities under current authorizations until such authorization expires.

3.24.3 Cumulative Impacts

The CESA is shown in **Figure 3.24-1**. Past, present, and RFFAs are described in Section 3.2. The transportation and use of hazardous materials and the generation and disposal of solid waste would represent a small increase within the study area. For example, the usage of diesel fuel for the Proposed Action is estimated to be about 306,000 gallons per year at the Hollister Site, which amounts

to less than 1 percent of the 62 million gallons of annual diesel fuel combined consumption by Barrick and Newmont at their respective mining operations in the Carlin Trend (BLM 2010d,e). Based on the foregoing, the relatively small amount of hazardous material use expected for the Proposed Action at the Hollister Site as compared to use in the entire CESA, would only represent a very small increase in the risk of transportation spills and spills in the CESA. Given that ore processing would not take place in the project area, the use of hazardous materials would be much less than other mines in the area CESA and no cyanide would be transported or used at the mine site.

The cumulative impacts for the Mud Springs Road Transmission Line, Mud Springs WRSF, and Backfill alternatives would be the same as described for the Proposed Action.

3.24.4 Potential Monitoring and Mitigation Measures

The transportation and use of hazardous materials and the generation and disposal of solid wastes are regulated by federal and state regulations and should be sufficient to provide protection to the environment and public health. Therefore, no additional mitigation measures or monitoring is recommended.

3.24.5 Residual Impacts

Residual adverse effects from the use of hazardous materials under the Proposed Action would depend on the substance, quantity, timing, location, and response involved in the event of an accidental spill or release. Operation in compliance with applicable regulations and in accordance with the facility's SPCC Plan as well as the prompt cleanup of potential spills and releases would minimize the potential of residual adverse effects due to accidental spills or releases of hazardous materials.

3.25 Energy Requirements, Climate Change, and West Nile Virus

3.25.1 Energy Requirements

Greenhouse gas (GHG) emissions associated with the proposed project would be associated primarily with the consumption of energy for mining and ore processing over the 20-year project life. Operations that would contribute to GHG emissions would include:

- Fuel consumption (vehicles and machinery); and
- Electricity consumption (machinery and water removal).

The 2008 national annual emissions of GHGs were approximately 8 billion tons United States Environmental Protection Agency (USEPA) 2008, reported in carbon dioxide (CO_2) equivalents (CO_{2e}). In Nevada, the total CO_2 emissions from all combustion sources (diesel, gasoline, coal, propane, etc.) are approximately 62 million tons (56.3 million metric tons) (Nevada Division of Environmental Protection [NDEP] 2008b). A total of 78 percent of Nevada statewide emissions of CO_2 are from electrical power generation and transportation (NDEP 2008b). Approximately 3.5 percent of Nevada CO_2 emissions, which is 2.2 million tons or 2.0 million metric tons of CO_2 per year, is from mining activities in the Carlin Trend (NDEP 2008b).

Under the Proposed Action, it is estimated that the proposed project would emit approximately 30,768 tpy (27,912 metric tons per year) of CO_{2e} GHGs, which is approximately 1.4 percent of the estimated annual CO_2 emissions from mining in the Carlin Trend. The estimated fuel and electrical power consumption for the Proposed Action and No Action Alternative are provided in **Table 3.25-1**. All alternatives, except the No Action Alternative, are anticipated to have similar GHG emissions as the Proposed Action.

The Proposed Action would reduce the direct emissions of CO_2 at the Hollister Site relative to the No Action Alternative. This reduction is due to the reduction in emissions from the generators, which under the Proposed Action would be used for backup emergency power. However, the Proposed Action indirect GHG emissions (which are the GHG emissions from electricity generation) would increase relative to the No Action when the site switches to on-line power. When accounting for both direct and indirect GHG emissions, the Proposed Action GHG emissions would increase, respectively, relative to the No Action Alternative.

3.25.2 Climate Change

GHGs consist of compounds in the earth's atmosphere that absorb outgoing long-wave radiation emitted from the earth's surface, resulting in a warming of the atmosphere. Naturally occurring GHGs include CO_2, methane (CH_4), nitrous oxide, and ozone. Although many of these gases occur naturally in the atmosphere, man-made sources have substantially increased the emissions of GHGs over the past several decades. Of the man-made GHGs, the greatest contribution currently comes from CO_2 emissions.

Table 3.25-1 Estimated Fuel and Electrical Power Consumption

Case	Diesel Consumption (gallons)	Diesel Consumption (m^3)	Propane Consumption (gallons)	Propane Consumption (m^3)	Power Consumption (kW-hour/year)	Direct GHG (tons/yr) CO_2	Indirect GHG (tons CO_{2e}/yr)[1,2]	Total GHG (tons CO_{2e}/yr)
Proposed Action[3] (Stationary Sources)[4]	135,135	511.5	0	0	25,000,000	1,342	17,238	18,580
Proposed Action[3] (mobile sources)[5]	687,804	2,610.8	0	0	0	12,188	0	12,188
Proposed Action Total	822,939	3,122.3	0	0	25,000,000	13,530	17,238	30,768
No Action Alternative (stationary sources)	744,851	2,819.6	0	0	0	8,268	0	8,268
No Action Alternative (mobile sources)	295,878	1,120.0	0	0	0	1,327	0	1,327
No Action Alternative Total	1,040,729	3,939.6	0	0	0	9,595	0	9,595

[1] USEPA 2011. Greenhouse Gas Equivalences Calculator accessed May 24, 2011. http://www.epa.gov/cleanenergy/enrgy-resources/calculator.html.

[2] NVEnergy would provide electric power to the Hollister Site via the proposed electric power transmission line (transmission line).

[3] Fuel and power consumption and GHG emissions for the Mud Springs Road Transmission Line, Mud Springs Waste Rock Storage Facility, and Backfill alternatives would be similar to the Proposed Action.

[4] Calculations assume 500 hours per year for operation of the generators as backup emergency power.

[5] Calculations assume all ore is transported to the Esmeralda Mill.

Source: Rodeo Creek Gold Inc 2010f.

Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks (i.e., vegetation) cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy radiated by the earth back into space. Although GHG levels have varied for millennia, recent industrialization and burning of fossil carbon sources have caused carbon dioxide equivalent[1] (CO_2 [e]) concentrations to increase dramatically, and are a possible contributor to overall global climatic changes (Intergovernmental Panel on Climate Change [IPCC] 2007).

Global mean surface temperatures have increased an average of nearly 1.8 degrees Fahrenheit (°F) (1.0 degree Celsius [°C]) from 1890 to 2006, with variation dependent on where measurements are reported (Goddard Institute for Space Studies 2007). Northern latitudes (above 24°N) have exhibited temperature increases of nearly 2.1°F (1.2°C) since 1900, with nearly a 1.8°F increase since 1970 alone. Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions. However, increasing concentrations of GHGs is likely to accelerate the rate of climate change.

At present, there is no regulatory program which requires reductions in GHG emissions. However, in response to a Supreme Court decision interpreting the Clean Air Act, on July 30, 2008, USEPA published an advance notice of proposed rulemaking addressing regulatory mechanisms for regulating GHG emissions for purposes of addressing climate change.

As with any field of scientific study, there are uncertainties associated with the science of climate change. This does not imply that scientists do not have confidence in many aspects of climate change science. Some aspects of the science are known with virtual certainty, because they are based on well-known physical laws and documented trends (USEPA 2008). It should be noted however, that while many in the scientific community assert that increases in global mean surface temperature are undoubtedly caused by increases in global GHG concentrations, others continue to debate this theory for varying reasons, including uncertainty in the empirical evidence and theoretical models (Waugh 2011).

A recent study provides further evidence that the earth is getting warmer. The Berkeley Earth Surface Temperature study (Berkeley 2011) found reliable evidence of a rise in the average world land temperature of approximately 1.8°F (1°C) since the mid-1950s (Science Daily 2011). Analyzing temperature data from 15 sources, in some cases going as far back as 1800, the Berkeley Earth Surface Temperature study directly addressed scientific concerns raised by climate change skeptics, including the urban heat island effect, poor station quality, and the risk of data selection bias.

Specifically, the Berkeley Earth Surface Temperature study concluded that (Berkeley 2011; Science Daily 2011):

- The urban heat island effect is locally large and real, but does not contribute significantly to the average land temperature rise. That's because the urban regions of Earth amount to less than 1 percent of the land area.
- About one-third of temperature sites around the world reported global cooling over the past 70 years (including much of the U.S. and northern Europe). But two-thirds of the sites show warming. Individual temperature histories reported from a single location are frequently noisy

[1] Carbon dioxide equivalents represent the quantity of CO_2 that would be required to produce the same global warming potential (GWP) as any given GHG. Typically, this value is presented over a 100 year period where a given quantity (i.e., 1 pound) of CO_2 has a GWP of 1 and the same quantity of CH_4 has a GWP of 21. Therefore, given the same quantities, CH_4 has an impact 21 times greater than CO_2.

Source: American Petroleum Institute 2009.

and/or unreliable, and it is always necessary to compare and combine many records to understand the true pattern of global warming.

- The large number of sites reporting cooling might help explain some of the skepticism of global warming. In fact, it is very hard to measure weather consistently over decades and centuries, and the presence of sites reporting cooling is a symptom of the noise and local variations that can creep in. A good determination of the rise in global land temperatures cannot be done with just a few stations: it takes hundreds -- or better, thousands -- of stations to detect and measure the average warming. Only when many nearby thermometers reproduce the same patterns can we know that the measurements were reliably made.
- Stations ranked as "poor" in a survey by Anthony Watts and his team of the most important temperature recording stations in the U.S., (known as the USHCN -- the U.S. Historical Climatology Network), showed the same pattern of global warming as stations ranked as OK. Absolute temperatures of poor stations may be higher and less accurate, but the overall global warming trend is the same, and the Berkeley Earth Surface Temperature analysis concluded that there is not any undue bias from including poor stations in the survey.

Another recent study titled The Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation concluded that climate change would likely lead to global increases in extreme weather, along with heightened risks to livelihoods, human health, and infrastructure, both today and in the future (IPCC 2011). It also describes the costs -- in terms of lives lost and economic damages -- that have already occurred, plus those that would likely result from this phenomenon, and the societal implications of a warmer world, in which yesterday's extreme conditions become the new norm (IPCC 2011).

Climate change analyses are comprised of several factors including, but not limited to, GHGs, land use management practices, and the albedo effect (the fraction of solar radiation reflected by a surface or object). While emissions from mining activities may contribute to the effects of climate change to some extent, it is currently not possible to associate any particular actions with the creation of any specific climate–related environmental effects. The tools necessary to quantify climatic impacts presently are unavailable. As a consequence, impact assessments of specific effects of man-made activities cannot be determined. Therefore, climate change analysis for the purpose of this document is limited to accounting and disclosing of GHG emissions that may contribute to climate change.

3.25.2.1 Proposed Action

The proposed project would emit approximately 30,768 tpy (27,912 metric tons per year) of CO_{2e} that would incrementally add to the GHGs in the region from other sources including power plants, mining activities, industrial operations, vehicle traffic, wildfires and other activities as identified in Section 3.2, Past, Present, and Reasonably Foreseeable Future Actions. The proposed project represents 1.4 percent of the GHG emissions from all sources in the region, approximately 0.05 percent of the emissions in Nevada, and a tiny fraction of the emissions on a global basis. As a result, the proposed project would be expected to have a negligible effect on climate.

Historically, the climate in the project area (the Great Basin Desert) has been highly variable due to its location in respect to atmospheric circulation patterns and the surrounding complex topography. However, it is highly probable that temperatures in North America would rise over the next 100 years with temperatures in the western U.S. increasing between 4.5°F (2.5°C) and 10.8°F (6°C) relative to pre-1900 levels (Christiansen et al. 2007). These increased temperatures would have numerous impacts, including diminished water resources related to longer periods of drought, snowpack dissipation due to warmer temperatures (snow would occur later in the year and melt sooner) (Bureau of Reclamation 2011), and a direct effect on ozone, which has been shown to have increased ground level concentrations due to increasing temperature (USEPA 1998b).

3.25.2.2 Mud Springs Road Transmission Line, Mud Springs Waste Rock Storage Facility, and the Backfill Alternatives

The Mud Springs Road Transmission Line, Mud Springs Waste Rock Storage Facility, and the Backfill alternatives would have similar GHG emissions as the Proposed Action, and as a result, would have a negligible effect on climate.

3.25.2.3 No Action Alternative

Under the No Action Alternative, the proposed project would not be developed, and the existing exploration and bulk sampling activities at the Hollister Site would continue to operate under current authorizations and at current GHG emission levels.

3.25.3 West Nile Virus

The potential for the Proposed Action and alternatives to increase the likelihood of West Nile Virus (WNV) was evaluated, including the effects of climate change. WNV is an arbovirus typically spread by the mosquito species *Culex pipiens* and can infect numerous species including humans, birds, horses and other mammals. Typically, WNV is transmitted to humans from the bite of a mosquito that became infected by feeding on infected birds. **Table 3.25-2** shows the number of human WNV cases in Elko County, and the entire State of Nevada, over the past three years. In the past 3 years, there were a total of 27 human cases of WNV reported in Nevada with zero reported cases in Elko County (Nevada State Health Division [NSHD] 2011) and a total of 2,399 for the entire U.S. over the same timeframe (Center for Disease Control [CDC] 2011).

Table 3.25-2 Human West Nile Cases in Elko County Nevada, 2009 to 2011

	2009	2010	2011	Past 3 Years
Elko County	0	0	0	0
State of Nevada	12	2	13	27

Sources: CDC 2011; NSHD 2011.

Any human residing or working in areas where WNV activity have been identified are potentially at risk of contracting the virus. The virus itself can present in several forms ranging from West Nile Fever (a mild disease causing flu-like symptoms), West Nile Encephalitis (inflammation of the brain), West Nile Meningitis (inflammation of the membrane around the brain and spinal cord), or West Nile Meningoencephalitis (inflammation of the brain and the surrounding membrane). However, many individuals who become infected with WNV would experience no symptoms. Of those that become infected, 1 in 5 would develop mild flu-like symptoms and only 1 in 150 would contract more serious symptoms. Individuals infected with the more serious illnesses as a result of WNV typically see a fatality rate ranging from 3 to 15 percent with the highest number of fatalities in the elderly.

The mosquito can potentially breed in any environment with stagnant, shallow, or slow moving water.

3.25.3.1 Proposed Action

The Proposed Action utilizes the same water collection and disposal facilities as the No Action Alternative and includes the existing North Surge, South Recycle, and storm water ponds; storm water diversion ditches; and the Rapid Infiltration Basins (RIBs). The storm water pond and diversion ditches only contain water on a temporary basis after storm water runoff or snowmelt events. The RIBs are designed to infiltrate excess mine water into the alluvium and do not hold standing water on a permanent

basis. As a result, the storm water pond, diversion ditches, and RIBs do not support mosquito breeding habitat. The North Surge and South Recycle ponds contain water and potentially could support mosquito breeding habitat; however, the risk of contracting WNV at the Hollister Site and in Elko County is very low (**Table 3.25-2**).

The Proposed Action would not be creating any additional ponds that potentially could increase the likelihood of humans contracting WNV over the No Action Alternative. The proposed NPDES discharge of excess mine water into Little Antelope Creek potentially could result in minor, additional marginal pooled habitats that could be suitable for mosquito breeding habitat compared with the No Action Alternative. Most of the discharged water would be flowing down Little Antelope Creek due to stream gradient and would result in poor breeding habitat for mosquitoes. Eventually the discharged water would evaporate or infiltrate into the alluvium. Discharge of excess mine water into Little Antelope Creek is not expected to result in an increase in the incidences of WNV over the No Action Alternative given the low rate of water discharge (up to 1,100 gallons per minute maximum), arid climate, poor mosquito breeding habitat along the creek, and low potential of contracting WNV in Elko County (**Table 3.25-2**).

The existing West Pit sometimes has standing water at the bottom of the pit due to the proximity of the perched aquifer to the base of the pit. The West Pit would be backfilled with waste rock under the Proposed Action. As a result, this potential mosquito breeding habitat would no longer be available under the Proposed Action.

3.25.3.2 Mud Springs Road Transmission Line, Mud Springs Waste Rock Disposal Facility, and Backfill Alternatives

These alternatives would have the same very low risk of spreading WNV as the Proposed Action.

3.25.3.3 No Action Alternative

As demonstrated by **Table 3.25-2**, there have been no reported human WNV cases in the immediate project area in the prior 3 years. This is primarily due to the environment not being hospitable for *Culex pipiens* due to the arid climate and lack of suitable habitats. Standing water at the Hollister Site is very infrequent, thus limiting the breeding habitat for *Culex pipiens*. Any wet areas of potential habitat at the site would typically dry out within a few days. The risk of workers and visitors to the Hollister Site contracting WNV is very low.

3.25.3.4 West Nile Virus and Climate Change

As mentioned previously, temperatures in the western U.S. are predicted to increase between 4.5°F (2.5°C) and 10.8°F (6°C) over the next 100 years relative to pre-1900 levels (Christiansen et al. 2007). Potential impacts associated with increasing temperatures include diminished water resources related to longer periods of drought that could result in less mosquito habitat and resulting reduced risk of contracting WNV.

3.26 Relationship between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity

As described in the introduction to Chapter 3.0, short-term is defined as the 20-year operational life of the project and the 3-year reclamation period; long-term is defined as the future following reclamation (i.e., beyond 23 years). This section identifies the tradeoffs between the short-term impacts to environmental resources during operation and reclamation versus the long-term impacts to resource productivity that would extend beyond the end of reclamation.

The short-term use of resources during the expansion, operation, and reclamation of the proposed project would result in beneficial impacts in the form of an extension of local employment and the generation of revenue.

The proposed project would result in various short-term adverse impacts, such as the temporary loss of soil and vegetation productivity and the associated loss of wildlife habitat, possible wildlife avoidance and displacement, and temporary increases in fugitive dust. These impacts are expected to end upon completion of operations.

The short-term adverse visual impacts would last a few years beyond mine closure and gradually would be reduced as vegetation becomes more established. The scale and extent of the facilities would continue to alter the local landscape and views in the long term.

Impacts to long-term productivity (i.e., following project reclamation) primarily would depend on the effectiveness of the proposed reclamation of the disturbed areas. Successful reclamation would provide for post-mining wildlife and self-sustaining plant communities. Revegetation also is expected to stabilize disturbed surfaces and control erosion.

There would be a long-term loss in soil and vegetation productivity and associated terrestrial wildlife habitat that would be reclaimed, but may take longer than 23 years to re-establish productivity and habitat equivalent to present conditions. There may be a long-term loss in wetland/riparian vegetation (approximately 12 acres) associated with potential flow reductions in seeps and springs from mine groundwater pumping pending recovery of the groundwater table. There also may be long-term losses of springsnail populations associated with the potentially impacted seeps and springs inside the maximum extent of the 10-foot groundwater drawdown contour.

3.27 Irreversible and Irretrievable Commitment of Resources

The Proposed Action could result in the irreversible commitment of resources (e.g., the loss of future options for resource development or management, especially of nonrenewable resources such as minerals or cultural resources) or the irretrievable commitment of resources (e.g., the lost production or use of renewable natural resources during the life of the operations). Irreversible and irretrievable impacts of the Proposed Action are summarized for each resource in **Table 3.27-1**.

Table 3.27-1 Irreversible and Irretrievable Commitment of Resources by the Proposed Action

Resource	Irreversible Impacts	Irretrievable Impacts	Explanation
Land Use and Access	No	No	There would be no irreversible or irretrievable impacts to access; public access patterns would be maintained.
Geology and Minerals	Yes	Yes	Approximately 2 to 3 million tons of gold ore would be mined during operations. This would result in the irreversible and irretrievable commitment of this resource.
Groundwater Resources and Geochemistry	No	Yes	The loss of groundwater as a result of groundwater pumping and discharge activities would be an irretrievable impact. Groundwater recharge would occur in the long term. Therefore, groundwater impacts would not be irreversible.
Surface Water Resources and Watersheds	No	Yes	The loss of surface water as a result of groundwater drawdown would be an irretrievable impact. Groundwater recharge would occur in the long term. Therefore, surface water impacts would not be irreversible.
Soils and Reclamation	No	Yes	Suitable growth media would be salvaged from the mine disturbance areas for use in reclamation. There would be a loss of soil productivity during operations on approximately 117 acres, resulting in an irretrievable commitment of this resource. There would not be an irreversible commitment of the resource because all disturbed land would be reclaimed.
Vegetation Resources	No	Yes	There would be an irretrievable commitment of vegetation resources on approximately 117 acres during operations. Vegetation subsequently would be re-established on all areas via reclamation; therefore, vegetation would not be irreversibly lost as a result of development of the proposed project.
Riparian and Wetland Areas	No	Yes	Approximately 12 acres of wetland vegetation may be affected by groundwater drawdown, which may result in an irreversible loss of wetland vegetation. An irreversible impact to wetland vegetation would not occur with recharge of groundwater.
Noxious and Invasive Weeds	No	No	Disturbance areas within the project area would be monitored to identify any noxious or invasive species. If populations are observed within the project area during operations, they would be removed. Successful reclamation of past and proposed disturbed areas also would minimize the potential for establishment of noxious and invasive species within the project area.
Range Resources	No	Yes	There would be an irretrievable loss of less than 1 animal unit month (AUM) for each of the Squaw Valley and Twenty-Five allotments during the life of the project. An irreversible loss of AUMs would not occur because all surface disturbance areas would be reclaimed.

Table 3.27-1 Irreversible and Irretrievable Commitment of Resources by the Proposed Action

Resource	Irreversible Impacts	Irretrievable Impacts	Explanation
Wildlife Resources	No	Yes	Approximately 117 acres of habitat would be irretrievably lost until vegetation has re-established following reclamation. Wildlife habitat would not be irreversibly lost because all surface disturbance would be reclaimed.
Aquatic Resources	Yes	Yes	Groundwater drawdown may result in the loss of springs that support aquatic species in the long term. Even if springs are lost as a result of groundwater drawdown and become re-established after groundwater recharge, some aquatic species may not become re-established in these aquatic habitats, which would be an irreversible impact.
Special Status Species	Yes	Yes	Irreversible impacts to special status species could occur as a result of the Proposed Action. Applicant-committed environmental measures and mitigation may lessen the impacts.
Paleontological Resources	No	No	No disturbance to scientifically important paleontological resources is anticipated.
Cultural Resources	Yes	Yes	National Register of Historic Places-eligible sites could be irreversibly and irretrievably lost if inventory, avoidance, and/or mitigation efforts are not sufficient to identify and protect these sites.
Native American Traditional Values	Yes	Yes	Adverse effects to religious, spiritual, or sacred values cannot be monitored or mitigated.
Air Quality	No	No	Project emissions would not exceed federal or state Ambient Air Quality Standards. Air quality would return to existing conditions after completion of the project.
Recreation and Wilderness	No	Yes	There would be an irretrievable loss of public land available for dispersed recreational opportunities during operations and reclamation; an irreversible loss would not occur because all surface disturbance areas would be reclaimed.
Social and Economic Resources	No	Yes	Labor and some capital resources would be irretrievable after committed and expended.
Environmental Justice	No	No	The proposed project would not disproportionately affect minority or low-income populations.
Visual Resources	No	No	Impacts to visual resources would be reduced through successful reclamation procedures and implementation of the applicant-committed environmental protection measures.
Noise	No	No	Noise is not considered irreversible because it would cease following the completion of mine operations.
Hazardous Materials and Solid Waste	No	No	No irreversible or irretrievable commitment of resources or impact is anticipated. However, if a spill were to affect a sensitive resource, an irretrievable impact could occur pending the recovery of the resource.

4.0 Public Consultation and Coordination

4.1 Scoping

4.1.1 Notification

The initial step in the National Environmental Policy Act (NEPA) process is to notify the public, other government agencies, and Native American Tribes of the lead agency's intent to prepare an Environmental Impact Statement (EIS) by publishing the Notice of Intent (NOI) in the *Federal Register*. The NOI for the project was published in the *Federal Register* on April 19, 2010 (Federal Register Vol. 75, No. 74), and included a description of the proposed project and provided BLM contact information. The BLM mailed "Dear Interested Party" letters on April 28, 2010, to 211 interested parties including federal, state, and local agencies, Tribes, individuals, and organizations. The letters included a description of the proposed project, the scoping statement, and a project location map. A news release was issued on April 21, 2010, announcing publication of the NOI, the initiation of the public scoping period, and information about the upcoming public scoping meetings. The scoping period ended on June 4, 2010.

The Bureau of Land Management (BLM) encouraged the Native American Tribes to participate in the scoping process. Dear Interested Party letters were mailed to the Tribes on April 28, 2010, announcing publication of the NOI, the initiation of the public scoping period, and information about the upcoming scoping meetings. See Section 4.3, Draft EIS Distribution List, for a list of the Tribes that were notified.

4.1.2 Scoping Meetings

Public scoping meetings offer an opportunity for public participation during the scoping period. The meetings are designed to promote information exchange about the proposed project and to gather public input. The BLM initially announced and held four public scoping meetings in Winnemucca, Battle Mountain, Elko, and Mountain City, respectively. The Shoshone-Paiute Tribe of Duck Valley requested an additional public meeting be held in Owyhee, Nevada. On May 20, 2010, the BLM held a public meeting at the Owyhee Tribal Council Headquarters to provide project information and receive their comments and concerns about the proposed project.

A notification flyer was posted at the local post offices. The dates, locations, and number of public attendees at all scoping meetings are provided in **Table 4-1**.

Table 4-1 Scoping Meetings

Meeting Location	Meeting Date/Time	Number of Attendees that Signed In
Winnemucca, Nevada	May 10, 2010, 4:00-7:00 p.m.	32
Battle Mountain, Nevada	May 11, 2010, 4:00-7:00 p.m.	13
Elko, Nevada	May 12, 2010, 4:00-7:00 p.m.	17
Mountain City, Nevada	May 13, 2010, 4:00-7:00 p.m.	11
Owyhee, Nevada	May 20, 2010, 5:00-8:00 p.m.	22

The Mountain City and Owyhee scoping meetings were conducted in a semi-open house format. The BLM opened the meetings, thanked participants for attending, and described the NEPA process, federal guidelines, and the dates the public could provide their comments to the BLM during the EIS

process. The project applicant, Rodeo Creek Gold Inc (RCG), provided an overview of the proposed project and modifications to the project to protect resources. The presentations were followed by a question and answer period to allow meeting attendees the opportunity to ask the BLM representatives, the project applicant, and the NEPA contractor questions. Display boards showing the NEPA process, the general location, the project area boundary, the ore transportation route, the proposed facility details, the project area surface ownership, and the post-mining topography were provided to facilitate conversation.

The Winnemucca, Battle Mountain, and Elko scoping meetings were held as an informal open house to allow meeting attendees the opportunity to ask the BLM representatives, the project applicant, and the NEPA contractor questions. Display boards showing the NEPA process, the general location, the project area boundary, the ore transportation route, the proposed facility details, the project area surface ownership, and the post-mining topography were provided to facilitate conversation.

BLM received a total of 46 comment submittals (e.g., letter, comment form, or email) containing 288 individual comments during the public scoping period. Most of the comments the BLM received were from federal and state agencies. Scoping comments were used to help determine the scope of issues to be addressed and helped to identify the issues related to the Proposed Action (40 Code of Federal Regulations 1501.7). Most of the public comments were related to impacts to surface water resources, air quality, cultural resources/Native American concerns, and mitigation and monitoring. Numerous comments were received in support of the proposed project.

A Public Scoping Comment Summary Report was prepared that provided a detailed table listing each individual comment, its location in the original scoping submittal, the BLM's determination of the comment, and where the comment is addressed in the EIS.

4.1.3 Public Review of the Draft EIS

The Draft EIS will be available for a 45-day public review and comment period from the date the Notice of Availability (NOA) is published in the *Federal Register*. All who provided scoping input will receive a paper copy or CD of the Draft EIS or will have access to the document on BLM's website http://www.blm.gov/nv/st/en/fo/ elko_field_office.html.

4.2 Consultation and Coordination with Federal, State, and Local Agencies, and Tribes

Specific NEPA regulations require BLM to coordinate and consult with federal, state, local agencies, and tribes about the potential of the proposed project and alternatives to affect sensitive resources. The BLM initiated coordination and consultation activities with federal, state, and local governments during the scoping process. Consultation between the BLM and federally recognized tribes was initiated on July 30, 2009, and currently is ongoing. Elko County Commissioners and Nevada Department of Wildlife (NDOW) are participating in the EIS as cooperating agencies.

Issues related to agency consultation and/or reviews include mining regulation and reclamation, biological and cultural resources, socioeconomics, and water management. Consultation efforts for cultural resources are focused on potential impacts to important historic and archaeological sites, as well as places of cultural and religious importance to Native Americans. The BLM currently is consulting with the Nevada State Historic Preservation Office and the Advisory Council for Historic Preservation regarding potential adverse effects to National Register of Historic Places-eligible sites located in the Hollister Underground Mine project area.

AECOM, BLM's EIS consultant, has engaged in conversation with the U.S. Fish and Wildlife Service regarding threatened, endangered, and sensitive species. As the state agency with jurisdiction and special expertise related to impacts on wildlife, NDOW has agreed to participate as a cooperating agency in the preparation of the EIS, as previously mentioned. NDOW expressed concerns during scoping about effects to pronghorn and mule deer migration, greater sage-grouse, Pacific chorus frogs, and nongame species.

4.3 Draft EIS Distribution List

Federal Agencies

DOI, Office of Environmental Policy and Compliance (Office of the Secretary)
U.S. Army Corps of Engineers (Reno)
U.S. Bureau of Indian Affairs, Eastern Nevada Agency
U.S. Bureau of Reclamation
USDA Cooperative Extension Service
USDA Forest Service, Ruby Mountain/Jarbidge Ranger Station
USDA Forest Service, Humboldt/Toiyabe National Forest (Elko, Sparks
USDA Forest Service, Carson Ranger District
USDA Forest Service, Bridgeport Ranger District
U.S. Environmental Protection Agency (Las Vegas)
U.S. Environmental Protection Agency Region IX (San Francisco)
U.S. Fish and Wildlife Service (Reno)

State Agencies

Central Committee of Nevada Grazing Boards
Division of Conservation Districts
Nevada Department of Agriculture (Elko, Reno)
Nevada Department of Business and Industry
Nevada Department of Cultural Resources
Nevada Department of Transportation (Carson City, Elko)
Nevada Department of Wildlife, (Elko, Reno)
Nevada Division of Environmental Protection
Nevada Division of Forestry
Nevada Division of Minerals (Carson City, Las Vegas)
Nevada Division of State Lands
Nevada Division of Water Resources
Nevada State Clearing House
Nevada State Division of Agriculture
Nevada State Library and Archives
Nevada Wildlife Federation
Rangeland Resources Commission
State Department of Conservation and Natural Resources
State Environmental Commission
State Grazing Boards
State Historic Preservation Office

Elected Officials

Mark Amodei, U.S. House of Representatives
Shelley Berkley, U.S. House of Representatives
Randy Brown, Elko County Commissioner
John Ellison, State Assemblyman, District No. 33
Pete Goicoechea, State Assemblyman, District No. 35

Don Gustavson, State Assemblyman, District No. 32
Joe Heck; U.S. House of Representatives
Dean Heller, U.S. Senate
Harry Reid, U.S. Senate
Dean Rhoads, Rural Nevada Senatorial District
Brian Sandoval; Governor

County and Local Agencies

City of Carlin City Council
City of Elko City Council
City of Elko, Mayor
City of Wells City Council
City of Winnemucca City Council
Elko Chamber of Commerce
Elko County Board of Commissioners
Elko County Manager
Eko County Natural Resource Advisory
Elko County Public Works Department
Elko County School District
Eureka County District Attorney
Eureka County Natural Resources Department
Eureka County School District
Eureka County Board of Commissioners
Humboldt County Board of Commissioners
Humboldt County Planning Department
Humboldt County School District
Lander County Board of Commissioners
Lander County Clerk
Lander County Planning Commission
Mineral County Board of Commissioners
Mineral County Chamber of Commerce
Mineral County Clerk
Mineral County School District
Winnemucca Chamber of Commerce
Winnemucca, Public Administrator

Tribal Organizations

Battle Mountain Band Council
Duckwater Shoshone Tribe
Elko Band Council
Ely Shoshone Tribe
Goshute Business Council
Nevada Indian Commission
Shoshone-Paiute Tribes of Duck Valley
South Fork Band Council

Te-Moak Tribe of Western Shoshone
Wells Band Council
Western Shoshone Committee of Duck Valley
Western Shoshone Committee
Western Shoshone Defense Project
Western Shoshone Descendents of Big Smokey
Yomba Shoshone Tribe

Newspapers and Libraries

Elko Daily Free Press
Great Basin College Library
James Dickenson Library, University of Nevada
Range Magazine

Industry/Business

Al Park Petroleum
Allied Nevada Gold Holdings
Boart Longyear Company
Bamco Exploration
Baroid Drilling Fluids, Inc.
Barrick Gold Exploration, Inc.
Barrick Goldstrike Mines, Inc.
Big G Construction
Boss Tanks
Conagra Beef Company
Ellison Ranching Company
Evolving Gold Corporation
Fronteer Development USA, Inc.
Fronteer Gold
Global Mining and Tunneling
Great Basin Gold Inc
Halliburton Energy Service, Inc.
Hi-Tech Exploration, Ltd.
Jennmar
John Davis Trucking Co. Inc.
Largo Flight, Ltd.
Marigold Mining Company
Meridian Minerals Corporation
Meridian Rossi Corporation
Nevada Trend Exploration
Newcan Inc.
Newmont Mining Corporation
NVEnergy
Parsons Behle & Latimer
Rayrock DBA Cordex Exploration

Rodeo Creek Gold Inc
Sandvik Mining and Construction
Squaw Valley Ranch LLC
Sweeney Enterprises
Tire Factory
Twenty Five Ranch LLC
VEK/Andrus Associates
Western Nevada Supply
White Knight Gold (US), Inc.
Wind Haven Farm

Organizations/Associations

American Horse Protection Association
Animal Welfare Institute
Citizens against Recreation Eviction USA
Friends of Nevada Wilderness
Glendale Ranches
Great Basin Ecology
Great Basin Resource Watch
Hawk Watch International
Humboldt Outfitters, Inc.
Mineral Policy Center (Durango)
Mineral Policy Center (Washington DC)
National Mustang Association
Native American Program Citizens Alert
Natural Resources Defense Council (San Francisco)
Natural Resources Defense Council (Washington DC)
Natural Resources Management Advisory Commission
NE Nevada Chapter of Trout Unlimited
Need More Sheep Company
Nevada Archaeological Association
Nevada Cattlemen's Association
Nevada Commission on Tourism
Nevada High Country Tours
Nevada Mining Association
Nevada Natural Heritage Program
Nevada Outdoor Recreation Association
Nevada Wilderness Project
Nevada Wildlife Federation
Nevada Wool Growers Association
Ormsby Sportsman Club
Public Lands Foundation
Red Rock Audubon Society
Resource Concepts

Ruby Lake National Wildlife Refuge
Sierra Club – Toiyabe Chapter
Sierra Club – Washington DC
Sustainable Grazing Coalition
The Nature Conservancy
The Wilderness Society
U.S. Post Office
University of Nevada Cooperative Extension
University of Nevada, Reno (Department of Range, Wildlife, and Forestry)
Water Quality Section AFS
Western Cultural Resource Management
Western Watersheds Project (Boise)
Western Watersheds Project (Hailey)
Wild Horse Commission
Wild Horse Spirit
Wilderness Impact Research Foundation
Wildhorse Observers Association
Wildlife and Habitat Protection

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Deborah Durand
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Louie Ortega
Kristen Plascencia
Jason Moon
Steve Konieczki
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5.0 List of Preparers and Reviewers

5.1 Bureau of Land Management EIS Team

Responsibility	Name
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Cultural Resources, Native American Traditional Values	Bill Fawcett
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Hydrology Modeling	Tom Olsen
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Land Use and Access	Marissa Dolfin
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Wildlife Resources, Special Status Species, Riparian and Wetlands	Nycole Burton

5.2 Cooperating Agencies

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Elko County Commission	Randy Brown

5.3 AECOM EIS Team (Third-party Consultant)

Responsibility	Name
Project Initiation, Project Management, EIS Preparation Plan, Draft EIS Preparation, Final EIS Preparation	Scott Duncan
Senior NEPA Reviewer	Valerie Randall
Project Management, Draft EIS Preparation, Final EIS Preparation, EIS Preparation Plan, NEPA Document Coordinator	Anne Doud
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Cultural Resources, Native American Traditional Values	Kim Munson
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Groundwater Resources and Geochemistry	Bob Berry
Public Participation	Peggy Roberts
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Soils and Reclamation	Terra Mascarenas
Surface Water Quality and Quantity and Watersheds	Jim Burrell
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Document Production	Susan Coughenour

5.4 Rodeo Creek Gold Inc Reviewers

Name	Title and Company
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Doug Crawford	Mine Manager, Rodeo Creek Gold Inc
Willie Beckmann	Vice President, Legal and Compliance, Great Basin Gold Ltd
Janette Ferguson	Attorney, Davis Graham & Stubbs LLP
John Jacus	Attorney, Davis Graham & Stubbs LLP
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Draft
Environmental Impact Statement for the Hollister Underground Mine Project

Volume II - Appendices

Bureau of Land Management

June 2012

BLM

Elko District Office, Tuscarora Field Office, Nevada

BLM Mission Statement

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

BLM/NV/EK/ES/12-4+1793

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Appendix A

Permits and Authorizations

Appendix A Current Hollister Mine Permits and Authorizations

Permit Title and Number	Operation Covered by Permit	Agency	Period Covered
AP1041-1298	Class I Air Quality Operating Permit	NDEP/ BAPC	September 26, 2008 to September 26, 2013
NEV2003114	Water Pollution Control Permit – Infiltration	NDEP/BMRR	April 22, 2009 to April 22, 2014
NEV 2003107	Water Pollution Control Permit	NDEP/BMRR	June 9, 2009 to December 24, 2013
NVR300000 MSW-271	Storm Water General Permit	NDEP/BWPC	June 1, 2007 to June 1, 2012
#0227	Reclamation Permit	NDEP/BMRR	Life of Project
S-29241	Industrial Artificial Pond Permit	NDOW	September 1, 2007 to August 31, 2012
LOA05HT0001	Holding Tanks	NDEP	April 15, 2011 to May 8, 2014
52928-56875	Hazardous Materials Storage Permit	NV State Fire Marshall	February 28, 2011 to February 29, 2012
Verification Letter	Jurisdictional Determination	USACE	April 27, 2009
N-77637	GBG Right-of-Way	BLM	December 2019
Joint Resolution	Humboldt County Road and Landfill	NDOT/NDEP	Life of Project
EI-0349-12NTNC	Permit to Operate a Public Water System	NDEP/BSDW	May 18, 2011 to June 30, 2012
NV0000349	Public Water System	NDEP/BSDW	June 30, 2009
EI-0349-TP01-12NTNC	Permit to Operate a Treatment Pond	NDEP/BSDW	June 10, 2011 to June 30, 2012
NV0000349	Public Water System	NDEP/BSDW	June 30, 2009

Source: RCG 2011b, 2010b.

Appendix B

Groundwater

B1 Water Quality
B2 Groundwater Model Report
B3 Geochemical Model Report
B4 Hollister Mine West Pit Shallow Groundwater Technical Memorandum

B1 Water Quality

Table B1-1 Nevada Water Quality Standards and Mine Wall Rock and Waste Rock Surface Area

Parameter[1] (mg/L)	Mine Wall Rock and Waste Rock Surface Area		Drinking Water Standards		Municipal or Domestic Supply	Drinking Water Standards		
	5.411 m^2/L	54.11 m^2/L	Primary	Secondary		Irrigation	Stock Water	Wildlife Propagation
Antimony	0.02222	0.1381	0.006	--		--	--	--
Arsenic	5.477×10^{-7}	4.100×10^{-6}	0.05	--	0.146	0.1	0.2	--
Barium	0.001997	6.134×10^{-4}	2.0	--	0.05	--	--	--
Beryllium	0.002037	0.01684	0.004	--	2.0	0.1	--	--
Boron	0.34651	2.516	--	--	0	0.75	5.0	--
Cadmium[3]	1.427×10^{-4}	0.001451	0.005	--	--	0.01	0.05	--
Chromium	0.2253	0.4303	0.1	--	0.005	0.1	1.0	--
Copper[3]	2.685×10^{-4}	2.880×10^{-4}	1.3	--	0.10	0.2	0.5	--
Iron	4.929×10^{-4}	5.948×10^{-4}	--	0.3 [0.6][5]	--	5.0	--	--
Lead[3]	9.402×10^{-7}	1.055×10^{-5}	0.05	--	--	5.0	0.1	--
Magnesium	0.004043	0.003428	--		0.05			
Manganese	3.004×10^{-8}	6.367×10^{-4}	--	0.05[0.1]	125/150	0.2	--	--
Mercury			0.002	--	--	--	0.01	--
Molybdenum			--	--	0.002			
Nickel[3]	0.02087	0.05370	0.1	--	--	0.2	--	--
Selenium	0.3231	0.08062	0.05	--	0.0134	0.002	0.05	--
Silver			0.05	--	0.05	--	--	--
Thallium	0.03141	0.3158	0.002	--	--	--	--	--
Zinc[3]	1.935×10^{-5}	0.05634	--	5.0	0.013	2.0	25.0	--
Cyanide (WAD)			--	--	--	--	--	--
Alkalinity			--	--	0.2	--		30-130
Chloride	30.17	75.12	--	250[400]	--	--	1,500	1,500
Color (PCU)			--	15	250[400]	--	--	--
Dissolved Oxygen			--	--	75	--	Aerobic	Aerobic
Fluoride	1.964	2.367	4.0	2.0	Aerobic	1.0	2.0	--
Nitrate as N	1.782	5.241	10	--	--	--	100	100
pH (SU)	10.24	10.32	--	6.5-8.5	10	4.5-9.0	5.0-9.0	7.0-9.2
Sulfate	1,602	2,277	--	250[500]	5.0-9.0	--	--	--

Table B1-1 Nevada Water Quality Standards and Mine Wall Rock and Waste Rock Surface Area

Parameter[1] (mg/L)	Mine Wall Rock and Waste Rock Surface Area		Drinking Water Standards		Municipal or Domestic Supply	Drinking Water Standards		
	5.411 m^2/L	54.11 m^2/L	Primary	Secondary		Irrigation	Stock Water	Wildlife Propagation
Temperature °C			--	--	250[500]	--	--	--
TDS	2,473	3,736	--	500[1,000]	--	--	3,000-7,000	--
TSS			--	--	500[1,000]	--	--	--
Turbidity (NTU)			--	--	--	--	--	--

[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; WAD = weak acid dissociable.

[2] Dissolved fraction only.

[3] Parameter dependent on hardness; a hardness value of 175 mg/L was used to calculate the criteria for hardness-dependent metals in Maggie Creek and the Humboldt River.

[4] Numbers in brackets [ ] are mandatory secondary standards for public water systems.

[5] (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: Enchemica 2010; Nevada Administrative Code (NAC) 445.119; NAC 445A.144.

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
BH-1	Vinini	• TDS less than 500 mg/L • calcium-sodium Bicarbonate water • pH 7 – 8	
BH-2	Vinini	• TDS less than 500 mg/L • calcium-sodium bicarbonate water • pH 7 – 8	
BH-4	Vinini	• TDS less than 500 mg/L • calcium-sodium bicarbonate water • pH 7 – 8	
BH-7	Tertiary Volcanics	• TDS less than 200 mg/L • sulfate less than 100 mg/L • calcium-sodium bicarbonate water • pH 7 – 8	Background well: non-mineralized rock
BH-9	Tertiary Volcanics	• TDS less than 200 mg/L • sulfate less than 100 mg/L • calcium-sodium bicarbonate water • pH 7 – 8	Background well: non-mineralized rock
HP-1	Vinini	• TDS 250 mg/L • calcium-sodium bicarbonate water • pH 8.0 • arsenic 0.043 mg/L	Background well
HP-3	Tertiary Volcanics	• TDS 276 mg/L • calcium-sodium bicarbonate water • pH 7.4 • sulfate and bicarbonate less than 100 mg/L	Background well
HP-4	Vinini	• TDS 458 mg/L • calcium-magnesium sulfate water • pH 6.7 • sulfate 181 mg/L • arsenic 0.064 mg/L	Downgradient of West Pit
HP-5	Tertiary Fanglomerate	• TDS 256 mg/L • calcium-sodium bicarbonate water • pH 7.0 • sulfate less than 100 mg/L	Downgradient of West Pit
HP-6	Tertiary Volcanics	• TDS 304 mg/L • calcium-magnesium sulfate/bicarbonate water • pH 7.1 • sulfate 127 mg/L • bicarbonate 110 mg/L	Downgradient of West Pit

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
WW-0		• TDS 260 mg/L • calcium-sodium bicarbonate water • pH 7.9 • elevated iron and manganese	Background well: down gradient of West Pit
WW-1	Vinini	• TDS 300 – 400 mg/L • sulfate 140 – 160 mg/L • bicarbonate 60 – 50 mg/L • pH 6.5 – 8.0 • arsenic to 0.35 mg/L • iron to 180 mg/L with most in range of 1 – 7 mg/L	Downgradient of West Pit
WW-3	Tertiary Volcanics	• TDS 326 – 898 mg/L • sulfate 136 – 392 mg/L • calcium sulfate water • pH 6.8 – 7.6 • elevated iron	South of project
WW-4	Tertiary Volcanics and Vinini	• TDS 280 – 327 mg/L • calcium-sodium bicarbonate water • pH 7.6 – 8.1 • elevated iron and manganese • arsenic exceeds Nevada standards	Background well: upgradient of West Pit
WW-5	Tertiary Volcanics	• TDS 230 – 506 mg/L • sulfate 150 – 250 mg/L • pH 7.0 – 7.5 • arsenic .08 – .4 mg/L • iron 2 – 60 mg/L • manganese to 0.7 mg/L	
DGW-1R	Tertiary Volcanics	• TDS 11,000 – 15,000 mg/L • sulfate 5,5000 –10,000 mg/L • pH 3.5 • calcium-magnesium sulfate water • arsenic 2.0 – 4.5 mg/L • iron 750 – 1,150 mg/L • exceeds Nevada standards for aluminum, arsenic, cadmium, iron, manganese, nickel, thallium, zinc	
H6-224WW	Tertiary Volcanics	• TDS 800 – 1,100 mg/L • sulfate 500 – 900 mg/L • pH 4.0 – 6.7 • calcium-magnesium sulfate water • arsenic 0.053 – 0.067 mg/L • iron 1.45 – 17.9 mg/L • manganese 2.6 – 4.7 mg/L • fluoride to 2.5 mg/L	

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
H6-225WW	Tertiary Volcanics and Waste Rock	• TDS 1,000 – 1,300 mg/L • sulfate 380 – 480 mg/L • calcium-magnesium sulfate water • pH 5.5 – 6.5 • arsenic 0.16 – 1.72 mg/L • iron to 74 mg/L • manganese to 7.2 mg/L	
H6-226WW	Tertiary Volcanics	• TDS 690 – 1,100 mg/L • sulfate 270 – 720 mg/L • calcium-sodium-magnesium sulfate/bicarbonate water • pH 6.5 – 7.0 • mercury to 0.067 mg/L	
H6-227WW	Vinini	• TDS 8,000 – 12,000 mg/L • sulfate 5,300 – 10,000 mg/L • calcium-magnesium sulfate water • pH 2.6 – 2.8 • fluoride to 30 mg/L • aluminum 209 – 613 mg/L • arsenic .11 –.47 mg/L • iron 316 – 834 mg/L • manganese to 398 mg/L • thallium to 0.022 mg/L • mercury to 0.13 mg/L • exceedences of Nevada standards for copper, zinc, cadmium, and selenium	
H6-228WW	Waste Rock and Tertiary Volcanics	• TDS 1,000 – 5,400 mg/L • sulfate 1,000 – 3,800 mg/L • calcium-magnesium sulfate water • pH 6 – 8 • arsenic 0.05 – 0.62 • iron 1.2 – 8 1 mg/L • manganese 5.2 – 21.6 mg/L	
H6-229WW	Vinini	• TDS 31,000 – 39,000 mg/L • sulfate 20,000 – 28,000 mg/L • calcium-magnesium sulfate water • pH 2.9 • aluminum 1,950 – 2,470 mg/L • arsenic 0.34 – 0.84 mg/L • iron 2,930 – 3,650 mg/L • manganese 535 – 594 mg/L • exceeds Nevada standards for cadmium, nickel, selenium, thallium, and zinc	

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
H6-230WW	Waste Rock	• TDS 4,600 – 14,000 mg/L • sulfate 3,000 – 8,500 mg/L • calcium-magnesium sulfate water • pH 2.8 – 3.0 • aluminum 121 – 634 mg/L • arsenic 0.071 – 1.52 mg/L • iron 211 – 1,150 mg/L • manganese to 85 mg/L • exceeds Nevada standards for cadmium, nickel, and selenium	
H7-251WW	Tertiary Volcanics	• TDS 800 – 1,000 mg/L • sulfate 470 – 560 mg/L • calcium-magnesium/sodium sulfate water • pH 5.0 – 6.0 • arsenic 11.6 – 41 mg/L • iron 1.1 – 10 mg/L	
H7-252WW	Vinini	• TDS 5,900 – 8,200 mg/L • sulfate 5,600 – 7,500 mg/L • calcium-magnesium sulfate water • pH 2.8 – 3.7 • aluminum 260 – 436 mg/L • arsenic 0.17 – 0.309 mg/L • iron 220 – 604 mg/L • manganese 19 – 27 mg/L • exceeds Nevada standards for cadmium, nickel, and thallium	
H7-253WW	Vinini	• TDS 1,400 – 2,600 mg/L • sulfate 1,000 – 2,500 mg/L • calcium-magnesium sulfate water • pH 3.5 – 4.5 • aluminum to 130 mg/L • selenium to 0.17 mg/L	
H7-254WW	Vinini	• TDS 1,300 – 4,100 mg/L • sulfate 1,700 mg/L or greater • pH 2.8 – 4.1 • calcium-magnesium sulfate water • aluminum to 130 mg/L • arsenic 0.069 – 0.19 mg/L • iron 77 – 230 mg/L • manganese 6 – 60 mg/L • exceeds Nevada standard for cadmium, nickel, thallium, and mercury	

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
H7-255WW	Tertiary Volcanics	• TDS 310 – 450 mg/L • sulfate 120 – 195 mg/L • bicarbonate 130 – 160 mg/L • calcium-magnesium/sodium sulfate/bicarbonate water • pH 7.1 – 7.5 • arsenic 0.07 – 0.4 mg/L • iron 5.4 – 7.7 mg/L	Background well: sulfide rock
H7-256WW	Tertiary Volcanics	• TDS 260 – 380 mg/L • sulfate and bicarbonate less than 200 mg/L • calcium-sodium bicarbonate/sulfate water • pH 6.9 – 7.5 • arsenic 0.065 – 0.23 mg/L	Background well: sulfide rock
P-1	West Pit – in Tertiary Volcanics	• TDS 1,700 – 2,840 mg/L • sulfate 1,160 – 2,200 mg/L • fluoride 4.7 – 5.65 mg/L • calcium-magnesium sulfate water • pH 4.1 – 5.65 • aluminum 11 – 28 mg/L • arsenic 0.055 – 0.085 mg/L • iron 4.4 – 89 mg/L • manganese 9.4 – 12.6 mg/L • nickel 0.13 – 0.21 mg/L	
P-2	West Pit – in Tertiary Volcanics	• TDS 900 – 1,300 mg/L • sulfate 230 – 480 mg/L • calcium-sodium sulfate/bicarbonate water • pH 5.7 – 6.9 • iron 6.7 – 90 mg/L • mercury 0.021 – 0.062 mg/L	
HOL-MW-1	Tertiary Volcanics	• TDS 250 – 280 mg/L • calcium-sodium bicarbonate/sulfate water • bicarbonate and sulfate less than 100 mg/L • pH 7.2	Background well
W-E-1	Tertiary Volcanics	• TDS 380 – 530 • sodium bicarbonate/sulfate water • pH 6.4 – 7.5	
West Pond		• TDS 1,800 – 5,800 mg/L • sulfate 1,000 – 5,400 mg/L • calcium-magnesium sulfate water • pH 4.0 – 7.0	

Table B1-2 Borehole Water Quality

Well ID	Unit Screened	Water Quality Summary	Comments
MA-1 Seep		• TDS 1,100 – 1,360 mg/L • sulfate 410 – 619 mg/L • bicarbonate 180 – 239 mg/L • calcium-sodium sulfate/bicarbonate water • pH 7.7 – 8.2	

mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids.

Source: Brown and Caldwell 2003; Montgomery & Associates 2010a.

Table B1-3 MWMP Results (NDEP Profile I)

Rotating Extraction

Parameter Unit Standard	pH	Aluminum	Iron	Manganese	Arsenic	Antimony	Zinc	Copper
IH020 COMP	4.08	6.93	86.4	0.67	0.087	0.019	1.81	0.0249
IH209 (1016-26+1040-50)	3.93	27.4	40.8	9.95	0.233	0.011	3.12	0.369
IH157 (1016-1026)	6.42	0.146	0.066	0.103	0.037	0.034	0.0634	0.0096
IH208 (514-522)	4.18	32.6	18.2	0.411	-0.01	0.011	0.674	0.0292
IH208 (530-37, 547-56)	3.13	106	117	0.576	0.096	0.005	13	3.94
IH112 (308-318)	4.59	0.51	5.89	0.168	0.232	0.045	0.453	-0.003
IH059 (641-51, 651-61)	3.19	100	157	1.56	0.365	0.005	24.1	5.98
IH057 (528-538)	3.65	32.8	53.7	0.442	0.044	0.009	3.69	0.385
IH013 (700-710)	3.59	112	72.6	0.386	0.02	0.006	10.9	1.24
IH013 (690-700)	3.51	87.5	77.9	0.478	0.028	0.005	6.04	1.37
IH149 (128-138,181-186)	5.08	0.144	0.048	0.0053	0.013	0.003	0.0435	0.0084
IH149 198-206 OLD&NEW	6.21	0.193	0.249	0.0994	0.016	0.007	0.586	0.0528
IH070 695-705 OLD&NEW	5.75	-0.005	4.31	-0.0002	75	-0.005	-0.01	0.0577
IH083 587-596 OLD&NEW	5.75	0.343	0.00022	0.913	-0.04	0.037	0.01	210
IH083 596-605 OLD&NEW	3.35	70.7	148	0.0742	0.127	0.011	4.44	1.13

Column Extraction

Parameter Unit	pH	Aluminum	Iron	Manganese	Arsenic	Antimony	Zinc	Copper
PL-5	6.58	0.122	-0.02	-0.002	0.018	0.001	0.0059	-0.003
BH01 (740-)	4.33	1	2.44	1.57	0.024	0.006	0.116	0.113
BH01 (745-)	4.36	1.21	3.11	1.8	0.027	0.006	0.117	0.167
BH02 (650-)	3.19	2.91	6.51	1.9	0.056	0.003	1.2	0.915
BH02 (665-)	4.17	0.787	1.87	0.649	0.025	0.003	0.226	0.168
BH03	5.07	0.228	0.275	0.919	0.038	0.002	0.235	0.0555
BH04	4.52	0.646	5.63	3.88	0.014	-0.001	0.104	0.197
BH05	4.07	8.27	4.53	1.51	0.05	-0.002	1.91	0.656
BH06	5.72	0.937	0.032	0.392	0.039	0.027	0.141	0.0107
BH08 (945-)	6.34	-0.02	-0.02	1.74	-0.01	0.009	0.0137	0.0049
BH08 (950-)	6.21	-0.02	0.039	2.26	-0.01	0.012	0.0092	0.0048

Note: All parameters reported in milligrams per liter except pH, which is reported in standard units.
Source: Walker and Associates 2003.

Table B1-4 Modeled Aqueous Concentrations at the Project Boundary Using Initial Underground Workings Water

	Average Groundwater	Initial Underground Workings Water	Groundwater/ Underground Workings Water Mixture with Reaction	Groundwater/ Underground Workings Water Mixture with Reaction and Inorganic Carbon Diffusion	NDEP Profile I Reference Values
pH	7.96	10.24	8.37	7.91	6.5 to 8.5
log P_{CO2} (atm)	-3.13	-8.00	-3.91	-3.13	--
pe	-0.37	10.32	-4.18	-3.65	--
Eh (mvolts)	-21.65	610	-247	-216	--
Aluminum	0.050	0.216	0.0028	0.00096	0.2
Antimony	0.0094	0.0222	0.0132	0.0132	0.006
Arsenic	0.0121	5.48×10^{-7}	8.29×10^{-4}	0.0085	0.01
Barium	0.0830	0.00200	0.0100	0.0103	2.0
Beryllium	0.00	0.00204	0.00061	0.00061	0.004
Boron	0.11	0.346	0.177	0.177	--
Inorganic carbon[a]	69.8	1.49	32.8	68.5	--
Cadmium	0.00	1.43×10^{-4}	4.26×10^{-5}	4.26×10^{-5}	0.005
Calcium	25.0	639	197	208	--
Chloride	25.0	30.2	26.5	26.5	400
Chromium	0.00	0.225	8.97×10^{-5}	1.74×10^{-4}	0.1
Copper	0.00	2.68×10^{-4}	8.01×10^{-5}	8.01×10^{-5}	1
Fluoride	1.08	1.96	1.34	1.34	4
Iron	0.02	4.93×10^{-4}	1.10	1.10	0.6
Lead	0.00	9.40×10^{-7}	2.80×10^{-7}	2.80×10^{-7}	0.1
Magnesium	7.80	0.00404	5.48	5.48	150
Manganese	0.08	3.00×10^{-8}	0.056	0.056	0.1
Nickel	0.00	0.0209	0.0062	0.0062	0.1
Nitrogen	0.00	1.78	0.53	0.53	10
Potassium	2.53	43.5	14.7	14.7	--
Selenium	0.00	0.323	5.15×10^{-10}	1.46×10^{-9}	0.05
Silica	0.00	68.8	17.5	17.1	--
Sodium	30.0	56.8	38.0	38.0	--

Table B1-4 Modeled Aqueous Concentrations at the Project Boundary Using Initial Underground Workings Water

	Average Groundwater	Initial Underground Workings Water	Groundwater/ Underground Workings Water Mixture with Reaction	Groundwater/ Underground Workings Water Mixture with Reaction and Inorganic Carbon Diffusion	NDEP Profile I Reference Values
Sulfate	53.5	1,602	519	519	500
Sulfide	0.00	0.00	2.62×10^{-6}	6.76×10^{-7}	--
Thallium	0.0000	0.0314	0.0094	0.0094	0.002
Zinc	0.00	1.93×10^{-5}	5.77×10^{-6}	5.77×10^{-6}	5
TDS	215	2,446	854	901	1,000

[a] mg CO_3^{2-}/L

Notes:

All units mg/L unless otherwise noted
atm – atmospheres
mvolts – millivolts
TDS – total dissolved solids

Source: Brown and Caldwell 2012.

B2 Groundwater Model Report

FINAL

HOLLISTER MINE GROUNDWATER MODEL DEVELOPMENT AND DEWATERING SIMULATIONS

Prepared for

Rodeo Creek Gold Inc., Winnemucca, Nevada

October 28, 2010

FINAL

HOLLISTER MINE GROUNDWATER MODEL

Prepared for

Rodeo Creek Gold Inc., Winnemucca, Nevada

October 28, 2010

Brown AND Caldwell

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LIST OF ABBREVIATIONS

2-D	two-dimensional
3-D	three-dimensional
AFY	acre feet per year
amsl	above mean sea level
BLM	Bureau of Land Management
EIS	Environmental Impact Statement
ft/day	feet per day
GBG	Great Basin Gold
GHB	general head boundary condition
gpm	gallons per minute
HDB	Hollister Development Block
Hecla	Hecla Mining Company
RCG	Rodeo Creek Gold Inc.
RIB	rapid infiltration basin
USX	U.S. Steel Corporation

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EXECUTIVE SUMMARY

The Hollister Mine Model (Hollister Model) and Final Hollister Mine Groundwater Modeling Report for Rodeo Creek Gold Inc. (RCG) has been prepared by Brown and Caldwell to document a numerical groundwater flow model developed to simulate mine dewatering and estimate the extent of groundwater drawdown that would result from current and future dewatering activities at the Hollister Mine and planned Hatter Expansion, which is sited approximately one mile to the east. RCG is in the process of permitting full-scale mining at the Hollister Mine, and the permitting process includes the preparation of an Environmental Impact Statement (EIS) by the United States Department of the Interior, Bureau of Land Management (BLM). Results of predictive groundwater flow model simulations are intended to support the EIS for the Hollister Mine.

Project Goals

As a part of the EIS process for permitting the Hollister Mine for full-scale production, groundwater modeling is required to estimate:

- the maximum areal extent of drawdown in the groundwater potentiometric surface resulting from dewatering of the Ordovician Vinini Formation-hosted aquifer;
- the timing of the occurrence of the maximum extent of drawdown;
- the post-mining rebound, or recovery, of the potentiometric surface;
- the relationship of the Hollister Mine-related groundwater drawdown to the hydrologic cumulative effects area created by major mine dewatering activities located to the southeast along the Carlin Trend; and
- future rates of groundwater pumping that will be necessary to achieve dewatered conditions in the underground workings.

Model simulations were used to compare the extent of the simulated 10-foot groundwater surface drawdown resulting from dewatering at the Hollister Mine with the cumulative drawdown prediction resulting from groundwater model simulations of combined dewatering efforts within the Carlin Trend by Barrick Goldstrike (BLM, 2008; Barrick, 2010). Additionally, a predictive simulation was performed for the Hollister Mine No Action Alternative scenario. This future scenario is defined as a continuation of underground test mining and exploration activities at current rates through the end of 2011, with groundwater recovery beginning in 2012.

Hydrogeologic Setting

The two hydrogeologic units of interest for development of the Hollister Mine are the 1) Vinini Formation and 2) overlying Tertiary volcanic rocks. The more permeable carbonate hydrogeologic units underlying the Vinini Formation are not included in this study because of the approximately 4,500-foot vertical separation between the planned lower-most extent of the Hollister Mine workings and the deeper carbonate units. The Vinini Formation is the unit that will be locally dewatered to accommodate subsurface mining activities at the Hollister Mine and Hatter Expansion. The shallower, Tertiary volcanic rock aquifer is separated from the Vinini in the vicinity of Hollister by low permeability clays, and hydrographs from monitor wells completed in both the Vinini Formation and the Tertiary volcanic rocks show that water levels have declined by up to 300 feet locally in the Vinini Formation as a result of dewatering at Hollister. Contrastingly, water levels in the Tertiary volcanic rocks have exhibited only minor seasonal fluctuation and no long-term changes.

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Unconfined groundwater flow directions in the regional aquifer in the Vinini Formation have a resultant flow direction to the southwest in the Hollister area. This general direction of groundwater flow reflects the influence of a major regional recharge area along the Tuscarora Mountains located up-gradient, east and northeast, of Hollister (BLM, 2000a). The orientation of groundwater flow direction for the Tertiary aquifer differs from that of the regional aquifer, and is directed to the south-southeast. The absence of water level response in the Tertiary volcanic aquifer, despite significant dewatering in the Ordovician Vinini Formation in the vicinity of the Hollister Mine, combined with the divergent groundwater flow directions for both aquifers indicate that there is a general lack of hydraulic communication between the aquifers.

The hydrogeologic conceptualization, hydrogeologic data, and results from previous regional and local groundwater dewatering and drawdown modeling efforts and aquifer testing activities, were all used as a starting point in the development of the Hollister numerical groundwater model. A two-dimensional (2-D), simplified, screening-level model ("screening model") was developed using MODFLOW-2000 in order to assess the sufficiency of the model domain and any anticipated model boundary interference (Harbaugh et al., 2000). The screening model consists of a single layer composed of 750 rows by 740 columns with 100 foot by 100-foot spacings. The areal extent of the model domain totals approximately 200 square miles and was generally centered upon the Hollister Mine location.

Model Development

Initially, the simplified, two-dimensional screening model was set up to estimate regional groundwater gradients, elevations, and regional impact of 20 years (2010 to 2030) of ongoing and future mine dewatering and associated groundwater drawdown in the vicinity of the Hollister Mine. The results of this preliminary modeling were then used to refine the model domain extent, construction, and overall design for a more advanced and expanded flow model that is better suited to estimate impacts of proposed and future dewatering activities at the Hollister Mine and Hatter Expansion.

Following the review of the screening model results, a more sophisticated three-dimensional (3-D) numerical flow model ("Hollister Model") was constructed using MODFLOW-SURFACT to simulate previous mine dewatering activities and estimate future groundwater conditions and dewatering rates. The Hollister Model contains multiple aquifer layers bounded by three-dimensional surfaces (or geologic contacts), and it is primarily a tool to assess the regional impacts attributable solely to mine dewatering at the Hollister Mine and Hatter Expansion. It was not designed to reflect detailed hydrogeologic heterogeneity or to include other regional groundwater sources or sinks other than underflow within the Ordovician Vinini aquifer.

The full active model domain of the refined Hollister Model is approximately 590 square miles, is centered upon the location of the Hollister Mine workings, and extends approximately 11 miles away from the mine workings. Three active model layers represent the portions of the Vinini Formation at similar elevations to the various Hollister and Hatter mine workings. With the exception of a zone of low- permeability intrusive geologic features immediately east of the Hollister Mine, the Vinini Formation in the Hollister Model was simulated as a homogeneous medium with constant hydraulic properties.

Both steady-state and transient models were constructed and calibrated to reproduce past, observed groundwater conditions prior to performing predictive dewatering simulations to estimate future groundwater drawdown and recovery. In particular, the model was calibrated to adequately match water level measurements and declines observed at monitor well locations BH-01 and BH-02. The steady-state model generally approximates groundwater conditions in March 2005, prior to dewatering activities at the Hollister Mine. The transient model simulates dewatering activities at the Hollister Mine from March 2005 through December 2009, and total dewatering pumping was based upon recorded, historical inflow volumes to the mine decline. Simulated dewatering proceeded at the recorded locations, elevations, and rate of advance of the mine workings. The model-simulated water levels and water budget for the local Vinini Formation aquifer both matched observed and interpreted local and regional groundwater conditions by the end of 2009.

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Additionally, a sensitivity analysis for the primary model inputs demonstrated the robustness of the model calibration and supported the estimated aquifer hydraulic parameters developed during model calibration.

Predictive Simulation

Following the successful calibration of the Hollister model, a predictive simulation was developed to estimate future groundwater drawdown and recovery associated with past and planned dewatering at the Hollister Mine and Hatter Expansion, per the project goals listed above. The predictive model simulation time period begins in January 2010 and continues through the year 2250. Future dewatering rates were estimated by the model based upon the specified elevations of planned future active mining activities and the calibrated model hydraulic parameters. Future water levels were allowed to decline to the prescribed elevations of future mine workings at both the Hollister Mine and Hatter Expansion coincident with the time when it is anticipated that they will be excavated and advanced. When mining and dewatering activities were anticipated to be complete in a given area, simulated dewatering pumping was turned off for that particular portion of the various mine workings.

Results

After completion of the predictive simulation, estimated future water levels, drawdown, dewatering rates, model water budgets, and water level recoveries were assessed at no greater than 10-year intervals. The simulated 10-foot drawdown was also superimposed upon the estimated maximum extent of cumulative dewatering impacts from the Barrick Goldstrike model (BLM, 2000b).

The simulated maximum extent of 10-foot drawdown that is attributable to past, current, and future dewatering activities at the Hollister Mine and Hatter Expansion has a radial extent of approximately 8 miles in every direction around the Hollister site and Hatter Expansion. The low conductivity intrusive zone, while significant to predicted drawdown and anticipated dewatering rates at the local scale of current and planned mine workings, did not significantly affect the shape or extent of the 10-foot contour. The maximum extent of 10-foot drawdown is predicted to occur in approximately 2070, or approximately 40 years after the cessation of dewatering at the Hollister Mine and Hatter Expansion. The estimated maximum extent of the 10-foot drawdown contour resulting from Hollister Mine and Hatter Extension overlaps the maximum extent of the cumulative 10-foot drawdown contour for pumping within the Carlin Trend by a maximum distance of approximately six miles directly southeast of the Hollister Mine.

Although the maximum 10-foot contours overlap, dewatering at mines in the Carlin Trend southeast of the Hollister Mine occurs primarily in the carbonate aquifer beneath the Vinini Formation. Elsewhere in the Carlin Trend, water levels in low permeability units overlying the deeper carbonates have declined at a lower rate or have remained relatively constant (Maurer, et. al, 1996); therefore, water level declines indicated by the Barrick groundwater model may be expressed at lesser magnitudes in the overlying, less permeable Vinini Formation. This indicated low level of communication between the Vinini Formation and underlying carbonate aquifer implies that the maximum extent of 10-foot drawdown predicted by the Hollister Model may not be directly summed with the drawdown from the Barrick Model to produce a revised cumulative extent of maximum impact.

The overall simulated water budget for the predictive simulation increased by approximately 300 AFY (or 190 gpm) from 2010 to 2030, in response to an estimated increase in dewatering pumping from approximately 420 gpm in 2010 to approximately 610 gpm by the planned end of mining activities in 2030. Additionally, by 2110, the total simulated water budget is within approximately 60 AFY of that for the steady-state simulation, indicating that regional groundwater flow conditions are no longer significantly influenced by dewatering at the Hollister Mine and Hatter Expansion. During the predictive simulation, estimated future average annual dewatering rates vary substantially in magnitude in response to mining activities and are almost always greater than those previously observed. This trend is due to the greater depth of additional mining at the Hollister

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Mine and additional deep mining activities at the Hatter Expansion. Overall, future annualized dewatering estimates for full scale mining activities range from approximately 450 gpm to over 1,100 gpm; however, beyond year 2020, in response to an anticipated consistent, active mine working elevation at Hatter, estimated dewatering rates asymptotically decline and ultimately approach 600 gpm. These future dewatering estimates are dependent upon current understanding of hydrogeologic conditions at depth at both the Hollister and Hatter Expansion locations and are simulated using numerical, passive drain boundary conditions. Due to local variations in hydrogeologic conditions, lithology, and required dewatering techniques, actual pumping and dewatering rates may vary depending upon conditions encountered in the field.

Simulated Water level declines reach the planned depths of mine workings at the appropriate future times for both sites. The minimum, simulated water level elevation in the future is approximately 4,000 feet amsl and occurs at the Hatter Expansion by the year 2019, when the planned, maximum mine depth is reached. This corresponds to a maximum simulated drawdown of approximately 1,420 feet at Hatter. When simulated mine dewatering ceases in 2030, water levels rapidly recover and rebound and come within 100 feet of pre-dewatering conditions by 2050. The timing of water level recoveries for 95 percent and 99 percent of the total maximum simulated drawdown were evaluated. For the Hollister Mine, 95 percent and 99 percent water level recovery is estimated to occur at a maximum of approximately 40 and 130 years after the cessation of mining in 2030. For the Hatter Expansion, the same recovery percentages were met 35 and 88 years after the cessation of mining activities.

Modeling of future potential groundwater conditions under the No Action Alternative scenario was also performed. The No Action Alternative is defined as a continuation of underground test mining and exploration activities at current rates through the end of 2011, with groundwater recovery beginning in 2012. A predictive simulation of the No Action Alternative scenario with the Hollister Mine groundwater model estimates that the maximum extent of the 10-foot drawdown contour will extend radially approximately 2 to 2.5 miles from the Hollister Mine, with the maximum extent of impact occurring approximately between the years 2020 and 2025. Water levels rapidly rise following the simulated cessation of mining activities at the Hollister Mine, and are estimated to recover to 95 percent and 99 percent of pre-mining conditions by approximately 2023 and 2034, respectively.

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1. INTRODUCTION

Brown and Caldwell has prepared this Final Hollister Mine Groundwater Modeling Report for Rodeo Creek Gold Inc. (RCG) to document a numerical groundwater flow model developed to simulate mine dewatering and estimate the extent of groundwater drawdown that would result from current and future dewatering activities at the Hollister Mine and planned Hatter Expansion area of the Hollister Mine, which would be connected via an underground drift to the Hollister Mine workings and is sited approximately one mile to the east. The Hollister Mine is an underground gold exploration and test mining operation that is operating under an exploration permit, which allows for underground exploration and a small amount of production per year for test mining purposes. RCG is in the process of permitting full-scale mining at the Hollister Mine. The permitting process for the Hollister Mine includes the preparation of an Environmental Impact Statement (EIS) by the United States Department of the Interior, Bureau of Land Management (BLM). Results of predictive groundwater model simulations presented in this report are intended to support the EIS for the Hollister Mine.

As a part of the EIS process for permitting the Hollister Mine for full-scale production, groundwater modeling is required to estimate:

- the maximum areal extent of drawdown in the groundwater potentiometric surface resulting from dewatering;
- the timing of the occurrence of the maximum extent of drawdown;
- the post-mining rebound, or recovery, of the potentiometric surface; and
- the relationship of the Hollister Mine-related groundwater drawdown to the hydrologic cumulative effects area created by major mine dewatering activities located to the southeast along the Carlin Trend.
- future rates of groundwater pumping that will be necessary to achieve dewatered conditions in the underground workings.

The remainder of Section 1 describes the location, physical and climatic setting, and background of the Hollister Mine. Section 2 presents the hydrogeologic conceptual model of the Hollister Mine and surrounding areas. Section 3 presents the model development, including the modeling approach, model domain and boundary conditions, and hydraulic parameterization. Section 4 presents the model calibration to observed groundwater conditions and sensitivity analyses of model parameters. Section 5 presents the predictive simulations, results, and analyses, including the cumulative effects assessment. Section 6 presents predictive simulations for the No Action Alternative. Section 7 presents conclusions. Section 8 presents cited references.

1.1 Location

The Hollister Mine is located in north-central Nevada, within Elko County and Section 4 of Township 37 North, Range 48 East, MDB&M (Figure 1-1). The Hollister Mine is approximately 38 miles northeast of the town of Battle Mountain and can be reached from Interstate 80 in Battle Mountain by way of the Silver Cloud Road, or by the Dunphy Road exit to the east. Year-round access is from State Route 18, which can be reached from the Golconda exit on Interstate 80 (approximately 61 miles to the intersection with the Ivanhoe Access Road, and then approximately 10 miles southeast to the Project site).

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1.2 Physical and Climatic Setting

The Hollister Mine is located in the Butte Creek Range within the northern Great Basin, part of the Basin-and-Range physiographic province. Elevations in the Butte Creek Range, on the western flank of the Tuscarora Mountains, approach 7,000 feet above mean sea level (amsl) and in the vicinity of the Hollister Mine vary from 5,500 to 5,900 feet amsl. The Butte Creek Range is bounded on the north by Willow Creek, and on the south by Antelope Creek. Little Antelope Creek, a tributary of Antelope Creek, is located east and south of the Project site. These creeks are within the Humboldt River drainage basin.

The site elevation and location results in a wide range of daily and seasonal temperatures, typical of the high desert climate within the northern Great Basin. High temperatures occur in late July and early August, and the coldest temperatures typically occur in January. Measured temperatures from nearby weather stations in Elko and Beowawe range from 104°F in the summer to -38°F in the winter (BLM, 1988).

The average annual precipitation in the region is about 10 inches, as a combination of snow during the winter months and rain in the late spring (May and June) and during summer thunderstorms. Pan evaporation, as measured at the Beowawe weather station, averages 44 inches per year.

1.3 Project Background

U.S. Steel Corporation (USX) initially explored the Hollister Mine area in the 1980's. Cornucopia Resources purchased what was then called the Ivanhoe property from USX in 1987, and teamed with Galactic Resources to permit and mine by open pit methods an epithermal oxide ore body hosted by Tertiary volcanic rocks. The first gold from the open pit mining operation was poured in 1990. Two pits were developed during this operation, known as the West and East Pits. Hollister Mine operations infrastructure facilities, including the portal for the exploration decline, are located within the East Pit.

Newmont purchased the majority share of the property in 1992, and subsequently determined that the open pit resource was mined out. However, Newmont continued heap leaching operations of the mined ore through 1997.

Great Basin Gold Limited (GBG) acquired Newmont's interest in the 504 claims of the Ivanhoe/Hollister claim block in 1998. GBG conducted several years of surface-based exploration for precious metal-bearing vein deposits hosted by the Ordovician Vinini Formation, which unconformably underlies the Tertiary volcanic rocks. Because of the narrow vein character of the mineralization and the depth to the deposit, exploration from underground workings was eventually determined to be the best method for delineating the deposit and determining its viability for full-scale production. GBG formed a joint venture with Hecla Mining Company (Hecla) known as Hecla Ventures, Inc. to facilitate underground exploration within a subset of the Ivanhoe/Hollister claims known as the Hollister Development Block (HDB).

Underground exploration of the HDB began with the driving of an exploration decline in 2004 from the East Pit area of the previously-mined open pit operations. After five years of site development, Hecla opted out of the agreement in 2007. GBG subsequently formed RCG as a wholly owned subsidiary to continue development of the Hollister Mine.

Inflows of groundwater to the exploration decline first occurred in March 2005 (at approximately five gallons per minute [gpm]) as the underground workings progressed below the water table. The inflow rate increased as the exploration decline progressed to deeper levels, and current inflow rates average approximately 450 gpm. These passive inflows to the underground mine workings are collected in underground sumps, and pumped to surface de-silting facilities before discharge to three rapid infiltration basins (RIBs) located approximately 4-1/2 miles south of the Hollister Mine.

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Active dewatering using underground wells is planned for the Hollister Mine to allow mining to greater depths. Groundwater produced by these wells will remain separate from mine water (i.e., passive inflows), and will be pumped to the surface via a dedicated pipeline where it will be discharged to Little Antelope Creek or some alternative disposal method. RCG anticipates active mine dewatering for the duration of the approximate 20-year mine life (S. Godden & Associates, 2009; RCG, 2009a).

Other mining operations along the Carlin Trend to the southeast of the Hollister Mine produce gold from carbonate rock formations that underlie the Ordovician host rock at the Hollister Mine. The regional aquifer within the carbonate formations is far more transmissive than the ore-hosting formation at the Hollister Mine, resulting in much larger mine dewatering rates. Combined Barrick and Newmont dewatering rates along the Carlin Trend change with time as operations are modified, but have been reported to be in excess of 115,000 gpm (BLM, 2000a).

1.4 Project Approach

The primary objective of the groundwater flow modeling for the Hollister Mine is to provide an estimate of the areal extent, magnitude, and timing of drawdown in the Ordovician Vinini Formation-hosted aquifer resulting from the dewatering of the underground mine workings of the Hollister Mine, including the Hatter Expansion area. Other objectives include providing an updated estimate of the rate of groundwater pumping that will be necessary to achieve dewatered conditions in the underground workings for safe and efficient mining.

Model simulations were used to compare the extent of the simulated 10-foot groundwater surface drawdown resulting from dewatering at the Hollister Mine with the cumulative drawdown prediction resulting from combined dewatering efforts within the Carlin Trend. The cumulative drawdown predictions are provided by Barrick Goldstrike (Barrick, 2010) from groundwater modeling results conducted by Barrick Goldstrike for the *Betze Pit Expansion Project Draft Supplemental Environmental Impact Statement* (BLM, 2008). The extent of the 10-foot drawdown contour presented in the *Betze Pit Expansion Project Draft Environmental Impact Statement* is presented on Figure 1-2 and represents the cumulative impacts area (CIA) relative to groundwater for the combined dewatering efforts within the Carlin Trend, excluding planned efforts at the Hollister Mine.

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2. CONCEPTUAL MODEL

2.1 Geologic Setting

The gold-bearing vein deposits of the Hollister Mine and the adjacent Hatter Expansion area are hosted in the Ordovician Vinini Formation, which comprises repeating, coarsening-upwards sequences of orthoquartzite, muddy quartzite, siltite and bedded to laminated argillite (RCG, 2009a). The Vinini Formation sediments have undergone a very low grade metamorphism to sub-greenschist facies, and in the Hatter Expansion area the Vinini Formation has been hornfelsed by the heat of one or both of two Tertiary intrusive bodies. Hornfelsing has changed the character of the Vinini Formation argillites to a hard rock that exhibits brittle deformation (RCG, 2009b).

Vinini Formation rocks overlie younger Devonian rocks of the Rodeo Creek Formation as a result of compressional tectonic forces associated with the Late Devonian to Early Missippian Antler Orogeny, which caused large-scale, eastward thrusting of western-facies eugeoclinal (siliciclastic) rocks, including the Vinini Formation, over eastern facies miogeoclinal units (shelf carbonates) along the Roberts Mountains thrust fault system. Lithologic data from a deep borehole completed in the Hollister Mine area indicate that the Roberts Mountain Thrust, and therefore the lower contact of the Vinini Formation, is approximately 6,500 feet below the surface (RCG, 2010a).

The Rodeo Creek Formation underlies the Vinini Formation and comprises a thick sequence of sedimentary rocks consisting of interbedded mudstones, quartzites and muddy carbonates. Underlying the Rodeo Creek Formation are later Silurian/early Devonian Popovich Formation and/or Roberts Mountains Formation carbonates (S. Godden & Associates, 2009).

The Vinini Formation is unconformably overlain by a succession of Tertiary volcanic rocks that range in thickness from 200 to 600 feet thick in the Hollister Mine/Hatter Expansion area. Widespread Tertiary volcanic activity began in the region approximately 43 to 41 million years ago (Ma), during the late Eocene epoch, when ash flow tuffs and lacustrine deposits were laid down on the Paleozoic and Mesozoic basement rocks. In the area of the Hollister Mine and Hatter Expansion, clays and re-worked quartzite characterize the contact between the Vinini Formation and the Tertiary volcanic units (HSI, 1989). Zones of re-worked quartzite ("fanglomerate") are discontinuous at the contact and vary in thickness between two and 50 feet, generally thinning to the west (HCI, 1997).

Regional-scale plutonic activity occurred across the entire Great Basin of Nevada, from the Late Triassic to the Cretaceous. Most of the intrusive bodies are intermediate in composition and tend to be stock size, although dykes and sills of this age are also common. Many of the intrusive bodies have a strong spatial, if not genetic, relationship to several of the region's precious metal districts and deposits (S. Godden & Associates, 2009). A small, altered, multi-phase rhyodacite to granodiorite pluton was emplaced into Paleozoic sedimentary rocks in the eastern portion of the Hollister Mine and Hatter Expansion area at about 39 Ma. The pluton, known informally as the Hatter stock, is one of many intrusive bodies along the northwest-trending Carlin trend (Wallace, 2003). Several other intrusive bodies are present in the Hatter Expansion area, indicated by borehole lithologic data and geophysical surveys (RCG 2010a).

Abundant high-angle faults cut the Tertiary volcanic and sedimentary rocks (Wallace, 2003). The principal orientations are north-northwest, north-northeast, and east-northeast. Movement along the faults was

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normal, and offset along individual faults is less than 100 meters (330 feet) and more commonly less than 50 meters (150 feet).

Four sets of faults have dissected stratigraphy at Hollister. A group of near-vertical faults and fissures that trend west-northwest to east-west host the deeper epithermal gold veins found in the Vinini Formation at the Hollister Mine. The amount of displacement across these faults is small and their strike continuity varies between 30 meters and over a thousand meters (one hundred to several thousand feet). Most of the structures are pre-Tertiary in age. Few of these structures appear to penetrate the lower section of Tertiary volcanic rocks. A second set of faults, that trend northwest to southeast, intersect Tertiary volcanic rocks and mineralized veins at depth. A third group of faults trends north-northwest to south-southeast; this group of faults may be related to a regional "Basin and Range" trend. The youngest set of faults trends northeast to southwest (Wallace, 2003). The offsets observed in these faults (in underground workings) are approximately 45 to 60 meters (150 to 200 feet) with downthrows to the northwest with possibly left-lateral movements (RCG, 2010b).

A northeast to southwest fault, known as the Little Antelope Creek Fault, lies between the Hollister Mine and the Hatter Expansion area (Figure 2-1). Exploration boreholes that have penetrated the Little Antelope Creek Fault indicate that rocks in the structural zone are a mixture of shattered areas and ductile deformation areas (RCG, 2009b), and as such are not anticipated to significantly influence groundwater flow. A graben, known as the Hatter Graben, is formed on the east side of the structure (Figure 2-2) where the stratigraphic sequence is down-dropped by at least 200 feet (possibly as much as 500 feet).

Mineralization at the Hollister Mine consists of epithermal banded quartz veins with electrum and silver selenides (Goldstrand and Schmidt, 2000). Veins in the Hatter Expansion area occur in a wide east-west trending structural zone containing several sub-parallel bonanza-grade veins similar to the vein systems within the adjacent Hollister Mine area.

2.2 Conceptual Hydrogeologic Model

The two hydrogeologic units of interest for development of the Hollister Mine and the Hatter Expansion are the Vinini Formation and Tertiary volcanic rocks. The more transmissive carbonate hydrogeologic units, described in Sections 1.3 and 2.1, are not included in the conceptual hydrogeologic model because of the approximately 4,500-foot vertical separation between the planned lower-most extent of the Hollister Mine workings and the Roberts Mountain Thrust, which separates the Vinini Formation from these deeper carbonate units.

The Vinini Formation forms a part of the regional aquifer, and is the unit that will be locally dewatered to accommodate subsurface mining activities at the Hollister Mine. An overlying, shallow aquifer within the Tertiary volcanic rocks is separated from the regional aquifer in the Vinini Formation in the vicinity of Hollister by an aquitard consisting of clays found at the unconformity between the Vinini Formation and the Tertiary volcanic rocks. Hydrographs from monitor wells completed in both the Vinini Formation and the Tertiary volcanic rocks, presented on Figure 2-3, show that water levels have declined by up to 300 feet locally in the Vinini Formation as a result of dewatering at Hollister, whereas water levels in the Tertiary volcanic rocks have exhibited only minor seasonal fluctuation and no long-term changes. The locations of these monitor wells are presented on Figure 2-4.

Groundwater flow directions in the regional aquifer are presented on Figure 2-5, reproduced from the cumulative impact analysis conducted by the BLM (2000a) for large-scale mine dewatering operations conducted by Newmont and Barrick along the Carlin Trend. This map is based on 1990-1991 unconfined groundwater conditions, and depicts a resultant flow direction to the southwest in the Hollister area. This general direction of groundwater flow reflects the influence of a major regional recharge area along the

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Tuscarora Mountains located up-gradient, east and northeast, of the Hollister Mine/Hatter Expansion area (BLM, 2000a). Areal recharge of the regional aquifer in the Vinini Formation may also occur in areas where hydrogeologic conditions allow (i.e., where downward flow is not impeded by aquitards). However, areal recharge is not considered in the numerical groundwater model presented in this report.

Groundwater flow directions in the Tertiary volcanic aquifer at the Hollister Mine are to the south-southeast (Figure 2-6). The orientation of groundwater flow direction for the Tertiary aquifer differs from that of the regional aquifer (Figure 2-5) due primarily to local topographic influences on groundwater flow. Big Butte, located approximately two miles north-northwest of Hollister at an elevation of 6,890 feet amsl, is the major topographic high in the Hollister area, and groundwater flow directions in the volcanic and overlying unconsolidated rocks emanate from it (Brown and Caldwell, 2003). The absence of water level response in the Tertiary volcanic aquifer, despite significant dewatering in the Ordovician Vinini Formation in the vicinity of the Hollister Mine, combined with the divergent groundwater flow directions for both aquifers indicate that there is a general lack of hydraulic communication between the aquifers.

Observations of inflows to the exploration decline and laterals indicate that lithology is a major influence on groundwater movement within the Vinini Formation (RCG, 2007). Most of the groundwater flow through the Hollister underground workings occurs in fractures or along bedding planes of the quartzites of the Vinini Formation; however, large-scale open fractures have not been observed. The argillites, siltstones and mudstones within the Vinini Formation display a very low permeability, evidenced by the very limited groundwater inflow to segments of underground development completed within these lithologic types (RCG, 2007).

Geologic structures that may act as hydraulic barriers within the Vinini Formation aquifer have not been identified. A constant-rate aquifer test of water supply WW-4 (Figure 2-6) was halted when the water level in the well fell abruptly approximately 1,000 minutes into the test (HSI, 1989). This sudden decline in water level would suggest either the dewatering of a fracture system or that the drawdown cone from WW-4 encountered a low-permeability region or a low-permeability fault (i.e., aquifer boundary condition). However, a sudden decrease in inflows to the underground mine workings has not been observed, suggesting that the observed water level decline during the constant-rate aquifer test of WW-4 was related to fracture dewatering. The mixture of shattered areas and ductile deformation areas observed in the Little Antelope Creek Fault (see Section 2.1) together with the absence of sudden decreases in inflows to the underground mine workings indicate that this fault zone has little effect on groundwater flow between the Hollister Mine and the Hatter Expansion area.

Hydraulic conductivity values for the Vinini Formation in the Hollister vicinity have previously been estimated from two constant-discharge aquifer tests (aquifer tests) conducted in two water supply wells (HSI, 1989) and from air lift aquifer testing conducted as part of the hydrogeologic investigation of the mine site (Brown and Caldwell, 2003). An aquifer test conducted in WW-1 (Figure 2-6) yielded an estimated hydraulic conductivity of 0.10 feet per day (ft/d), and an aquifer test conducted in WW-4 yielded an estimated hydraulic conductivity of 0.11 ft/d. The airlift aquifer testing yielded estimated hydraulic conductivity values ranging from 0.002 ft/d to 2.4 ft/d.

The aquifer test at WW-4 yielded an estimated aquifer storativity of 0.008 (HSI, 1989). This value is comparable with the range of confined storativity of 0.0001 to 0.004 for marine clastic rocks above the Roberts Mountain Thrust, which would include the Vinini Formation, presented in BLM (2000b).

The hydrogeologic conceptualization, geologic data, hydraulic parameters derived from previous aquifer testing, as well as from the previous cumulative effects groundwater modeling conducted by Barrick, were all used in the development of the Hollister numerical groundwater model, as discussed in the following sections.

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3. MODEL DEVELOPMENT

3.1 Previous Groundwater Modeling

Several groundwater modeling efforts have been previously performed for the Hollister Mine site to estimate likely passive groundwater inflows to the mine as well as potential regional drawdown. The data used in the simplified, precursor modeling, as well as the model results, were used as a starting point in the development of the updated Hollister Mine model. Two of these modeling efforts are discussed below.

3.1.1 Exploration Decline Modeling

Groundwater modeling for the Hollister Mine was first conducted in 2003 to estimate the passive groundwater inflow to a then-proposed exploration decline, and the results were presented in the *Hydrogeologic Report for the Hollister Development Block, Revision I* (Brown and Caldwell, 2003). A spreadsheet model was used for this initial modeling effort. The spreadsheet model utilized aquifer hydraulic data generated from airlift recovery aquifer testing of four boreholes (Figure 3-1) that were part of a hydrogeologic investigation conducted to support permitting of the exploration decline. The equation upon which the spreadsheet modeling was based considered the rate of mining, the depth of the decline below the initial potentiometric surface, the hydraulic conductivity of the geologic unit being penetrated, the specific yield of the aquifer, and time. Although hydraulic conductivity estimates and water levels were available from site data, specific yield was estimated from tests conducted in the same geologic unit at the Turquoise Ridge Mine, located approximately 35 miles west of the Hollister Mine.

Hydraulic conductivity estimates from the airlift recovery aquifer testing ranged from 0.002 ft/d to 2.4 ft/d. Two hydraulic conductivity values were assumed for the spreadsheet model; 0.1 ft/d for decline segments distal from the targeted mineralized veins, and 1.12 ft/d for decline segments proximal to the veins. A specific yield value of 0.01 was used to model all decline segments.

Maximum model-estimated inflow rates to the decline ranged from 335 gpm to 385 gpm, for mining rates of 15 ft/d and 20 ft/d, respectively. The predicted inflow rates compared very favorably with the observed inflow rates.

3.1.2 Drawdown Extents Modeling

An analytic element groundwater flow model was developed to estimate the likely extent of aquifer drawdown created by the pumping of passive inflows into the decline during the initial underground exploration effort (Brown and Caldwell, 2003). The analytic element model was used to simulate the decline as a well located at the site of borehole BH-04 (Figure 3-1) drilled for the hydrogeologic investigation, with groundwater extraction equal to the estimated maximum inflow rate of 385 gpm (i.e., the predicted inflow rate from the spreadsheet model) for a period of 300 days. Aquifer parameters for the analytic element model were set at the same values as those used for the inflow calculations, with the addition of a northeast to southwest hydraulic gradient of 0.01. The model considered drawdown in the Vinini Formation only, which is consistent with evidence that an overlying shallow aquifer hosted in tuffaceous Tertiary volcanic rocks is not hydraulically connected with the Vinini-hosted aquifer. The model simulation indicated that the 10-foot drawdown contour would have an approximate radius of 4,500 feet.

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3.2 Screening-Level Model Development and Results

A two-dimensional (2-D), simplified, screening-level model ("screening model") was developed using MODFLOW-2000 to assess the sufficiency of the model domain and any anticipated model boundary interference (Harbaugh et al., 2000). The screening model consists of a single layer composed of 750 rows by 740 columns with 100 foot by 100 foot spacings. The areal extent of the model domain totals approximately 200 square miles and was generally centered up on the Hollister Mine location. Constant head boundary condition cells were used to represent underflow coming into the model from the northeast as well as the underflow leaving the model to the southwest. The constant head values representing inflow to the model were set at a uniform elevation of 5,650 ft amsl, and the constant heads representing outflow were set to a uniform elevation of 4,800 ft amsl. These head values were based upon a review of regional water levels presented by the BLM (2000a). The top elevation of the model represents the approximate upper contact of the Vinini Formation in the vicinity of the mine workings, at an elevation of approximately 5,420 ft amsl. The bottom elevation was set at a uniform elevation of 3,700 ft amsl to ensure that the model had sufficient thickness to adequately represent the full depth of planned mine dewatering. The resultant thickness of Vinini Formation included in the screening model was approximately 1,720 feet. All hydraulic parameters were assumed homogeneous and isotropic, with hydraulic conductivity set at 0.08 ft/day, storativity (or storage coefficient) set at 0.008, and specific yield set to 0.01 percent. The magnitudes of these parameters were based upon calibrated values from previously analytical element dewatering modeling as well as interpretations from local aquifer testing.

The model was set up as a combined steady state/transient model with the first stress period set to produce a steady state solution that was calibrated to approximate regional groundwater gradients and elevations prior to simulating dewatering. The second stress period was set to produce a transient solution that covering 20 years of mine dewatering and associated groundwater drawdown in the vicinity of the mine workings. The remaining transient stress periods account for 100 years of simulated post-mining groundwater recovery.

Numerical "drains" were used to simulate mine dewatering and were placed parallel to the current distribution of mine laterals (Harbaugh and McDonald, 1996; Harbaugh et al., 2000). Drains will remove or "pump" water from the groundwater model over time in order to draw down water levels to an elevation specified for each drain cell. Drain cell width and length were each set to 100 feet. The thickness of the drain bed was set at one foot and drain hydraulic conductivity was set to 0.08 ft/d, or the same value as that used for the surrounding Vinini Formation. Prescribed head values for the drains were set to draw down water levels to the elevation of the deepest mine workings planned for the Hollister Mine, or 4,570 ft amsl, by the end of the 20-year mine dewatering period.

After 20 years of mine dewatering, simulated drawdown at the workings was approximately 800 ft. The extent of the future, estimated 10-foot drawdown contour over time was then used to refine the model domain extent, approach, and overall model design for the more refined and expanded flow model to be used to more accurately estimate impacts of proposed and future dewatering activities at the Hollister Mine.

3.3 Refined MODFLOW Model Development

3.3.1 Approach

Following the development and review of the results of the 2-D screening model, a refined three-dimensional (3-D) numerical flow was constructed using MODFLOW-2000 to simulate and estimate 1) previous mine dewatering activities, 2) the extent and magnitude of future groundwater drawdown associated with planned full scale and No Action Alternative mining scenarios, and 3) the timing of future water level recovery at the mine site. A summary of the specifications of the 3-D numerical flow model (Hollister Model) are presented below in Table 3-1.

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Although the Hollister Model contains multiple layers bounded by three-dimensional surfaces (or geologic contacts), it is intended to serve primarily as a tool to assess the regional impacts attributable solely to mine dewatering at the Hollister Mine. It is not designed to reflect detailed or refined hydrogeologic heterogeneity in either the lateral or vertical dimensions, nor does it include other regional groundwater sources or sinks other than underflow within the Ordivician Vinini aquifer. However, previous modeling efforts by Barrick Goldstrike were considered during model development and were used in the development of layer elevations and initial hydraulic parameter estimates (BLM, 2008).

Table 3-1. Specifications of the Hollister Model

Model Characteristics	Specifications
Active Model Domain	~590 square miles
Units	Time: Day Length: Feet
Coordinate System	Adjusted State Plane Nevada East NAD 1927 (See Section 3.3.3)
Model Grid	825 rows by 815 Columns; 2,689,500 Total Cells; 2,010,618 Active Cells; Origin: X:218248 Y: 223041 Rotation: 41° counterclockwise
Cell SIze	100 ft by 100 ft telescoping mesh, increasing to a maximum of 2,000 ft by 2,000 ft at model edges.
Layering – 4 Layers	Layer 1: No Flow – Tertiary Volcanic Aquifer Layers 2, 3 and 4: Vinini Formation, Layer Type: Confined/Unconfined convertible unit with variable transmissivity (LAYCON = 3)
Hydraulic Parameters (Calibrated)	Layer 2: K: 0.2 Kx:Kz: 100:1 Ss = 5e-6 Sy = 0.03 Layer 3: K: 0.15 Kx:Kz: 100:1 Ss = 5e-6 Sy = 0.02 Layer 4: K: 0.15 Kx:Kz: 100:1 Ss = 5e-6 Sy = 0.02 Hatter Graben (Layer 2, 3, and 4): K: 0.003 Kx:Kz: 10:1 Storage parameters the same as those listed above.
MODFLOW-SURFACT Packages	Basic, BCF4, ATO4, PCG5, OC, Well, Drain, GHB
Stress Periods	Transient Calibration: 29 Stress Periods of 60.8 days each (March 2005 through December 2009) Predictive Simulation: 24 Stress Periods ranging from 365 days to 3,650 days through stress period 23 (January 2010 through December 2109). Stress period 24 covers 54,750 days (through December 2249)
Dewatering Wells/Drains	54 Wells simulated as analytic elements in the calibrated transient simulation; 1146 Drains used to simulate dewatering in the predictive simulation
Boundary Conditions	General Head Boundaries were simulated on all 4 sides of the model where the flow gradient was not perpendicular to the model boundary. Reference heads located approximately 2 miles away from model boundaries.
Initial Conditions	Heads from calibrated, steady-state, pre-dewatering simulation used as initial conditions for the transient calibration Head values for the final stress period of the transient calibration used for initial conditions for the predictive simulation
Solution Method	PCG5 using Newton-Raphson solution technique

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3.3.2 Computer Code Description

The Hollister Model was developed with MODFLOW-SURFACT version 3 (Hydro-Geologic, 1996). Groundwater Vistas™ (version 5.43) was utilized as the pre- and post-processing software, fully coupled with ESRI® ArcGIS™ (version 9.3) and associated standard GIS format datasets (ESI, 2010; ESRI, 2009).

3.3.3 Units and Coordinate System

The Hollister Model has linear units of feet, temporal units of days, and all model features georeferenced to mine site coordinates, which are a variant of the State Plane Nevada East NAD27 projection. Site coordinates can be adjusted to State Plane by adding a 2,000,000 foot adjustment to the northing values. GIS files associated with the modeling efforts are also georeferenced to the mine site coordinate system.

3.3.4 Model Domain and Boundary Conditions

As shown on Figure 3-2, the full active model domain of the refined Hollister Model is approximately 590 square miles; centered upon the location of the Hollister Mine workings. The model domain was expanded relative to the 2-D, screening-level model in order to limit boundary effects on predicted dewatering impacts from no-flow model boundaries during subsequent predictive model simulations.

General head boundary conditions (GHB's) were assigned to layers 2, 3 and 4 along all edges of the model where groundwater was interpreted to be entering or exiting the model domain; however, where the groundwater flow paths were approximately perpendicular to the edge of the model, no flow boundaries were used (Figure 3-2). Reference heads for the GHB's were set to approximated groundwater elevations 2 miles away from the model domain, based upon the water level contours shown on Figure 2-5 (BLM, 2000a). GHB cell widths, lengths, and thicknesses correspond exactly to individual grid cell dimensions. Hydraulic conductivity for all GHB's was set to the calibrated hydraulic conductivity values for each model layer of the Vinini Formation. During steady-state model calibration, GHB reference heads were adjusted to produce a groundwater flow regime representative of regional water level elevations and gradients prior to mine-dewatering (Figure 2-5). Post-calibration, fluxes at GHB cells were examined to verify that they were feasible and not likely to bias dewatering impact estimates.

3.3.5 Model Discretization and Layering

The Hollister Model consists of four layers and has a cell discretization of 100 by 100 feet in the center of the model, telescoping out to 2,000 by 2,000 feet along the model periphery. Layer 1 extends vertically from ground surface to the upper contact of the Vinini Formation and encompasses the overlying Tertiary volcanics. This layer was represented completely by no flow cells so that only groundwater conditions within the underlying Vinini formation were considered; however, it was included in the model construction to three-dimensionally represent the location of land surface, surficial hydrology features, and the thickness of the Tertiary volcanics within the model framework. Layers 2, 3 and 4 represent the Vinini Formation (at increasing depths) and were all simulated as convertible confined/unconfined aquifer units (or "layer type 3"), which allows the storage properties and transmissivities of the Vinini to vary and shift from unconfined to confined conditions as water levels decline during dewatering and refilling.

The upper contact of the Vinini Formation in the immediate vicinity of the Hollister Mine was provided by RCG. Because the model domain extends approximately 11 miles away from the mine workings, the bottom of the 1997 Barrick Goldstrike groundwater model layer 1 was utilized to represent the upper contact of the Vinini at distances greater than 2 to 3 miles away from the active mine workings (BLM, 2000b). These two data sources were combined using a kriging interpolation scheme to produce a smooth Vinini surface, shown on Figure 3-3, that completely defines the bottom of layer 1, which also corresponds to the top of model

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layer 2. Additionally, in a portion of the model domain approximately one mile southeast of the mine site, the elevation of the Vinini was set to a uniform elevation of 5,000 ft amsl. This localized adjustment to the upper contact of the Vinini formation was performed due to the presence of intrusive geologic units in this area that have replaced or highly altered the typical geologic units that comprise the Vinini Formation. In this area, as well as in the area surrounding it, the presence of the intrusive units was represented by changes in hydraulic properties rather than explicit changes in layering elevations. The bottom of layer 2 was set at a uniform thickness of 450 feet below the Vinini contact to represent the upper portion of the Vinini Formation that is currently being mined at the Hollister Mine. Layers 3 and 4 were set at constant thicknesses of 500 feet thick each and represent depths of mining proposed at the Hollister Mine and neighboring Hatter Graben in the future.

3.3.6 Temporal Discretization and Initial Conditions

Both steady-state and transient models were developed and calibrated prior to performing predictive dewatering simulations. A discussion of the calibration and simulation results for these models is presented in Section 4.0. The steady-state model was developed to approximate groundwater conditions in early 2005, prior to dewatering activities at the Hollister Mine. Initial heads for the steady-state model were based upon the head distribution presented by the BLM (2000a) and shown on Figure 2-5. Simulated water levels from the steady-state model were used as initial conditions for the transient, calibrated model. The transient simulation period begins in March 2005 and extends through December 2009. It is comprised of 29 stress periods of 60.8 days each, or approximately two months, with variable and adaptive time stepping to improve model convergence and stability.

3.3.7 Hydraulic Parameterization

Initial estimates of bulk aquifer hydraulic conductivity, specific storage, and specific yield were based upon previous modeling efforts, hydrogeologic investigations, and literature values presented in Section 2.0. However, hydraulic parameters were adjusted and refined during the model calibration process to produce final values. Hydraulic properties were assumed to be homogenous and isotropic within each model layer of the Vinini Formation and intrusive zone east of the Hollister Mine (Figure 3-4). All final, calibrated values fall within appropriate ranges for the observed lithology of the Vinini Formation and neighboring intrusive bodies (BLM, 2000b).

3.3.7.1 Hydraulic Conductivity

With the exception of the zone of intrusive geologic features immediately east of the Hollister Mine, the Vinini Formation in the Hollister Model was simulated as a homogeneous medium. Both the low conductivity intrusive zone and bulk Vinini Formation were conceptualized and simulated as "equivalent porous media". This simplifying assumption means that this fractured and locally complex geology can be simulated as porous media with bulk aquifer hydraulic properties at the scale of the model. Given previous modeling work performed by Barrick Goldstrike, this assumption appears to be validated and appropriate for application to the Hollister Mine dewatering modeling (BLM, 2000b; BLM, 2008).

Hydraulic conductivity for the Vinini Formation in model layer 2 was calibrated to 0.2 ft/day. Upon review of site dewatering rates, water level trends, and regional geologic conditions, it appears that the formation may have a lower fracture density and correspondingly lower permeabilities at greater depths. Therefore, a slightly lower hydraulic conductivity of 0.15 was assigned to model layers 3 and 4 during the calibration process to represent this conceptualization. The horizontal to vertical hydraulic conductivity ratio (or anisotropy ratio) was assumed to be 100:1, reflective of the presence of low permeability argillites and siltstones within the model layers representing the bulk Vinini Formation. These units are conceptualized as

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limiting the vertical flow and drainage of water within the Vinini Formation when dewatering hundreds of feet of aquifer at the mine site.

Additionally, the area of intrusives within the adjacent Hatter Graben complex was depicted in the model as a low hydraulic conductivity zone (Figure 3-2). This area was assigned a horizontal conductivity value of 0.003 ft/day in all model layers. This same value was used in the 1997 Barrick Goldstrike model for the intrusive unit directly south of the Barrick Goldstrike mine (BLM, 2000b). The horizontal to vertical hydraulic conductivity anisotropy ratio was assumed to be 10:1 for this low permeability zone; reflective of non-layered intrusive features.

3.3.7.2 Storage

A uniform specific storage value of 5e-6 ft^{-1} was assumed for the entire model. A value of this magnitude is typical of competent yet fractured, hardrock aquifers (Schwartz and Zhang, 2003). Specific yield was calibrated to a uniform value of 0.03 for model layer 2. Similar to the vertical reduction in hydraulic conductivity values, specific yield was set to a uniform value of 0.02 for model layers 2 and 3, representing more competent material and decreasing fracture porosity at depth.

3.3.8 Wells and Mine Dewatering

During the transient calibration simulation, wells were used to simulate dewatering operations associated with the mine workings. No other groundwater pumping or demands were considered or included in the model construction. Total well pumping was based upon historical inflow volumes to the mine decline. Estimated inflows to the mine workings are based upon decline pumping records. Theoretical dewatering wells were placed along the mine decline and laterals according to the temporal locations of mine advance, elevations of the mine workings, and timing of mining activities. Throughout the transient model time period, the total bi-monthly and annual volumes of dewatering pumping matched the recorded volumes, presented in Table 3-2.

The assignment of pumping rates at individual wells was based upon the additional amount of total mine dewatering that occurred during each two-month stress period. The additional amount of total pumping was applied to theoretical wells located in areas of the mine workings that were actively being expanded during that time period. During times when the total dewatering rate declined, pumping was decreased uniformly at all well locations to account for the overall reduction. When the total dewatering rate declined but the mine workings were still being advanced, additional wells were still placed in the new portions of the mine, and the reduction in pumping was again accounted for by reductions in pumping for other wells in the model.

Additionally, as mining progressed it was assumed that the subsurface near shallower portions of the mine were essentially dewatered and no longer required significant dewatering activities. After confirming that simulated water levels were approaching or below the elevations of the mine workings, the simulated pumping for these areas was turned off, and the bi-monthly pumping volume was distributed over the remaining active, theoretical wells.

Table 3-2. Hollister Mine Stress Periods and Pumping Rates

Stress Period	Months-Year	Pumped Volume (Gallons)	Pumped Volume (Acre-feet)
1	March-April 2005	88,920	0.27
2	May-June 2005	455,240	1.40
3	July-August 2005	1,953,000	5.99

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Table 3-2. Hollister Mine Stress Periods and Pumping Rates			
Stress Period	Months-Year	Pumped Volume (Gallons)	Pumped Volume (Acre-feet)
4	September-October 2005	5,086,800	15.61
5	November-December 2005	7,318,800	22.46
6	January-February 2006	10,410,000	31.95
7	March-April 2006	14,750,000	45.27
8	May-June 2006	21,230,000	65.15
9	July-August 2006	24,080,000	73.90
10	September-October 2006	32,020,400	98.27
11	November-December 2006	30,960,000	95.01
12	January-February 2007	24,983,264	76.67
13	March-April 2007	25,158,256	77.21
14	May-June 2007	22,666,320	69.56
15	July-August 2007	21,099,000	64.75
16	September-October 2007	19,566,510	60.05
17	November-December 2007	18,007,805	55.26
18	January-February 2008	20,950,746	64.30
19	March-April 2008	26,305,420	80.73
20	May-June 2008	33,278,670	102.13
21	July-August 2008	41,420,388	127.11
22	September-October 2008	33,877,238	104.0
23	November-December 2008	27,733,666	85.1
24	January-February 2009	25,570,000	78.5
25	March-April 2009	30,569,000	93.8
26	May-June 2009	35,918,000	110.2
27	July-August 2009	35,241,000	108.2
28	September-October 2009	34,843,143	106.9
29	November-December 2009	36,648,000	112.5
Totals	1763 Days / 4.8 Years	662,189,586	2032.19

Sources: RCG records

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4. MODEL CALIBRATION RESULTS AND SENSITIVITY ANALYSIS

4.1 Calibration Approach

Calibration is the process of adjusting model parameters to achieve a good match between the simulated and observed hydraulic heads, hydraulic gradients, water level trends, or other relevant hydrologic data such as water budget components. These observed data are called calibration "targets". Initial estimates for hydrogeologic parameters are varied within a reasonable range of values, based upon observed or literature-derived estimates, to improve the model's ability to simulate these targets. The calibration exercise provides confidence that the model is capable of simulating the historical, observed groundwater conditions, and it was completed for both the steady-state and historical transient model simulations prior to performing the future, predictive dewatering simulations.

4.2 Model Calibration

The Hollister model was calibrated over the time period of historical dewatering: March 2005 through December 2009. Water levels from two, transient calibration targets were primarily utilized during calibration, monitor wells BH-01 and BH-02 (Figure 3-1) The key model variables that were varied during the transient model calibration process included hydraulic conductivity, specific storage, and specific yield. Reference heads for the general head boundary cells were also adjusted during steady-state calibration, but were primarily used to mimic regional flow gradients and pre-dewatering groundwater elevations at the mine site.

The target criteria for the steady-state calibration were to match the general groundwater elevation at the mine site, or approximately 5,400 ft amsl, and qualitatively match the magnitude and resultant flow direction of the regional groundwater gradient, which is generally directed from the northeast to the southwest. Once a calibrated steady-state simulation was achieved, calibration then focused on matching the transient, time-series water level data at BH-01 and BH-02 by varying the hydraulic properties of the Vinini Formation. The goal of the transient model calibration was to generally reproduce: 1) starting water levels, 2) water levels in 2010, 3) the general trends in observed water level declines, 4) the overall magnitude of drawdown at the two key monitoring locations, and 5) simulated water levels within 100 feet of the three-dimensional distribution of all current mine workings. Given the absence of reliable, observational water level data, other than those from BH-01 and BH-02, the final calibration criterion was critical in ensuring that the model was adequately simulating dewatering conditions over a significantly larger spatial extent than the two viable borehole monitoring locations. Additional calibration information, including comparisons of simulated versus observed values (or model residuals) and standard statistics are provide in Appendix A (Figure A-1 and Figure A-2).

To produce a better calibration and better represent aquifer properties at various depths within the model domain, the Vinini Formation was divided into three separate layers during calibration: model layers 2, 3, and 4. This model refinement improved model calibration by allowing slight adjustment to hydraulic parameters with depth as well as allowing dewatering pumping and associated simulated water levels to be representative of much smaller vertical intervals, thereby improving model resolution and substantially decreasing the degree of averaging of parameters over large thicknesses of aquifer material. Additionally, the additional model

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layers allowed both past and future dewatering activities to be more accurately placed with respect to the elevations of the portions of the mine workings being advanced, removing the limitations associated with a 2-D model representation of aquifer conditions.

Hydraulic conductivity, specific storage and specific yield were all varied to calibrate the transient groundwater flow model. In model layer 2, the calibrated hydraulic conductivity estimate for the bulk of the Vinini Formation was adjusted upwards to 0.2 ft/day, and the calibrated specific yield was also raised to a value of 0.03. Both of these values represent increases from the initial, conceptual estimates for hydraulic conductivity and specific yield of 0.08 ft/day and 0.02, respectively. In order to better match observed trends, the calibrated specific storage was determined to be approximately 5×10^{-6}, a reasonable value for a fractured rock aquifer (Schwartz and Zhang, 2003). For model layer 3 and layer 4, hydraulic conductivity was calibrated to a lower value of approximately 0.15 ft/day, and specific yield was estimated to be approximately 0.02. Specific storage was kept at the same value as that calibrated for model layer 2.

Figure 4-1 and Figure 4-2 present simulated versus observed water levels at monitoring locations BH-01 and BH-02, respectively. Overall, simulated water levels match the pre-dewatering groundwater elevations, observed water levels in 2010, the overall trend of declining water levels, and magnitude of total decline. A comparison of simulated water levels in 2010 versus existing mine workings performed using GIS also show that simulated water levels fall close to the elevations of all dewatered portions of the mine.

There are some variations between simulated and observed water levels over time due to uncertainty regarding placement of theoretical dewatering wells and the simplifying assumptions of horizontal and vertical homogeneity for the bulk of the model. Simulated water levels in late 2006 and throughout 2007 are generally lower than those observed at the two calibration target locations (Figures 4-1 and 4-2). This is likely due to a lack of information on the exact portions of the mine that were producing water. However, by the end of the transient simulation, simulated groundwater elevations and water level trends match observed values. Additionally, the steeper drop in water levels at BH-02 near the end of the transient simulation is due to the effects of dewatering of deeper mine workings laterally adjacent to the location of the monitor well. Because both the 5190 and 5050 mine levels fall within model layer 2, the simulated water level response at BH-02 is reflective of dewatering activities and pumping at both mine elevations. This produces a "hybrid" water level hydrograph at later time periods with a steeper rate of water level decline reflective of deeper dewatering activities occurring below the level that BH-02 was intended to monitor. Still, the overall response at BH-02 was deemed to be a suitably accurate representation of water level declines at the scale of the mine site.

4.3 Results

The results from the calibrated, transient model simulation are discussed below. Results include the simulated spatial and temporal distribution of water levels, simulated water budget estimates, and model sensitivity to key hydraulic parameter estimates.

4.3.1 Simulated Water Levels

Figure 4-3 and Figure 4-4 show simulated water level contours for the Vinini Ordivician aquifer from the steady-state and end of the transient dewatering simulations. Although, these water levels are not anticipated to match actual water level conditions within every part of the model domain, they are deemed to be an adequate representation of regional groundwater elevations and gradients at both the scale of the mine site as well as the scale of the regional aquifer. Generally, the primary groundwater flow direction is from the northeast to the southwest in both simulations, although water levels are significantly lower at the Hollister Mine due to approximately five years of dewatering activities. By 2010, there is a localized deflection of flow gradients toward the mine; however, this alteration in the regional flow regime is only persistent within one to

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two miles of the mine workings. Within approximately four miles of the mine, groundwater flow gradients are very similar to pre-dewatering conditions.

4.3.2 Simulated Water Budget

The simulated water budget was reviewed for both the calibrated steady-state and transient models, and is presented below in Table 4-1. Overall water budgets are within reasonable estimates given the hydrogeologic characterization of the regional, fractured rock aquifer system. Note that no recharge or leakage from overlying units was included in either simulation, a conservative assumption taken to not allow an underestimation of future mine-related drawdown during the predictive simulation. The overall water budget increases by approximately 700 acre-feet per year (AFY) from pre-dewatering conditions to 2010, reflective of the magnitude of dewatering pumping recorded in late 2009 (approximately 675 AFY). Mine dewatering is counterbalanced solely by removal of water from storage, and there was a negligible change in fluxes at the general head boundaries. These results demonstrate that no additional water was captured from model boundary conditions during the simulation time period, and there are no boundary effects biasing model results or calibration. Numerical error in the total water budgets was negligible for both simulations.

Table 4-1. Simulated Water budget

Water Budget Components	Steady-State Model Pre-Dewatering March 2005 (Stress Period 1)	Calibrated Model January 2010 (Stress Period 29)
Inflows in AFY (gpm)		
Storage	-	706 (438)
General Head Boundaries	2,892 (1,793)	2,893 (1,793)
Total	2,892 (1,793)	3,599 (2,231)
Outflows in AFY (gpm)		
Storage	-	negligible
Wells	-	675 (419)
General Head Boundaries	2,922 (1,812)	2,922 (1,812)
Total	2,922 (1,812)	3,598 (2,231)

AFY = acre-feet per year
gpm = gallons per minute

4.4 Sensitivity Analysis

A sensitivity analysis was performed on the primary model hydraulic parameters of hydraulic conductivity and storage properties. Figures 4-5 through 4-8 present the results of these analyses as simulated hydrographs at calibration target locations BH-01 and BH-02. Simulated head values from the calibrated model are also included on the figures for comparison purposes. On Figure 4-5 and Figure 4-6, the references to "Main K" and "Low K" refer to the hydraulic conductivity of the Vinini Ordivician aquifer and Hatter intrusive area immediately east of the Hollister Mine, respectively (Figure 3-4).

Model sensitivity to variations in hydraulic conductivity is presented on Figure 4-5 and Figure 4-6. The model is very sensitive to the magnitude of estimated hydraulic conductivity for the bulk Vinini Formation and highly insensitive to changes in assumed hydraulic conductivity for the Hatter intrusive area. This is a positive response because the limited amount of information and high uncertainty for the hydraulic properties of the intrusive area does not significantly effect model calibration or results. A doubling of the hydraulic

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conductivity for the Vinini Formation caused simulated water levels to be simulated approximately 100 feet and 70 feet above observed conditions at BH-01 and BH-02, respectively. In contrast, halving the hydraulic conductivity caused water levels to decline too quickly over the calibration time period, and "dried up" the simulated dewatering wells with simulated water levels approximately 120 feet and 80 feet below observed conditions at BH-01 and BH-02, respectively, by June 2008.

Model sensitivity to variations in storage parameters is presented on Figures 4-7 and 4-8. The model is significantly less sensitive to estimated storage values relative to hydraulic conductivity, with variations in simulated head values typically within 20 to 30 feet. However, the model is moderately sensitive to variations in specific yield across a fairly narrow range. The model is also moderately sensitive to specific storage values greater than the calibrated magnitude; however, it is not sensitive to specific storage estimates less than the calibrated value of 5×10^{-6}.

Overall, the results of the sensitivity analysis support the appropriateness of the final calibrated hydraulic parameters, as no significant improvement to model calibration was observed over the range of simulations. Additionally, simulated head responses at BH-01 and BH-02 show similar trends over time regardless of the magnitude of the parameters that were used; highlighting the fact that the model is accurately simulating groundwater conditions given the simplifying assumptions of homogeneity, equivalent porous media, and generalized dewatering locations. Although there is some non-uniqueness and uncertainty associated with the magnitude of the storage parameters used in the model, the sensitivity analysis demonstrated that the range of these values is likely constrained to a fairly narrow range.

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5. PREDICTIVE SIMULATIONS AND ANALYSIS

Following the model calibration process and review of the results of the historical transient conditions simulation, a predictive simulation was developed to estimate the future drawdown associated with dewatering to support full scale mining at the current Hollister Mine, future Hollister Mine workings, and planned mining activities within the Hatter Graben just east of the Hollister Mine (Figure 5-1). The development, construction, and results of the predictive model and associated simulations are described below.

5.1 Predictive Simulation Development

Future mine dewatering was simulated for approximately 240 years past present day conditions, or through the year 2250. This simulation time frame assumes a 20-year mine life, through 2030, and dewatering activities at both the Hollister Mine as well as the planned Hatter Expansion location. Because future dewatering requirements and pumping rates are uncertain, the simulated distribution of dewatering locations was based upon the 3-D plan of proposed, future mine workings at Hollister and the general footprint of potential mine workings at the Hatter Expansion site (Figure 5-1). Additional details of the development of the predictive model simulations are provided below along with a discussion of the maximum predicted lateral extent of 10-foot drawdown and simulated future recovery of water levels at both the Hollister and Hatter Expansion areas.

5.1.1 Stress Periods and Initial Conditions

The predictive Hollister model consists of 24 stress periods of varying time intervals that were selected to improve model run times and performance and match key changes in planned future mining activities. Details of the temporal setup of the predictive model are provided below in Table 5-1. The model simulation begins in January 2010 and continues through 2250. Initial water level conditions were imported from the head distribution for each model layer from the calibrated transient model at the end of 2009 (end of calibrated model simulation).

Table 5-1. Hollister Model Stress Period Setup

Stress Period	Length (days)	Elapsed Days	Year Start	Year End
1	365	365	2010	2010
2	365	730	2011	2011
3	365	1,095	2012	2012
4	365	1,460	2013	2013
5	365	1,825	2014	2014
6	365	2,190	2015	2015
7	365	2,555	2016	2016
8	365	2,920	2017	2017
9	365	3,285	2018	2018
10	365	3,650	2019	2019

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Table 5-1. Hollister Model Stress Period Setup				
Stress Period	Length (days)	Elapsed Days	Year Start	Year End
11	365	4,015	2020	2020
12	365	4,380	2021	2021
13	365	4,745	2022	2022
14	1,095	5,840	2025	2025
15	1,460	7,300	2029	2029
16	365	7,665	2030	2030
17	3,650	11,315	2031	2040
18	3,650	14,965	2041	2050
19	3,650	18,615	2051	2060
20	3,650	22,265	2061	2070
21	3,650	25,915	2071	2080
22	3,650	29,565	2081	2090
23	3,650	33,215	2091	2100
24	54,750	87,965	2101	2250

5.1.2 Simulated Dewatering

Because specific pumping rates required for future dewatering are unknown and highly uncertain, a different dewatering simulation approach was taken relative to the calibrated transient model. The MODFLOW "drain package" was used, which allows future dewatering rates to be calculated based upon the specified elevations of future active mining activities and the calibrated model hydraulic parameters (Harbaugh and McDonald, 1996). The drain package allows water levels to decline to the prescribed elevations of future mine workings coincident with the time when it is anticipated that they will be excavated and advanced.

Table 5-2 presents a time schedule and elevations for future mine development at each site. Drain properties were set to a length of 100 feet (matching model cell size), a width of 20 feet (matching a general width of the mine workings), and a 1-foot drain thickness. The hydraulic conductivity values for the drains were set to that of the surrounding aquifer unit, or 0.2 feet/day and 0.003 feet/day for the Vinini Formation in Layer 2 and Hatter intrusives, respectively. In Layers 3 and 4, the hydraulic conductivity of the drains in the Vinini Formation was set to 0.15 feet/day (i.e., equal to that of the surrounding aquifer unit in that layer). Drain elevations for the Hollister Mine were set to the active mine levels at any given time period by spatially joining the specific elevations of future mine workings from a CAD file provided by Rodeo Creek Gold to Brown and Caldwell (Table 5-2). Drains were assigned to specific model layers based upon their elevations. When mining activities were anticipated to be complete in a given area, drain elevations were reset for that model time period to a level above the pre-existing water table, effectively turning off model dewatering.

Table 5-2. Hollister Mine Drain Setup Schedule			
Year	Hollister Mine Level (Generalized)	Hatter Expansion Level	Comments
2010	4,979	-	Based upon future Hollister Mine plan
2011	4,930	-	Based upon future Hollister Mine plan
2012	4,810	-	Based upon future Hollister Mine plan

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Year	Hollister Mine Level (Generalized)	Hatter Expansion Level	Comments
2013	4,690	-	Based upon future Hollister Mine plan
2014	4,570	5,200 – 4,800	Subsurface drive over to Hatter, ending at 4,800 elevation at Hatter
2015	4,570	4,800	Hatter Expansion dewatering begins
2016	5,050	4,800	Deep mining stops at Hollister Mine
2017	5,050	4,400	Mine workings advanced downwards
2018	5,050	4,400	-
2019 through 2029	5,050	4,000	Mine workings advanced downwards to final elevation of 4,000 feet
2030 through 2250	-	-	Water level recovery period

5.2 Results of Predictive Simulation

After completion of the predictive simulation, estimated water levels, drawdown, dewatering rates, model water budgets, and water level recoveries were assessed for the entire model domain at a maximum of 10-year intervals to ensure that the model performed appropriately and to ensure that there were no significant boundary effects that biased model results. When appropriate, results for specific years were also assessed to evaluate the maximum extent of drawdown. Given the scope of this work and the modeling approach, the most attention was given to assessing changes from pre-dewatering conditions as opposed to absolute values of water levels or water budget features. However, all model results fall within anticipated magnitudes, given observed mine hydrogeologic conditions and the conceptual model for the mine site and surrounding area, and predicted drawdown can be superimposed upon observed, existing conditions or model results from the Barrick Goldstrike model as a means of assessing future potential impacts of dewatering at the Hollister Mine and future Hatter Expansion (BLM, 2000b). Predicted drawdown, water budget, and water level recoveries are discussed in the sections below.

5.2.1 Predicted Drawdown and Cumulative Effects

The simulated maximum lateral extent of 10-foot drawdown that is attributable to past, current, and future dewatering activities at the Hollister Mine and the Hatter Expansion area is presented on Figure 5-2. The estimated area of 10-foot or greater drawdown has a radial extent of approximately 8 miles away from the Hollister and Hatter Expansion areas. The low conductivity zone, while significant to predicted drawdown and anticipated dewatering rates at the scale of the current and planned mine workings, did not significantly affect the shape of the 10-foot contour, although it is based upon the predicted dewatering rates for the planned Hatter Expansion. The maximum extent of 10-foot drawdown is predicted to occur in approximately 2070, or approximately 40 years after the cessation of mine dewatering. Given the shape of the drawdown contours together with the lack of significant changes in inflows and outflows at the model general head boundaries, there appears to be no significant deflections that would indicate model boundary effects impacting estimated regional water level declines.

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The maximum extent of the cumulative 10-foot drawdown contour from the 2007 Barrick groundwater model is also displayed on Figure 5-2. The maximum extent of drawdown greater than 10 feet attributable to dewatering at the Hollister Mine and Hatter Expansion overlaps the extreme northwestern portion of the cumulative impact area, reaching a maximum overlap of approximately 6 miles directly southeast of the Hollister Mine site. Although there is an apparent overlap, dewatering at mines in the Carlin Trend that are southeast of the Hollister Mine occurs in the deeper carbonate aquifer, which is previously discussed in Section 1.3 and Section 2.2 of this report. Elsewhere in the Carlin Trend, water levels in low permeability units overlying the deeper carbonates have declined at a lower rate or have remained relatively constant with respect to water level declines in the deeper carbonates (Maurer, et. al, 1996). Therefore, water level declines indicated by the Barrick groundwater model may be expressed at a lesser magnitude in the overlying, less transmissive Vinini Formation. This lack of communication between the Vinini Formation and underlying carbonate aquifer means that the maximum extent of 10-foot drawdown predicted by the Hollister Model may not be directly summed with the drawdown from the Barrick Model to produce a revised cumulative extent of maximum impact. Also, it may be appropriate to compare the simulated drawdown extents from both the Hollister and Barrick groundwater models at the specific simulation times at which both models reach their respective maximum 10-foot drawdown extents in order to adequately assess cumulative dewatering impact and its relationship to dewatering at the Hollister Mine and Hatter Expansion sites.

Cross sectional views of the vertical change in piezometric surface and associated water level drawdown in 2015 and 2029, which represent the last year of dewatering at the deepest Hollister and Hatter Expansion areas, respectively, are presented on Figure 5-3 through Figure 5-6. Location maps for each cross section are included on each figure; generally, two perpendicularly oriented cross sections were developed for both the main portion of the Hollister Mine as well as the Hatter Expansion area. Also shown on the cross sections are the contact between the Tertiary Volcanics and underlying Ordivician Vinini Formation, as represented in the numerical model construction, and the model simulated full recovered groundwater level. Simulated water levels and associated drawdown over time at the Hollister and Hatter Expansion areas can also be viewed on the hydrographs presented on Figure 5-7. Additional information regarding simulated future water level and drawdown distributions can be found in Appendix A (Figures A-3, A-4, A-5, A-6, and A-7).

An analysis was also performed to assess the sensitivity of the estimated maximum extent of 10-foot drawdown to uncertainty associated with the hydraulic conductivity for the model's low permeability area and specific yield. These parameters were selected for the analysis because the transient model calibration was not found to be sensitive to them, meaning that these values were not highly constrained during the calibration process. Predictions of the maximum extent of the 10-foot drawdown were found to be essentially insensitive to reasonable variations in the hydraulic conductivity of the low permeability area as well as specific yield estimates.

5.2.2 Predicted Water Budget and Dewatering Rates

The simulated water budget components for both the calibrated transient simulation and predictive simulation are presented below in Table 5-3. The overall simulated water budget increased by approximately 300 AFY from 2010 to 2030, in response to an estimated increase in dewatering pumping of approximately the same magnitude (309 AFY). Changes in inflows and outflows at the upgradient and downgradient general head boundaries are negligible, indicating minimal impact or bias on drawdown from these water budget features. By 2110, the total simulated water budget is within approximately 60 AFY of that for the steady-state simulation, indicating that regional groundwater flow conditions are no longer significantly influenced by mining activity. Numerical error in the simulation water budget was negligible for the predictive simulation.

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Table 5-3. Simulated Water Budgets – Predictive Simulation			
Water Budget Components	Calibrated Model January 2010 (Stress Period 29)	Predictive Model End of Dewatering Activities January 2030 (Stress Period 15)	Predictive Model End of Simulation January 2110 (Stress Period 24)
Inflows in AFY (gpm)			
Storage	706 (438)	1004 (622)	negligible
General Head Boundaries (GHB's)	2,893 (1,793)	2,898 (1,797)	2,974 (1,843)
Totals	*3,599 (2,231)*	*3,902 (2,419)*	*2,975 (1,844)*
Outflows in AFY (gpm)			
Storage	-	-	133 (82)
Wells / Drains	675 (419)	984* (610*)	-
General Head Boundaries (GHB's)	2,922 (1,812)	2,919 (1,810)	2,841 (1,761)
Totals	*3,598 (2,231)*	*3,902 (2,419)*	*2,974 (1,844)*

AFY = acre-feet per year

gpm = gallons per minute

** Drains used to simulate dewatering.*

Total mine dewatering for both mine sites in 2030 was estimated to stabilize at approximately 610 gpm (~1,000 AFY) by the end of planned mining activities, an increase from the approximately 420 gpm (~675 AFY) of pumping recorded in early 2010 (Table 5-3). Figure 5-8 presents the recorded and estimated future groundwater dewatering rates at the Hollister Mine and Hatter Expansion over time. Note that wells were used to simulate recorded dewatering activities, while drains were used to estimate future potential dewatering rates with the beginning of the predictive simulation time period in 2010. During the predictive simulation, estimated future average annual dewatering rates vary substantially in magnitude in response to mining activities and are almost always greater than those previously observed. This trend is due to the greater depth of mining at the Hollister Mine and additional deep mining activities at the Hatter Expansion. As seen in Table 5-2, the driving of underground workings to the Hatter mine are simulated to begin in 2014 with simulated dewatering at that site beginning in 2015. Contrastingly, deep dewatering at the Hollister Mine ceases in 2016. As seen on Figure 5-8, there are corresponding increases and decreases in pumping rates (of hundreds of gallons per minute) in response to these planned changes in mining activities. Overall, future annualized dewatering estimates range from approximately 450 gpm to over 1,100 gpm; however, beyond year 2020, in response to a planned consistent, active mine working elevation at Hatter, estimated dewatering rates asymptotically decline and ultimately approach 600 gpm. These future dewatering estimates are dependent upon current understand of hydrogeologic conditions at depth at both the Hollister and Hatter Expansion locations and are simulated using numerical, passive drain boundary conditions. Due to local variations in hydrogeologic conditions, lithology, and required dewatering techniques, actual pumping and dewatering rates may vary depending upon conditions encountered in the field.

5.3 Water Level Recovery

The simulated water level elevations, declines, and recoveries for both the Hollister Mine and Hatter Expansion are presented on Figure 5-7. Simulated water levels at the Hatter Expansion were taken from a theoretical monitoring location in the center of the planned Hatter Expansion area. Simulated water levels for BH-02 were compiled from both the historical transient and predictive simulation in order to show a representative hydrograph of dewatering and recovery at the Hollister Mine in the vicinity of current mine

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workings. Additionally, a theoretical monitoring location was also placed where future, deeper mining is planned at the Hollister Mine. Water level declines reach the planned depths of mine workings at both sites, indicating that the use of numerical drains adequately dropped water levels to planned mining elevations (Table 5-2). The predictive simulation time period was also expanded to year 2250 to evaluate how close simulated water levels get to pre-dewatering conditions and to assess the sensitivity of predicted recovery times given various water level recovery criteria, discussed below.

Simulated mine dewatering ceases in 2030, and water levels rapidly rebound, coming within 100 feet of pre-dewatering conditions by 2050 for the Hollister Mine and 2060 for the Hatter Expansion. The minimum, simulated water level elevation of 4,000 feet amsl occurs at the Hatter Expansion beginning in 2019, identical to the planned future mine maximum depth presented in Table 5-2. This corresponds to a maximum simulated drawdown of approximately 1,420 feet (at the theoretical Hatter underground workings). The maximum simulated drawdown at the Hollister Mine is approximately 820 feet (an elevation of ~4570 ft amsl). Note that the model does not include sources of recharge or inflows to the aquifer system from overlying or underlying aquifers, nor infiltration from precipitation where the Ordivician Vinini Formation is exposed at land surface. Given these conservative model assumptions, it is likely that simulated water levels will take an unrealistically long time period to reach 100 percent recovery. Therefore, water level recoveries of 95 percent and 99 percent of maximum simulated drawdowns at both the Hollister Mine and Hatter Expansion were evaluated. These drawdown recovery criteria were used to estimate when "fully recovered" conditions occur in the predictive simulation.

Table 5-4 presents simulated water level recovery times based upon the criteria discussed above, and summarizes the information contained in Figures 5-9 and 5-10, which show the refilling curves for the Hollister Mine and planned Hatter Expansion area, respectively. The refilling curves present the percentage of groundwater recovery for each area with respect to the time elapsed after the assumed cessation of mining activities. Note that given the resolution, simplifying assumptions, and data available for the Hollister model construction, estimates of water level recoveries greater than 95 percent are likely beyond the ability of the model to predict with a high degree of confidence. Additionally, simulated groundwater conditions decades into the future are subject to a large amount of uncertainty due to a lack of knowledge about future groundwater inflows and outflows and future groundwater pumping and dewatering demands within the Carlin Trend.

Table 5-4. Simulated Water Level Recovery Times

Drawdown Recovery Percentage	Approximate Recovery Year (years after cessation of mining)		
	Hollister Mine (at BH-02)	Planned Deep Hollister Mine Area	Hatter Expansion Area
95%	2070 (~40 years)	2060 (~30 years)	2065 (~35 years)
99%	2160 (~130 years)	2109 (~79 years)	2118 (~88 years)

Water levels at the Hollister Mine generally recover slower at the location of BH-02 due to the longer period of mine dewatering that has occurred in the vicinity of this well. Relative to the current extent of the Hollister Mine (represented by the BH-02 hydrograph on Figure 5-7), water levels generally recover faster at the Hatter Expansion due to the much shorter duration of simulated dewatering. The shortest water level recovery times are estimated for the aquifer in the immediate vicinity of the planned deep Hollister Mine workings (Table 5-4). This is due in part to the much greater depth of mining at the Hatter Expansion as well as its more distal location to previous dewatering activities near BH-02 (Table 5-2).

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6. NO ACTION ALTERNATIVE SIMULATION AND ANALYSIS

The Hollister Model was used to simulate the extent and magnitude of groundwater drawdown and subsequent groundwater level recovery associated with Hollister Mine dewatering under the No Action Alternative. The No Action Alternative is defined as a continuation of underground test mining and exploration activities at current rates through the end of 2011. Under the No Action Alternative, groundwater pumping is permitted for up to 700 gpm, and test mining is permitted at a rate of up to 400 tons per day. At the end of 2011, test mining, exploration activities, and dewatering would cease, and the open stopes of the Hollister Mine would be backfilled in accordance with the plans for full-scale mining. Additionally, the underground workings of the Hollister Mine will refill with groundwater, beginning in 2012.

6.1 Development of No Action Alternative Simulation

The No Action Alternative simulation was created by modifying the predictive model used to simulate dewatering associated with full scale mining conditions over the next 20 years. All model construction details are the same as described in Section 5, with the exception of two modifications to the model drain package. First, the numerical drains used to simulate current and future dewatering at the Hollister Mine as well as the Hatter Expansion area were deactivated after the end of 2011. This represents the end of test mining and dewatering activities under the No Action Alternative scenario. Secondly, the spatial extent of additional dewatering activities in 2011 was reduced from the full scale mining plan by approximately 62 percent to appropriate future No Action Alternative conditions during that year (RCG, October 2010b). To achieve this, drain cells located in the deepest portions of the planned mine workings were removed first. The remaining active drain locations in 2011 correspond to the depths and lateral extent of theoretical test mining occurring in 2011, pursuant to the specifications of the No Action Alternative scenario and the current test mining permit. Simulated groundwater levels were allowed to recover from 2012 through 2250, although they approach pre-mining conditions much more rapidly than the simulation reflecting full scale mining conditions.

6.2 Results of No Action Alternative Simulation

The simulated maximum lateral extent of 10-foot drawdown that is attributable to past, current, and future No Action Alternative dewatering activities at the Hollister Mine is presented on Figure 6-1. The estimated area of 10-foot or greater drawdown has a radial extent of approximately 2 to 2.5 miles away from the Hollister and Hatter Expansion areas, and is estimated to occur between 2020 and 2025, depending upon the direction away from the mine site. This corresponds to approximately 18 to 23 years after the cessation of test mining activities under the No Action Alternative.

The maximum extent of the cumulative 10-foot drawdown contour from the 2007 Barrick groundwater model is also displayed on Figure 6-1. The maximum extent of drawdown greater than 10 feet attributable to dewatering at the Hollister Mine under the No Action Alternative does not overlap the cumulative impact area. See Section 5.2.1 for a discussion of the limitations of comparing drawdown estimates with those from the 2007 Barrick groundwater model.

The average dewatering rate predicted by the model for 2010 and 2011 was approximately 590 gpm. Simulated water levels declined to a maximum depth of approximately 500 feet below predevelopment conditions by the end of 2011. Beginning in 2012, water levels rapidly rebound, as seen on the No Action

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Scenario refilling curve shown on Figure 6-2. The refilling curve presents the estimated percentage of groundwater recovery under the No Action Scenario with respect to the time elapsed after the assumed cessation of mining activities in 2012. Groundwater levels are simulated to be recovered to within 95% and 99% of pre-mining conditions by 2023 and 2034, respectively.

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7. CONCLUSIONS

The Hollister Mine groundwater model presented in this report was developed to perform simulations of proposed current and future dewatering of the Ordovician Vinini Formation at the Hollister Mine workings in order to assess the maximum extent of the 10-foot drawdown contour, the cumulative groundwater impacts induced by other mining operations in the Carlin Trend, and the timing of groundwater recovery once dewatering operations at the Hollister Mine cease. The Hollister Mine groundwater model is consistent with the conceptual hydrogeologic model presented in Section 2.2 and incorporates geologic and hydrogeologic data that are both site-specific and derived from the Barrick Goldstrike groundwater model (BLM, 2000b). Calibration of the Hollister Mine groundwater model is based on the observed Ordovician Vinini Formation aquifer response to nearly four years of dewatering activities at the Hollister Mine (2005 through 2009), providing a high level of confidence in the model's ability to predict future groundwater conditions. Simulations of future dewatering activities at the Hollister Mine are based on actual conceptual mine plans, and thus present a realistic progression of target dewatering elevations through the life of the Hollister Mine.

Historical water level data from Hollister Mine monitor wells indicate that the past dewatering in the Ordovician Vinini Formation is not affecting water levels in the overlying Tertiary volcanic aquifer, indicating that the two aquifers are not in hydraulic communication. Therefore, significant impacts to the Tertiary volcanic aquifer and its related hydrology are not anticipated to occur as a result of future simulated Hollister Mine dewatering.

Predictive simulations of future full scale mining with the Hollister Mine groundwater model indicate that the maximum extent of the 10-foot drawdown contour will extend radially approximately eight miles from the Hollister Mine, with the maximum extent of impact occurring approximately 40 years post-mining, or approximately in the year 2070. The maximum extent of the 10-foot drawdown contour spatially overlaps a portion of the predicted cumulative effects drawdown induced by other mining/dewatering operations along the Carlin Trend (Figure 5-2). However, the cumulative effects drawdown depicted on Figure 5-2 may be greater than what will be experienced in the overlying low-permeability Vinini Formation being dewatered for Hollister Mine operations. Drawdown from Hollister Mine operations will also temporally precede the occurrence of the cumulative effects drawdown by approximately 40 years (i.e., 2070 versus approximately 2115 for the cumulative effects drawdown).

Water level recovery is simulated to initially be rapid following cessation of mining and dewatering activities at the Hollister Mine and Hatter Expansion, and then will slow with time. For the Hollister Mine, the predictive simulation estimates an asymptotic approach to full recovery, with 95 percent and 99 percent water level recovery estimated to occur approximately a maximum of 40 years and 130 years, respectively, after the cessation of mining activities (corresponding to the years 2070 and 2160). For the Hatter Expansion area, the predictive simulation also estimates an asymptotic water level recovery, with 95 percent and 99 percent recovery simulated to occur approximately 35 and 88 years, respectively, after cessation of mining activities (corresponding to years 2065 and 2118).

Modeling of future potential groundwater conditions under the No Action Alternative scenario was also performed. The No Action Alternative is defined as a continuation of underground test mining and exploration activities at current rates through the end of 2011 with groundwater recovery beginning in 2012.

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A predictive simulation of the No Action Alternative scenario with the Hollister Mine groundwater model estimates that the maximum extent of the 10-foot drawdown contour will extend radially approximately 2 to 2.5 miles from the Hollister Mine, with the maximum extent of impact occurring approximately between the years 2020 and 2025. Water levels rapidly rise following the simulated cessation of mining activities at the Hollister Mine, and are estimated to recover to 95 percent and 99 percent of pre-mining conditions by approximately 2023 and 2034, respectively.

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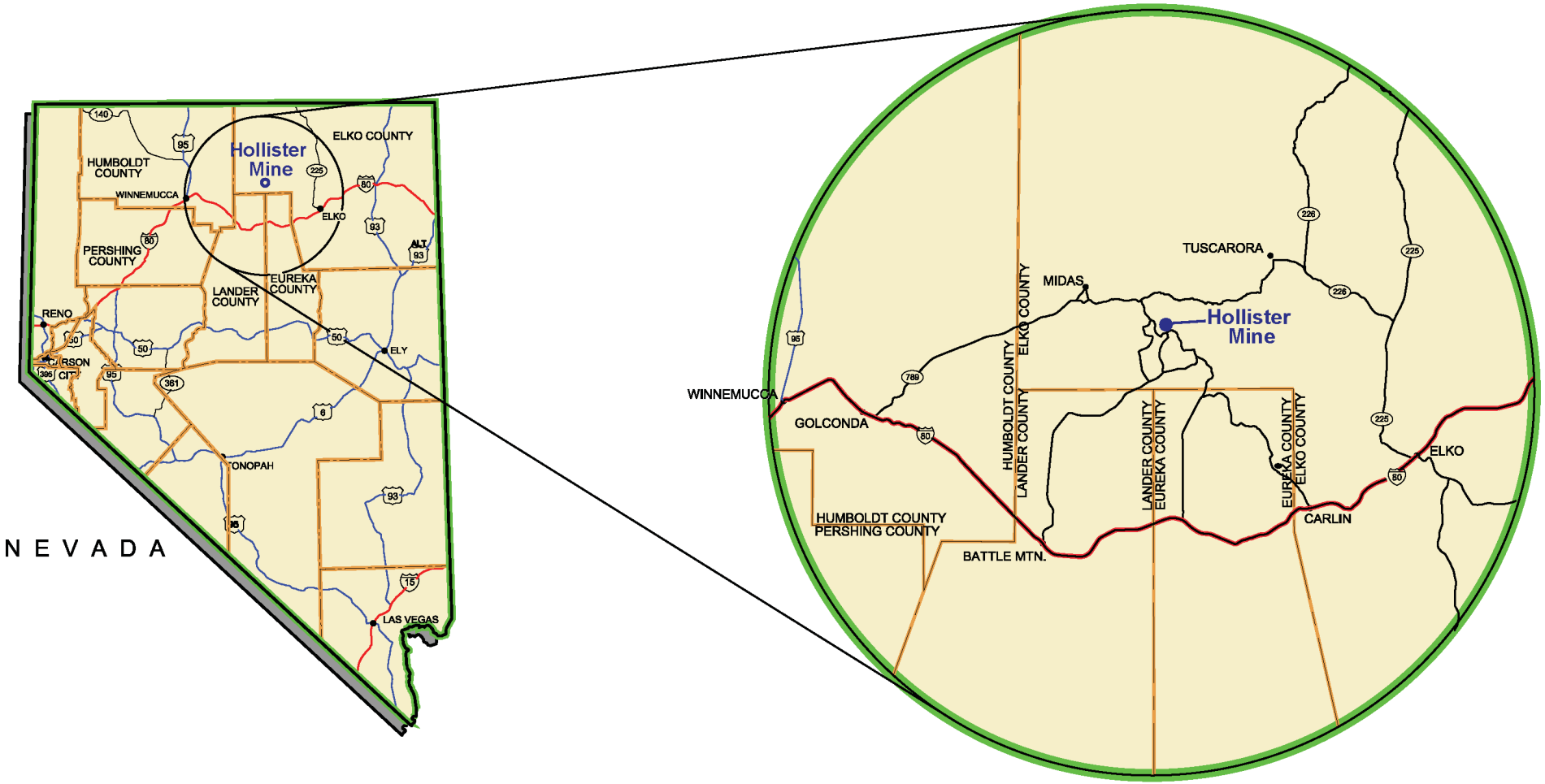

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BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 1-1
	DATE 7-7-10	TITLE Hollister Mine Location	

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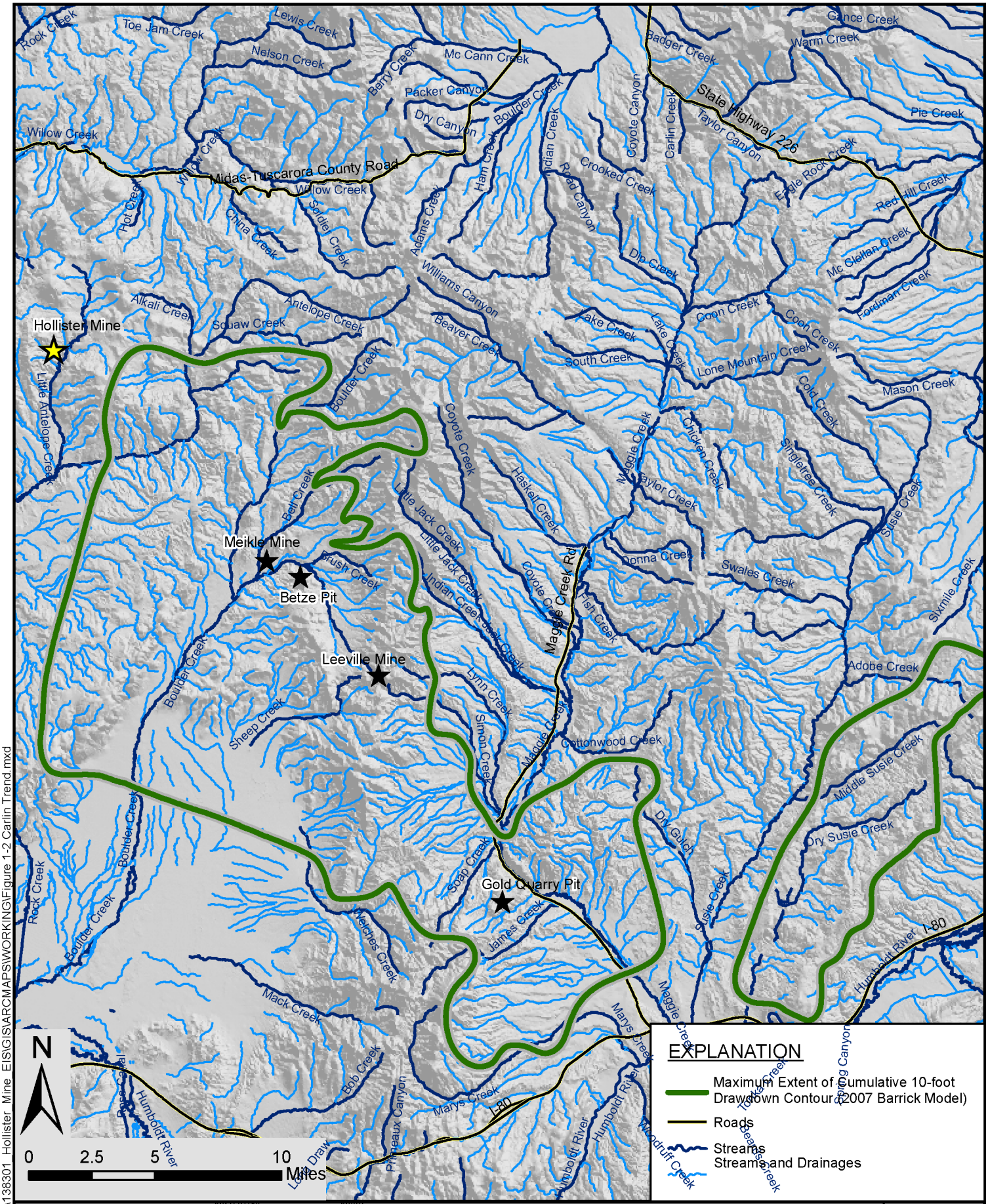

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BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 1-2
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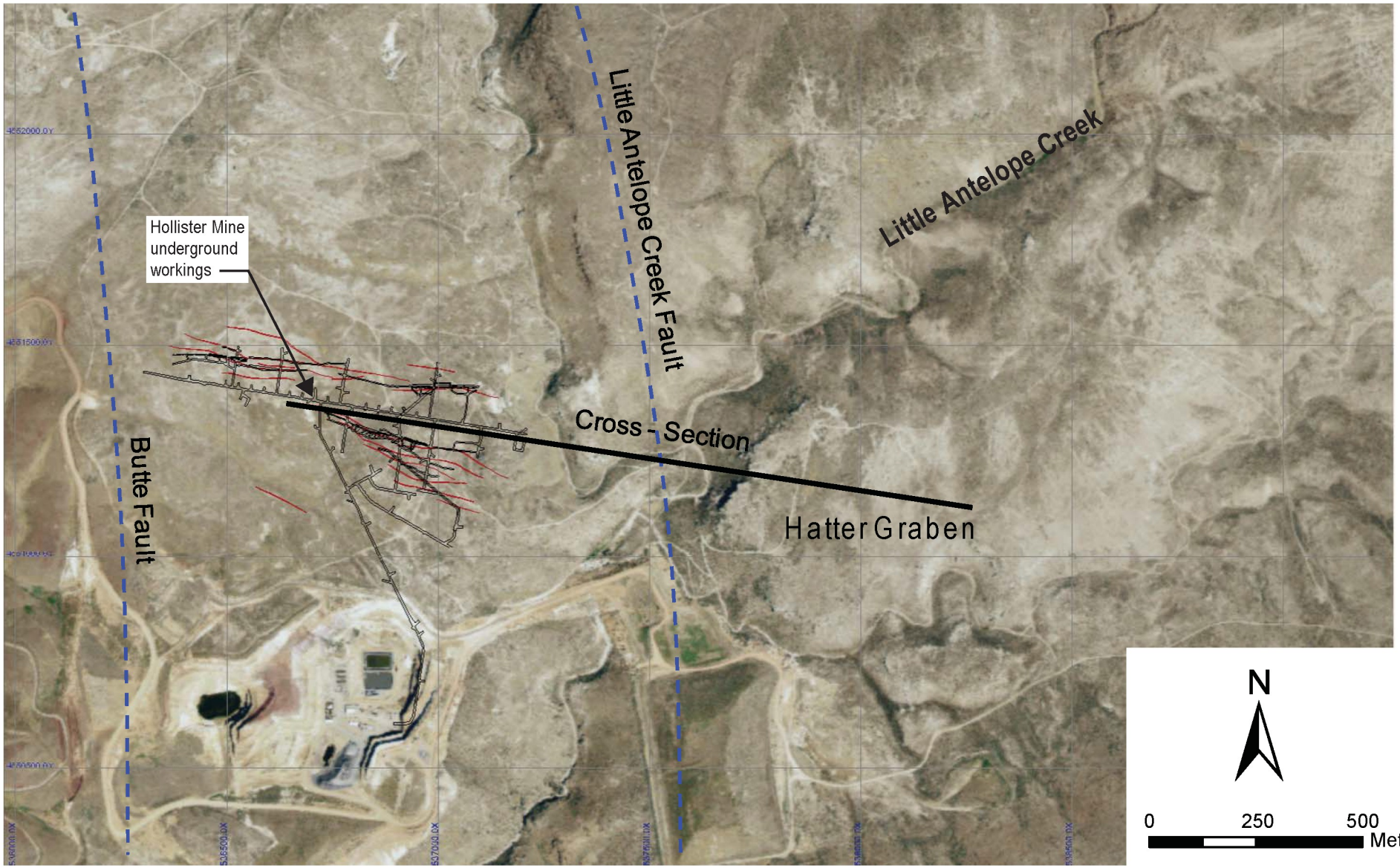

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	DATE 7-7-10	TITLE Location of the Little Antelope Creek Fault and the Hatter Graben	

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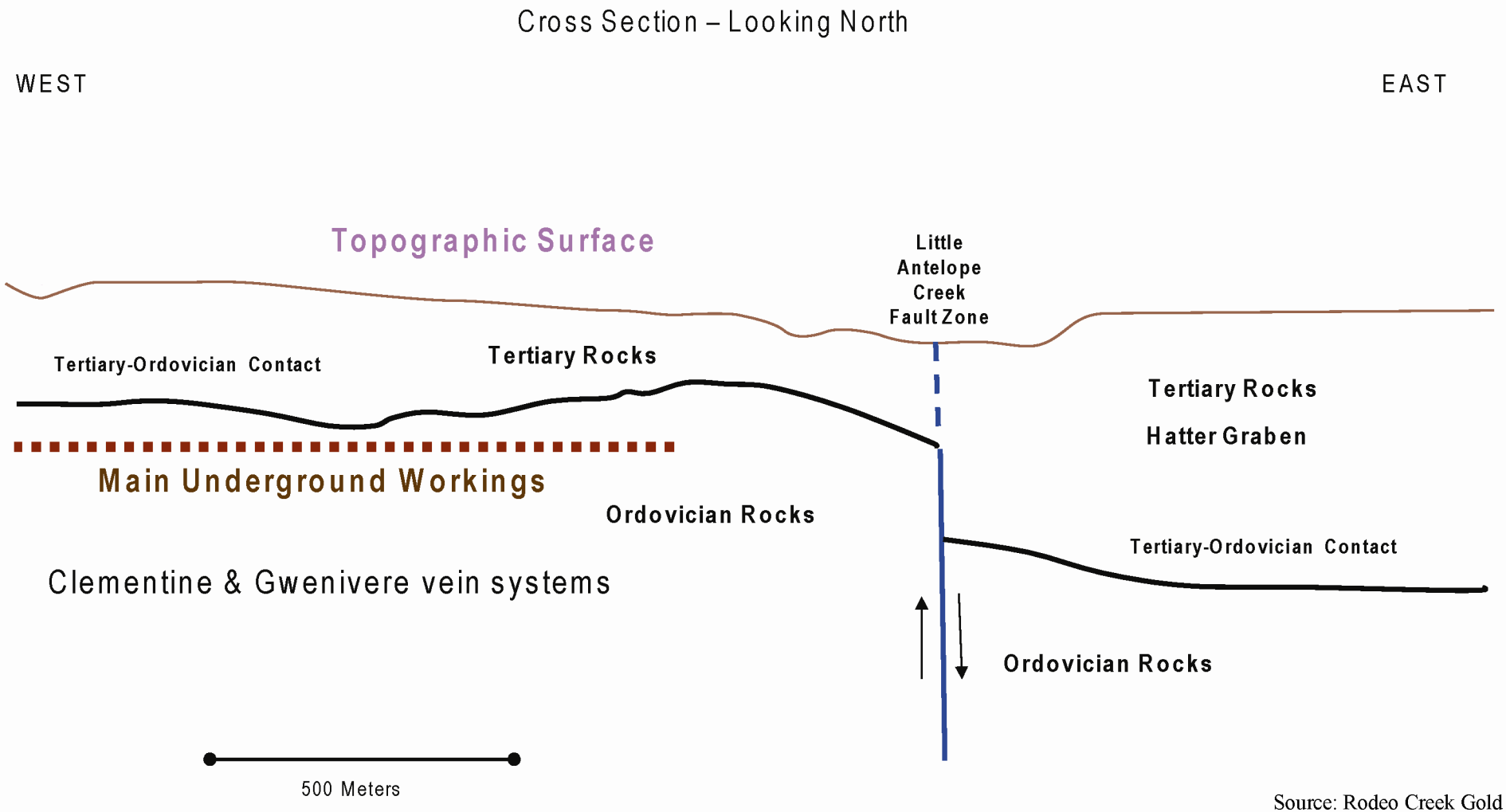

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BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 2-2
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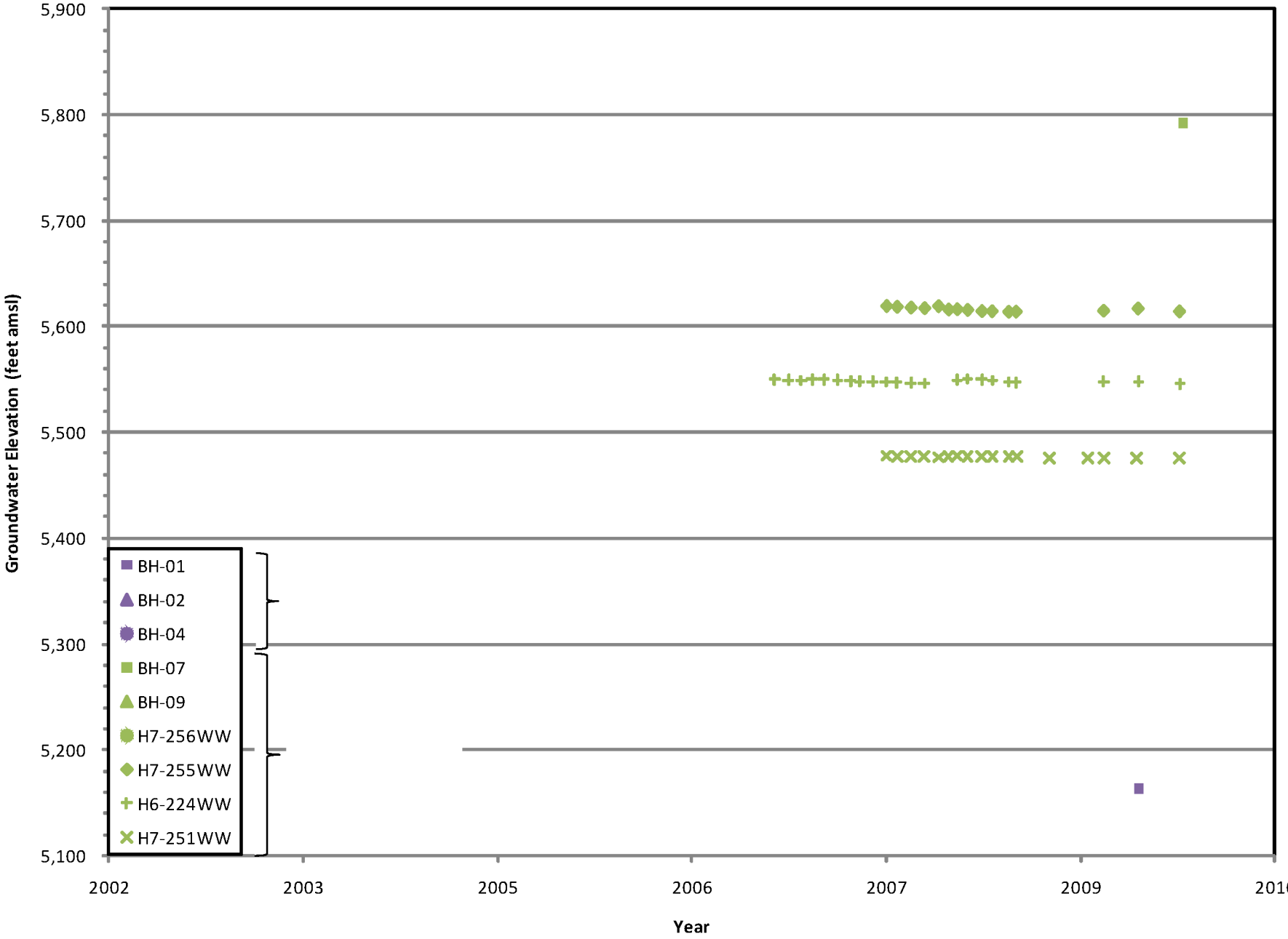

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BROWN AND CALDWELL

PROJECT	SITE	Figure
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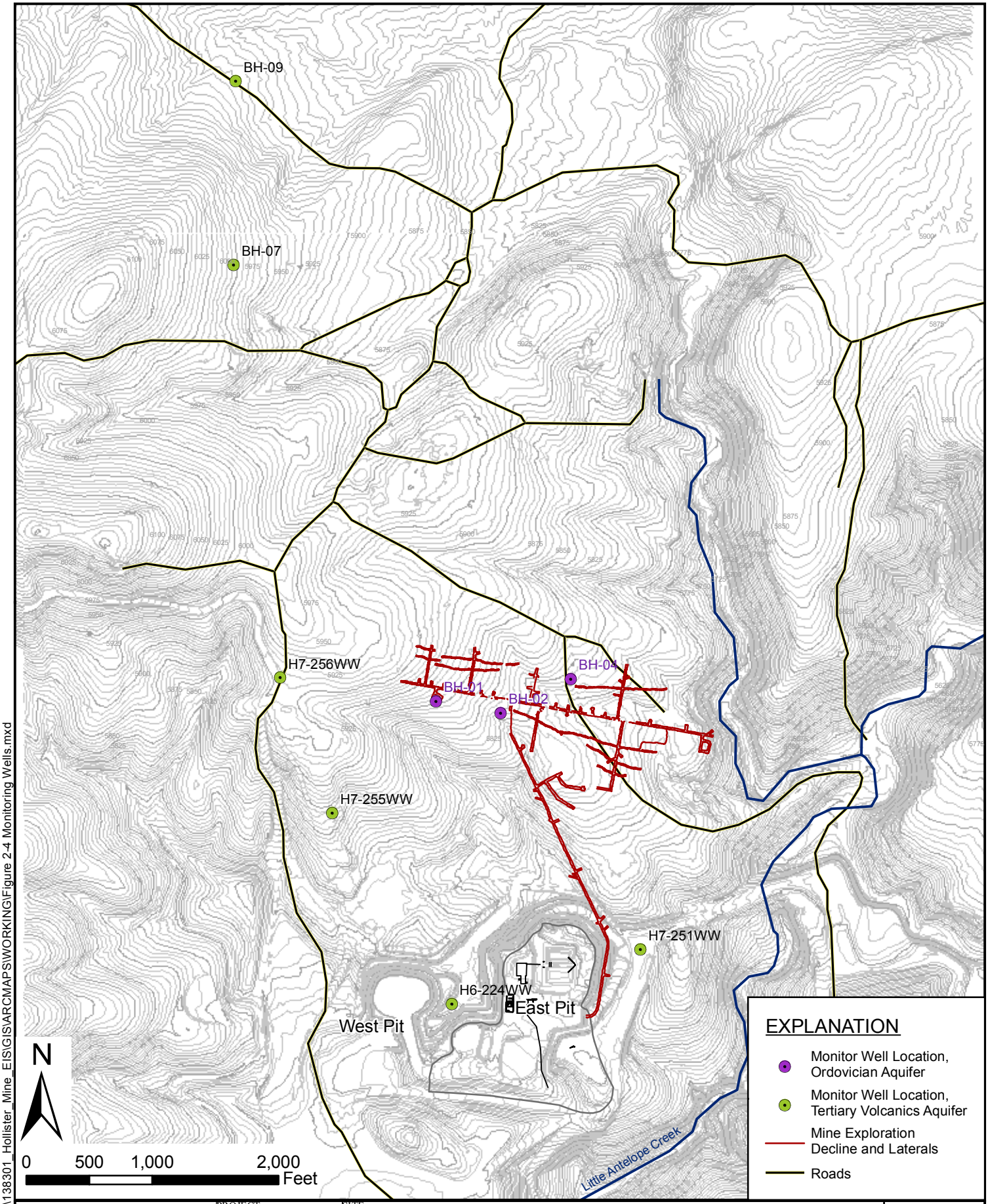
DATE	TITLE	
6/30/10	Hydrographs of Ordovician Vinini Aquifer and Tertiary Volcanics Aquifer Monitor Wells	



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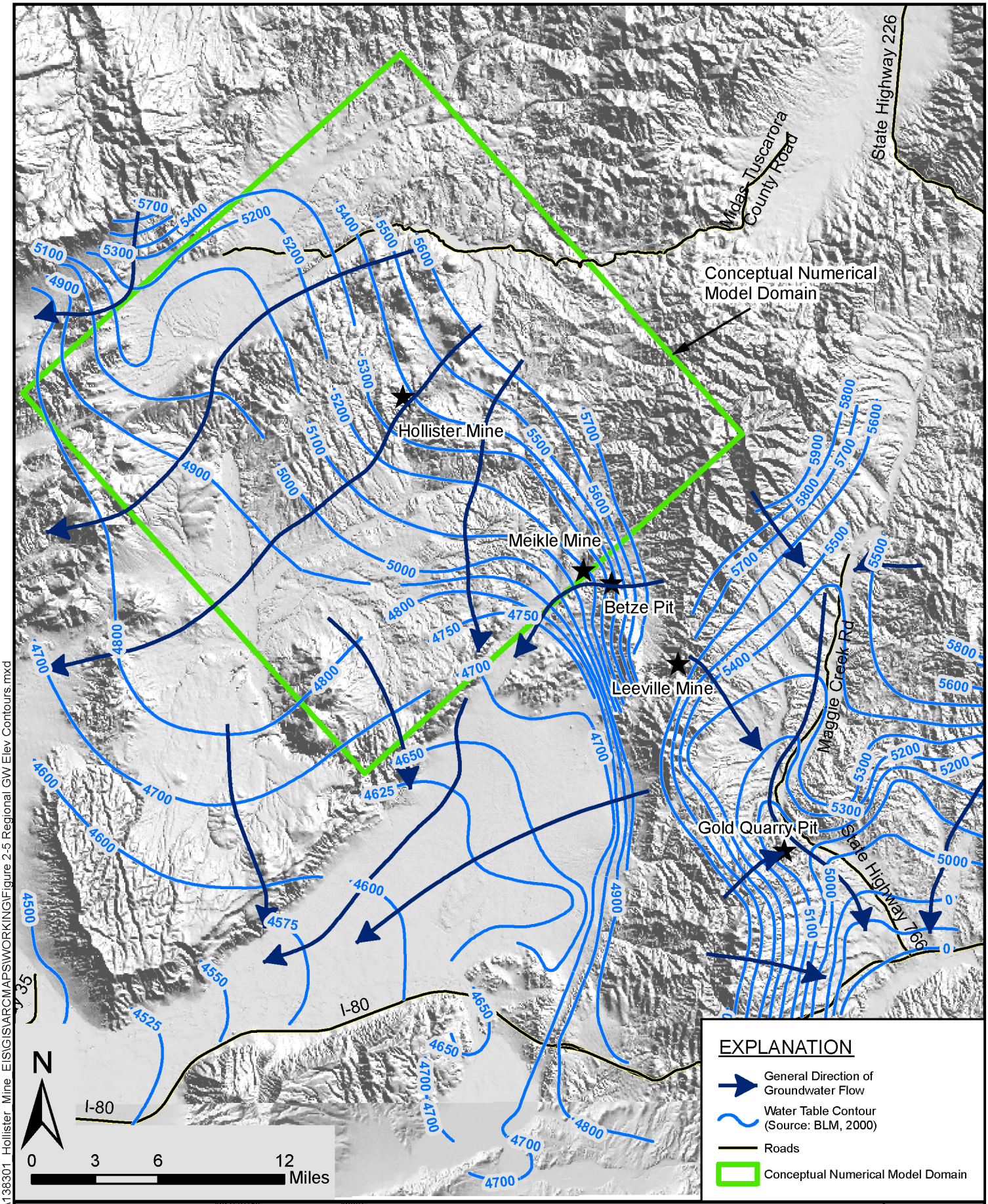
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	2-4
6/30/10	Locations of Ordovician Vinini Aquifer and Tertiary Volcanics Aquifer Monitor Wells	



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BROWN AND CALDWELL

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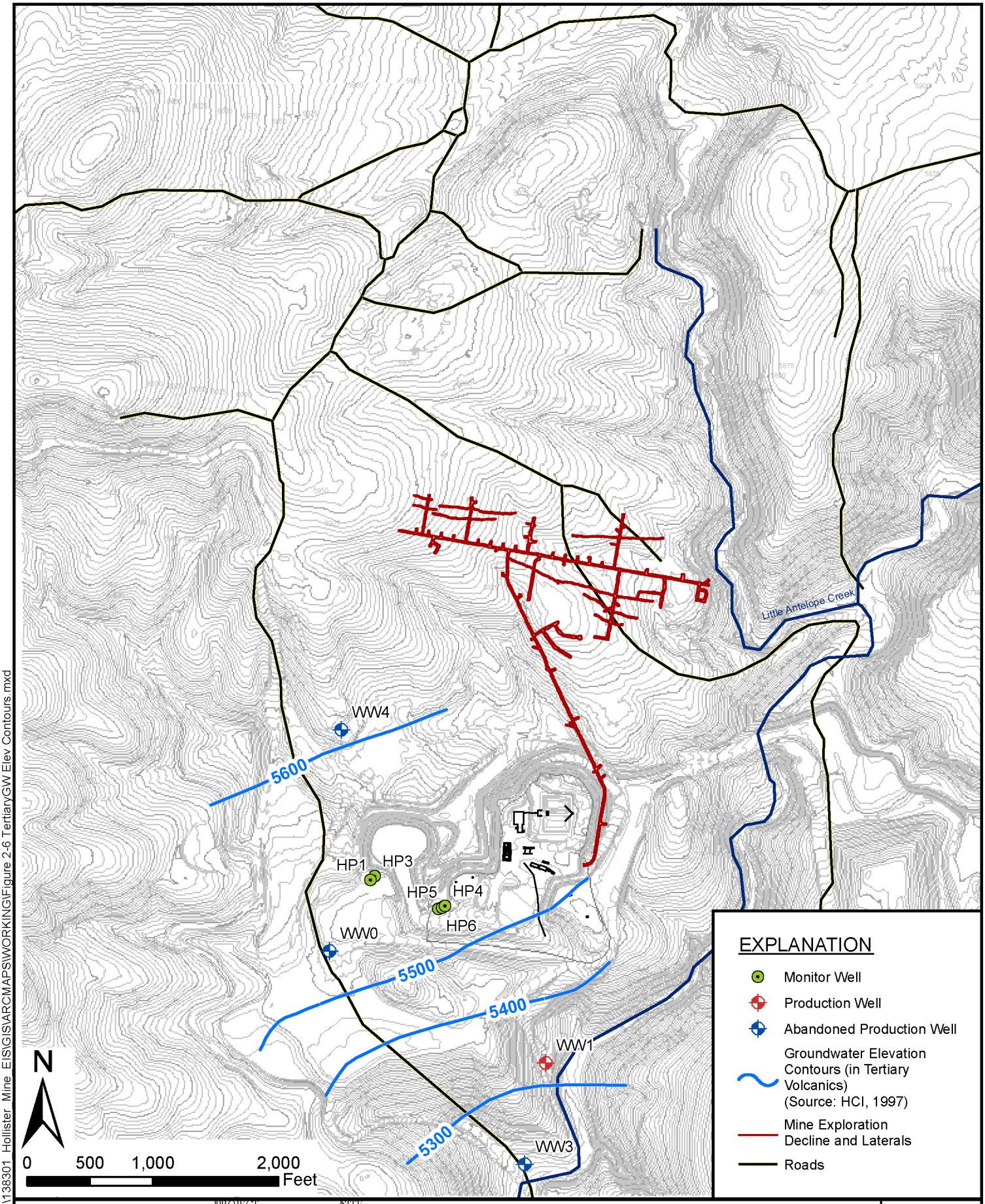
DATE	TITLE	2-5
6/30/10	Regional Groundwater Elevation Contours	



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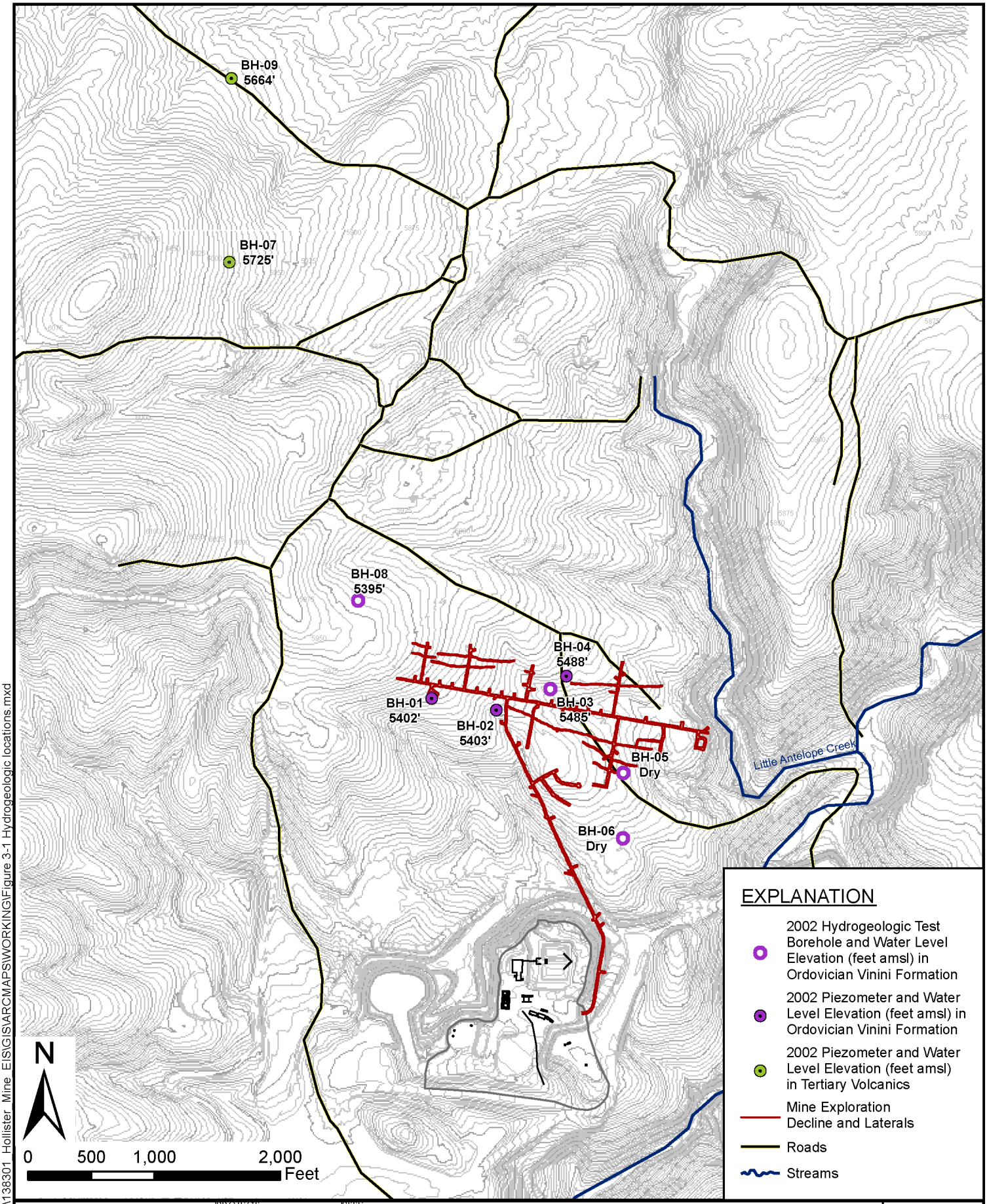

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BROWN AND CALDWELL

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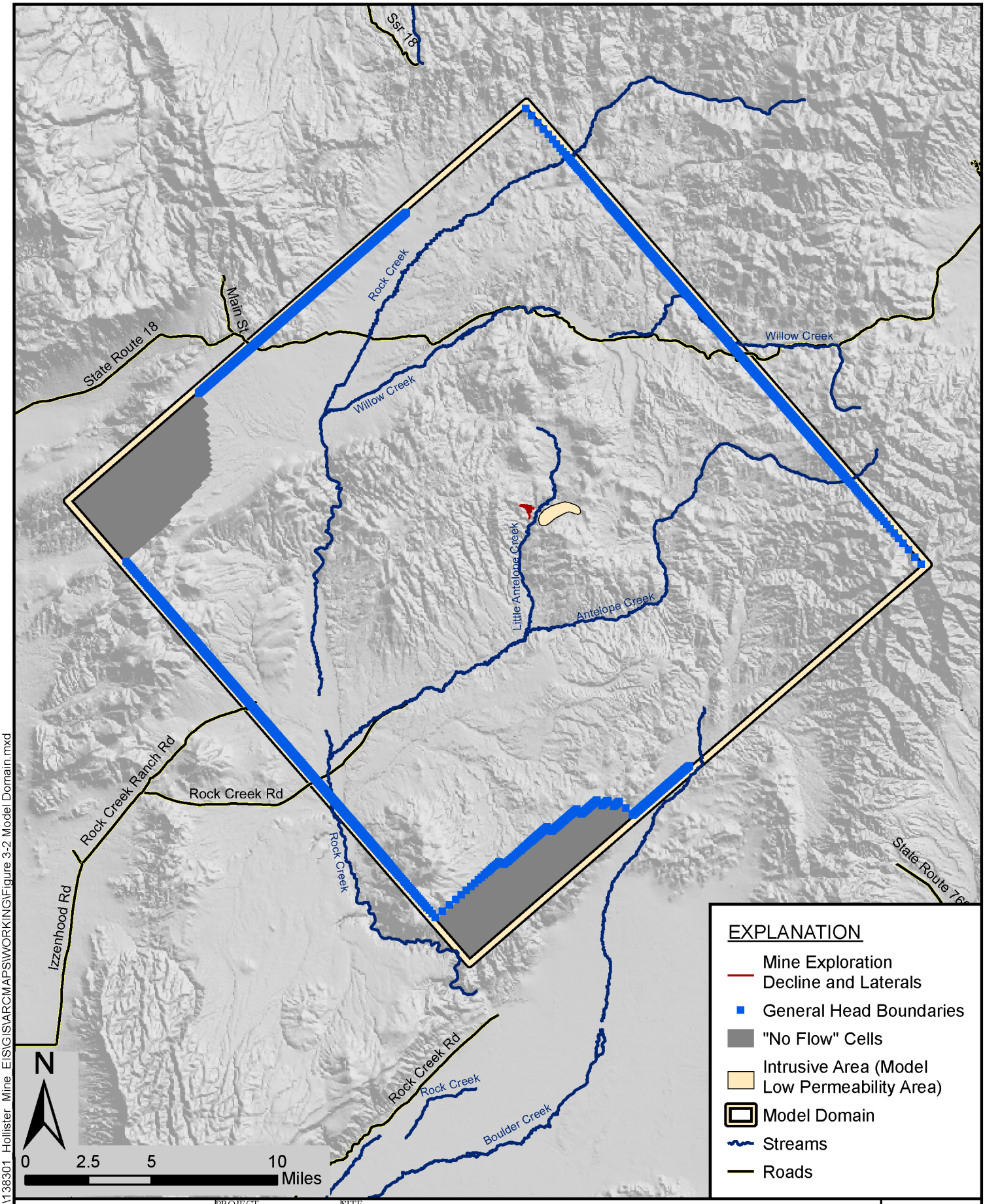
DATE	TITLE	
6/30/10	2002 Hydrogeologic Investigation Piezometer and Borehole Location Map	3-1



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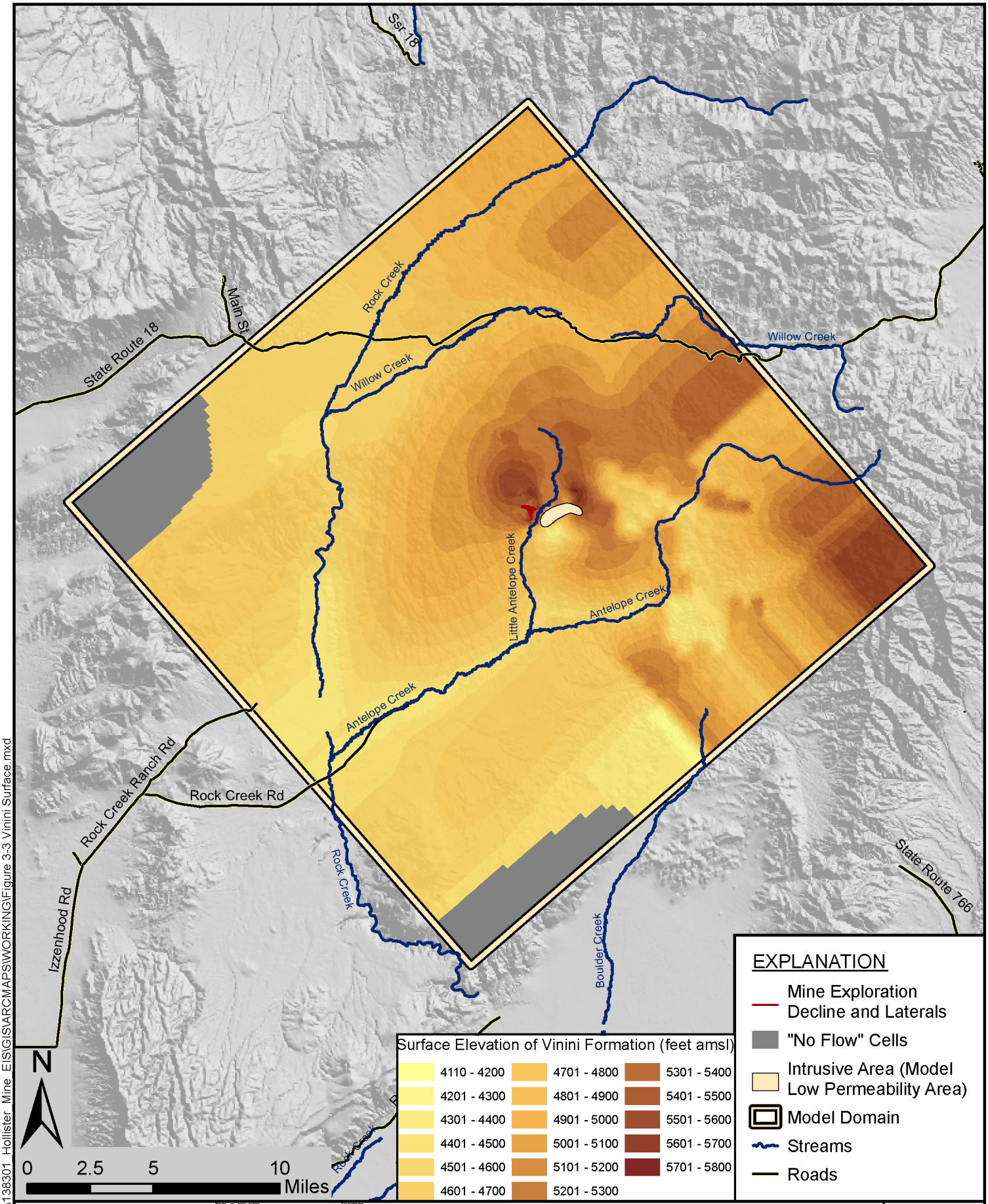
PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	3-2
6/16/10	Model Domain and Boundary Conditions	



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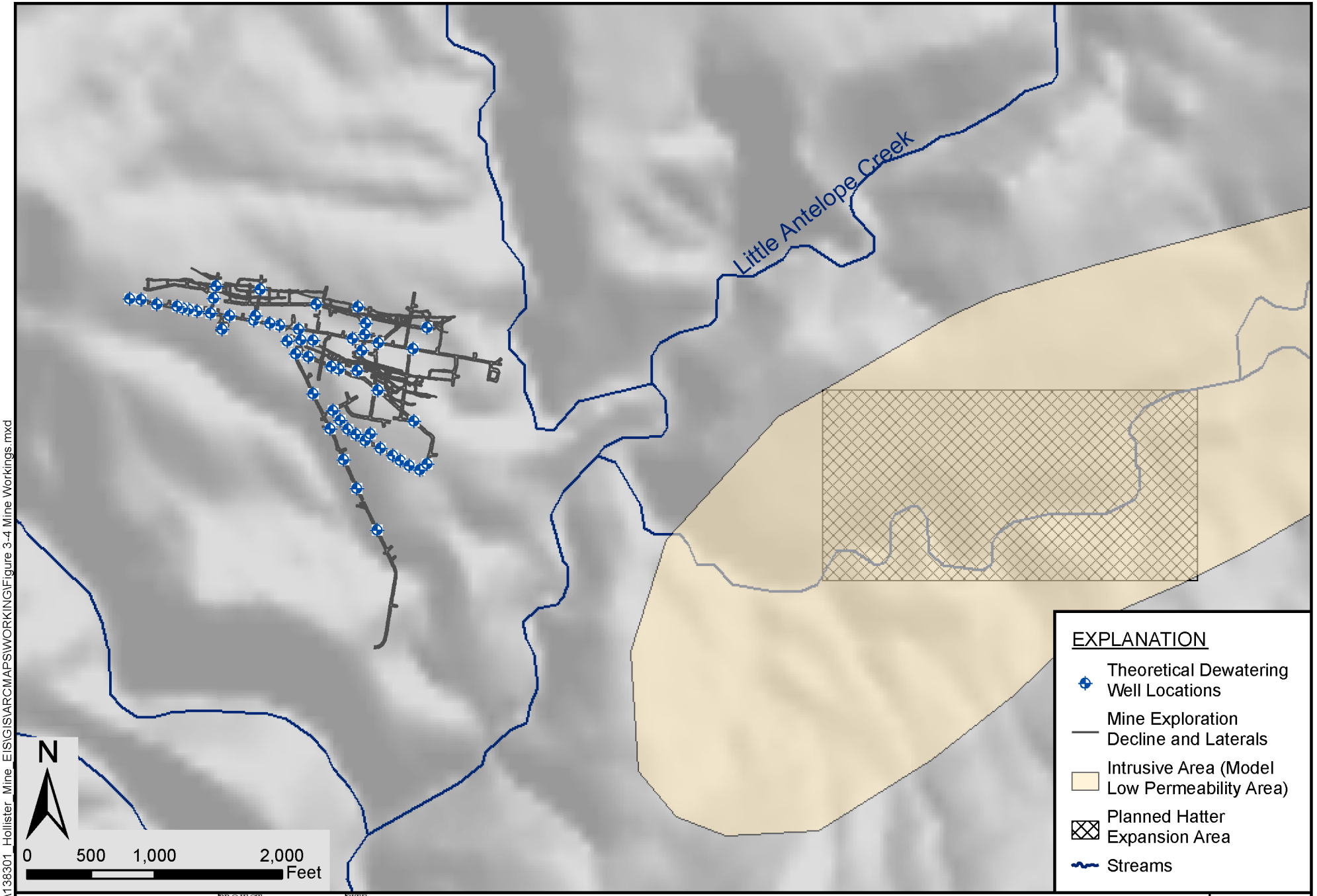
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	3-3
6/16/10	Surface of Vinini Formation	



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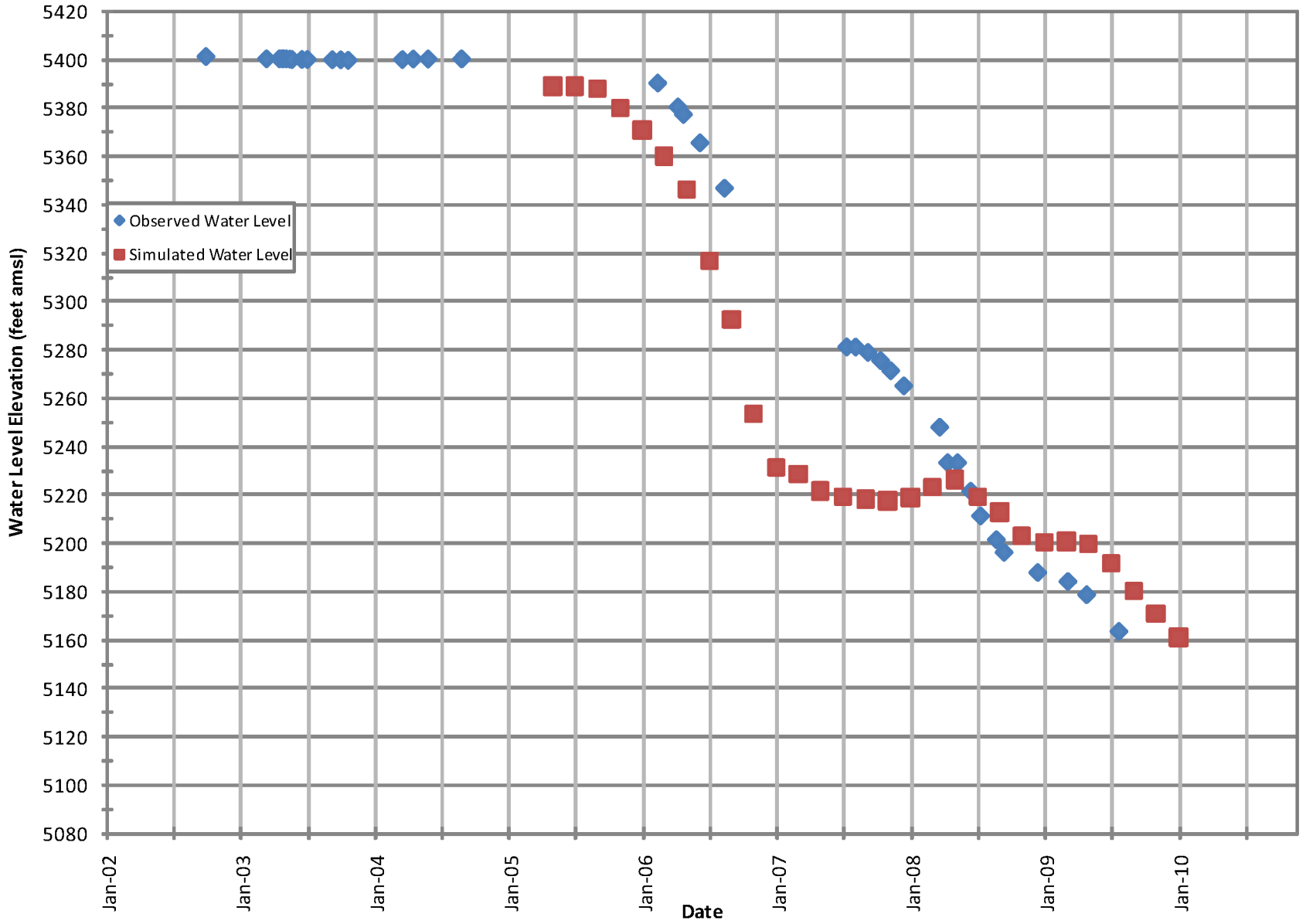
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
6/16/10	Mine Workings with Theoretical Dewatering Locations	3-4



BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 4-1
	DATE 6/30/10	TITLE BH-01 Observed Versus Simulated Water Levels	

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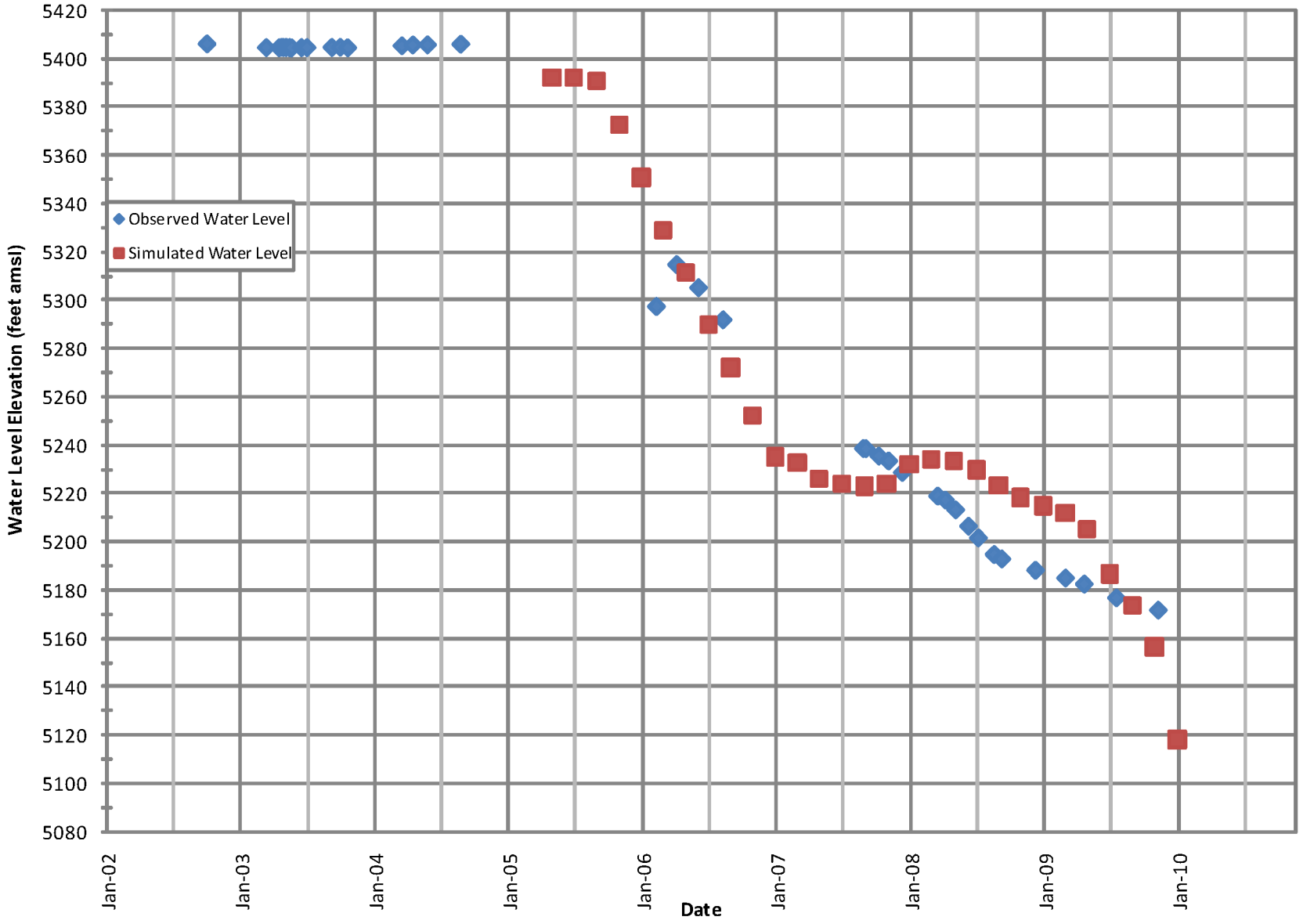

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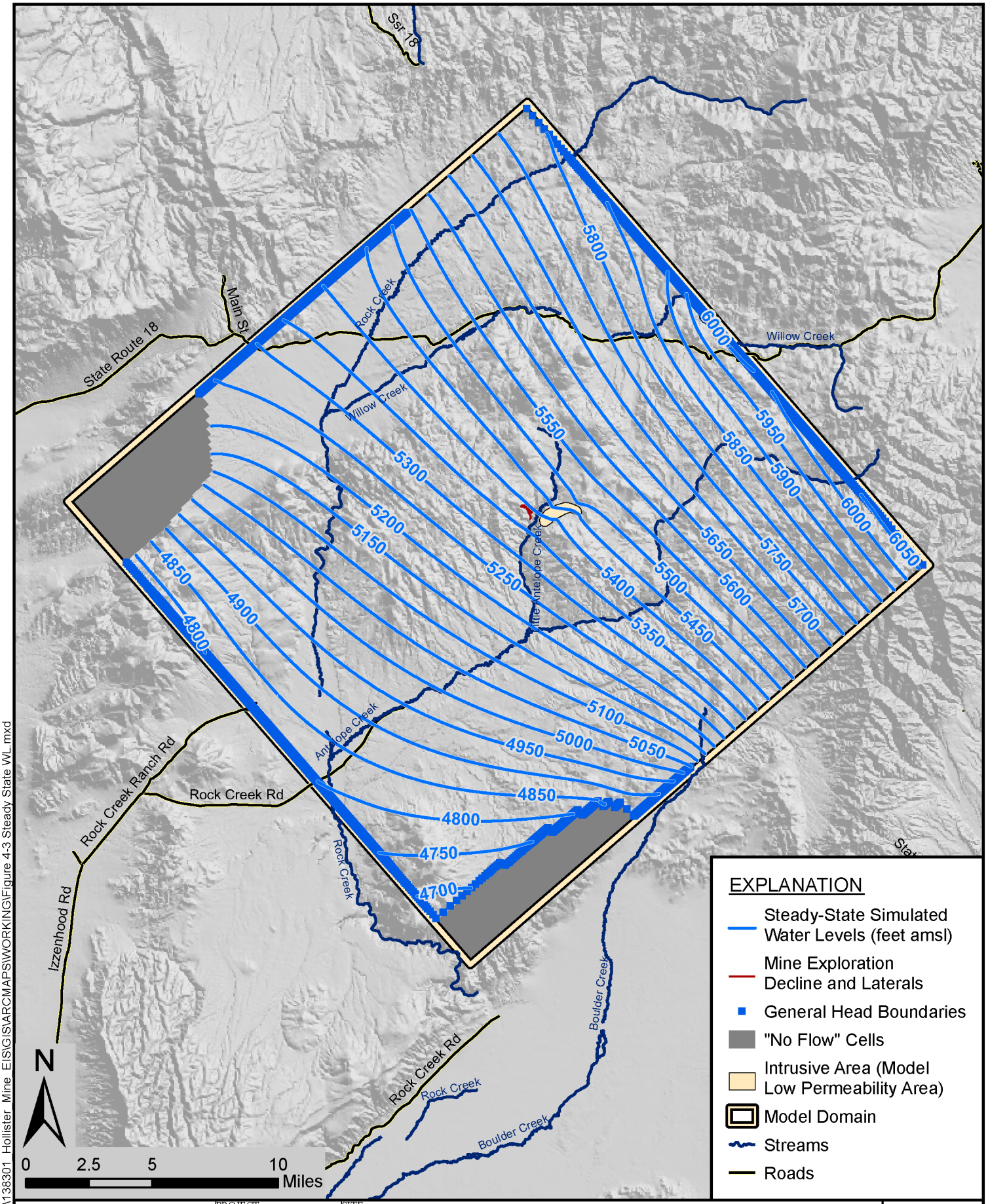
BROWN AND CALDWELL

PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	4-2
DATE	TITLE	
6/30/10	BH-02 Observed Versus Simulated Water Levels	



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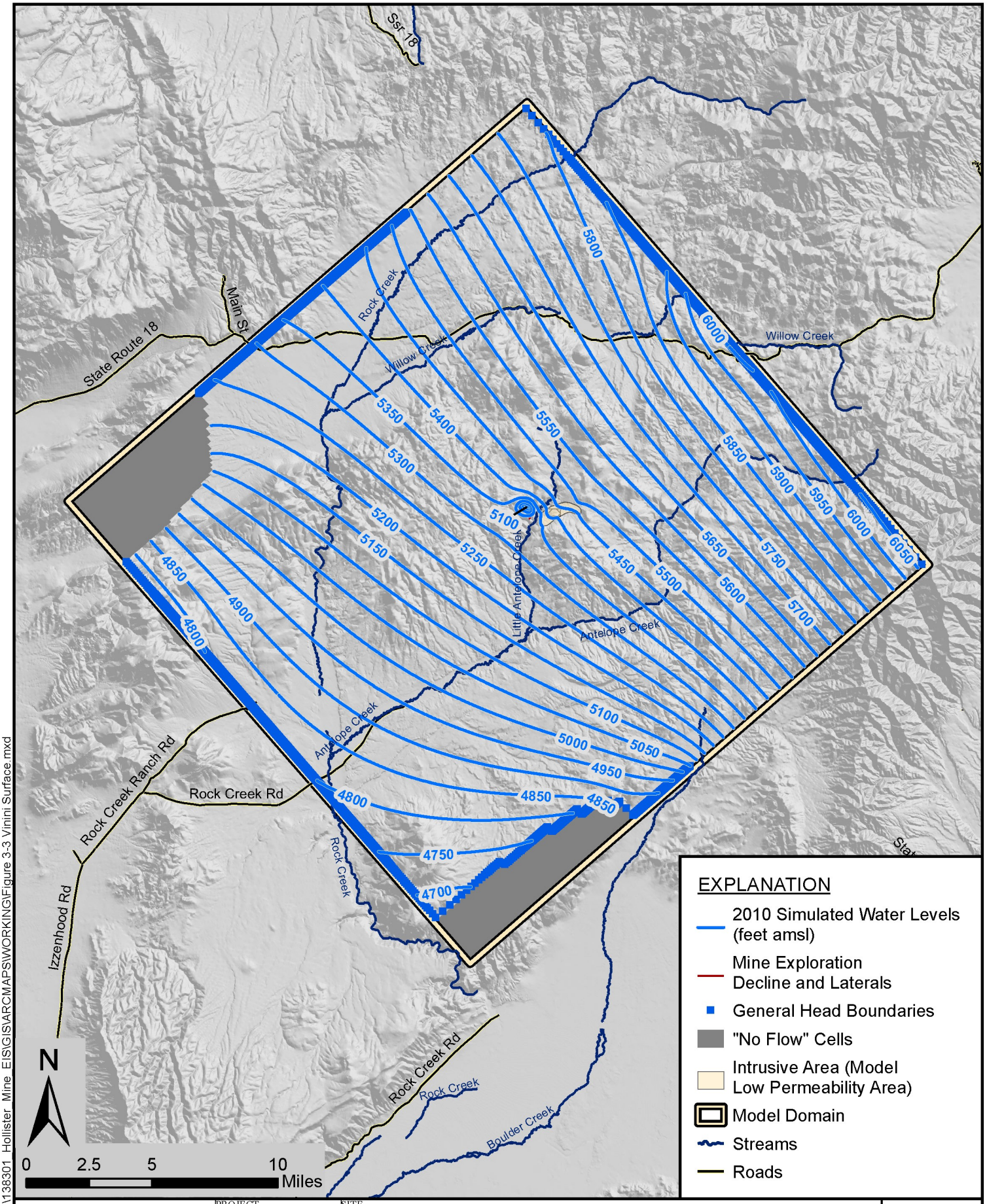
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	4-3
6/16/10	Steady-State Simulated Water Levels	



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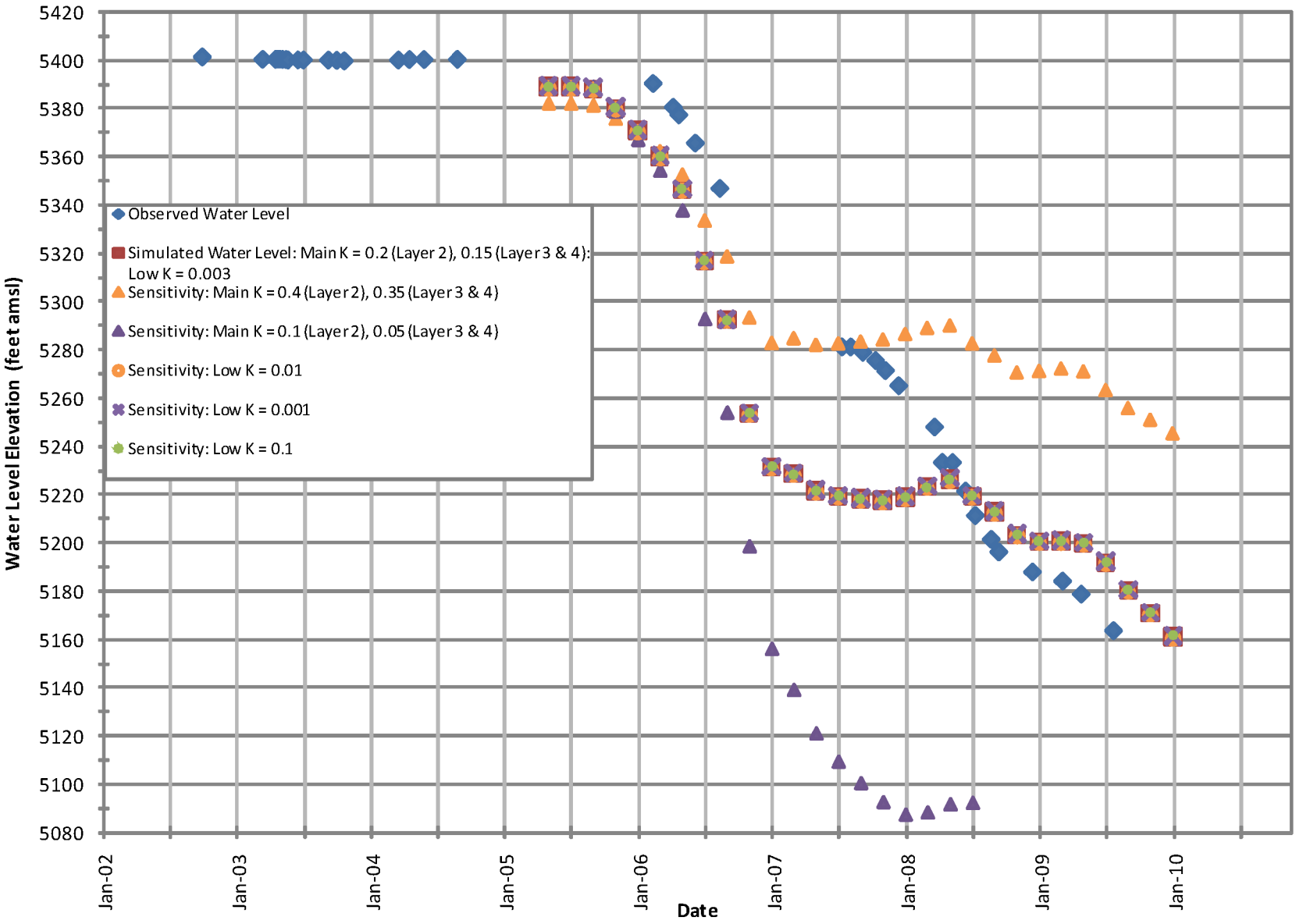
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	4-4
6/16/10	Transient Water Levels - 2010	



Note: K = Horizontal Hydraulic Conductivity (values in feet per day)
Low K = Horizontal Hydraulic Conductivity in Hatter low permeability area

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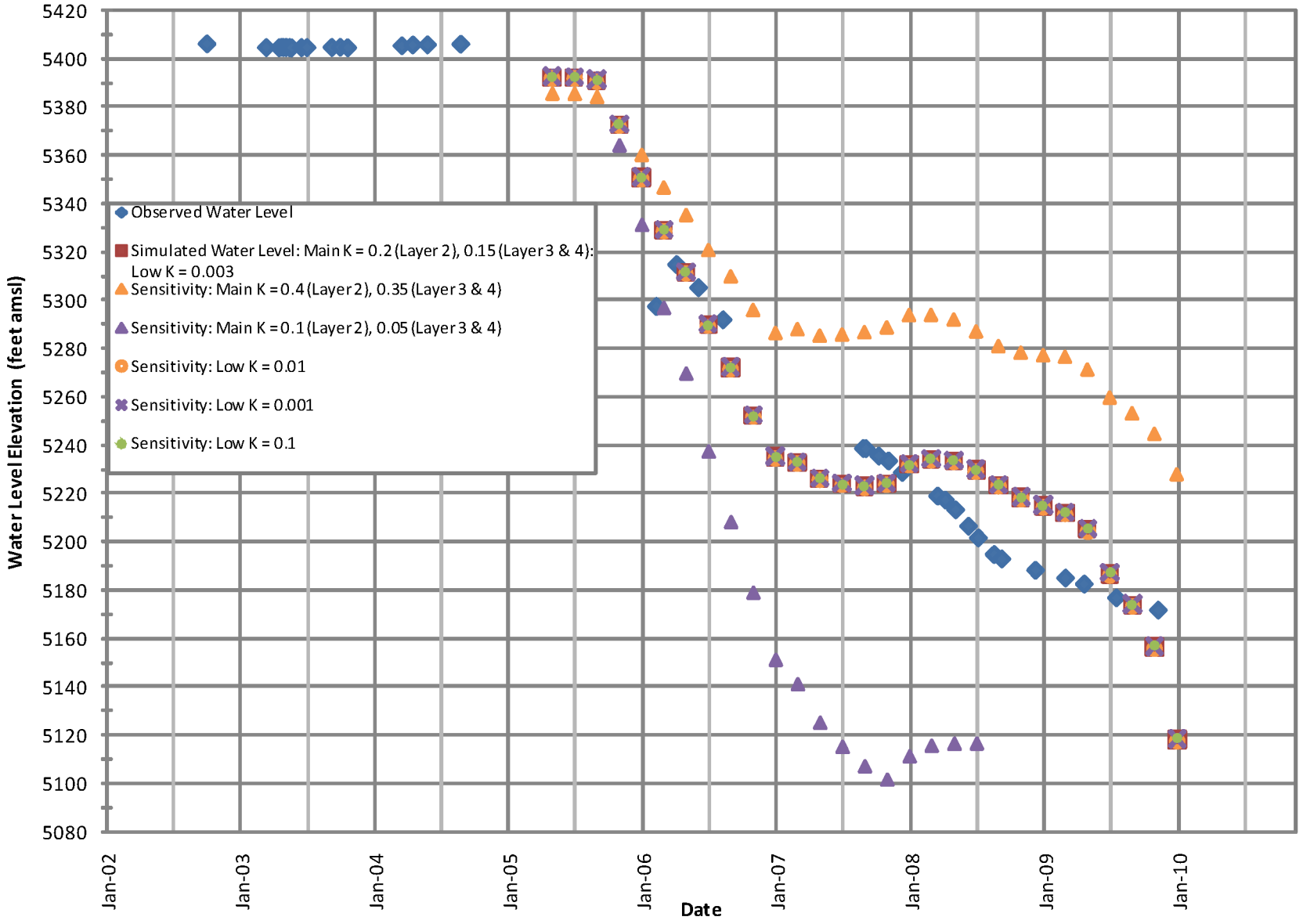
BROWN AND CALDWELL

PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	4-5
DATE	TITLE	
6/30/10	BH-01 Hydraulic Conductivity Sensitivity Plot	



Note: K = Horizontal Hydraulic Conductivity (values in feet per day)
Low K = Horizontal Hydraulic Conductivity in Hatter low permeability area

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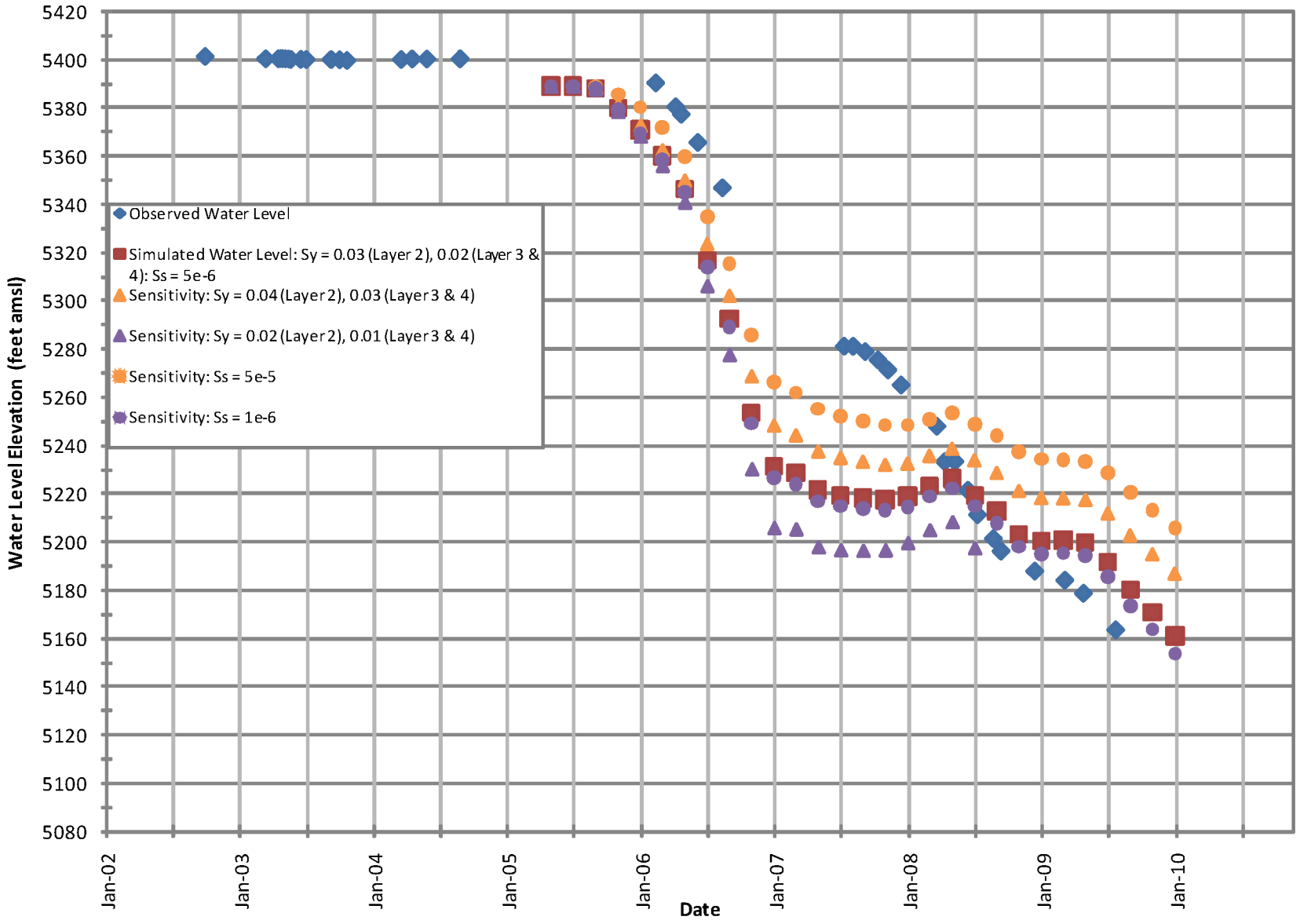
BROWN AND CALDWELL

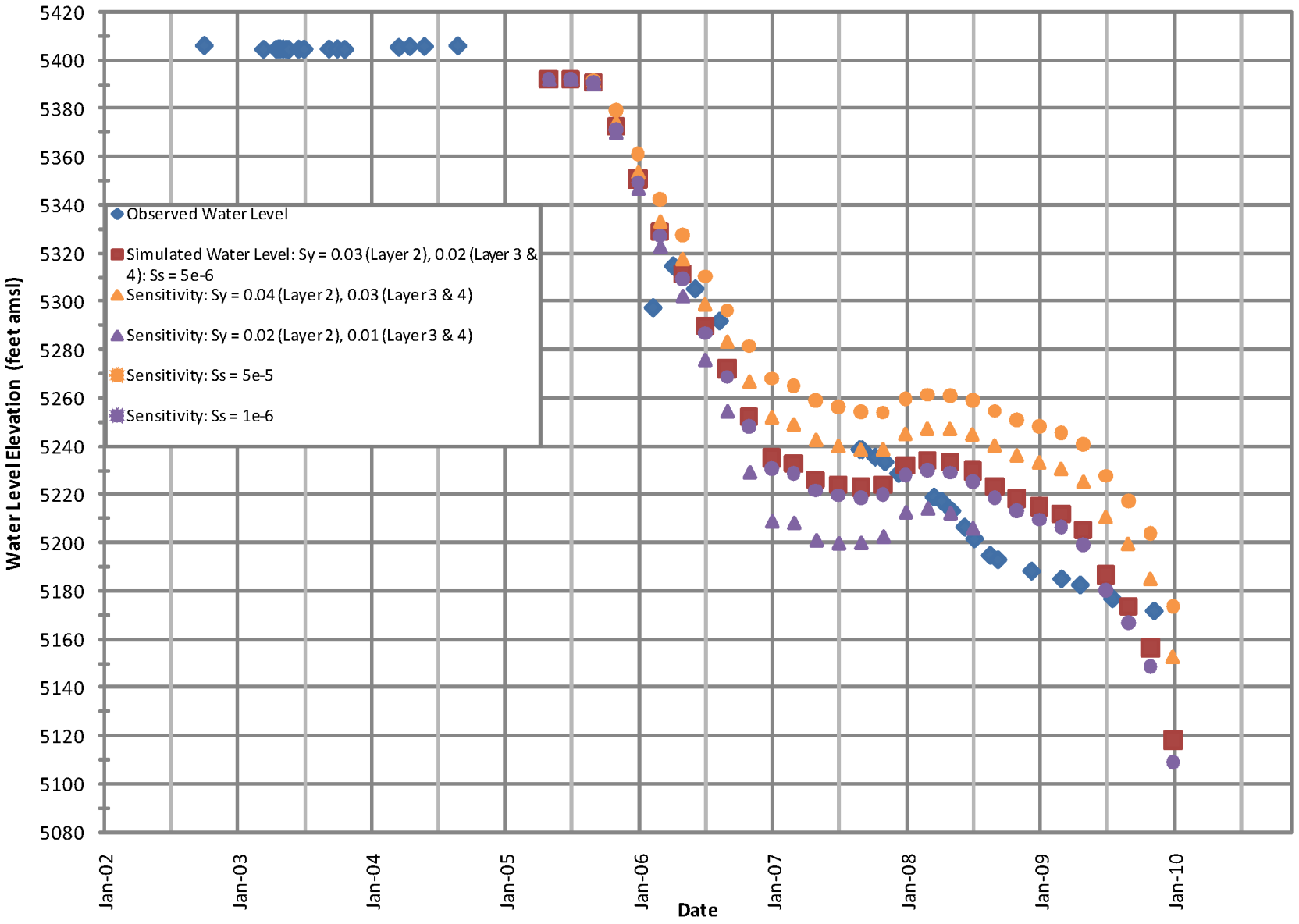
PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	4-6
DATE	TITLE	
6/30/10	BH-02 Hydraulic Conductivity Sensitivity Plot	



Note: Sy = Specific yield, Ss = Specific Storage

FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 4-7 BH-1 Sens Storage Chart.mxd

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 4-7
	DATE 6/30/10	TITLE BH-01 Storage Values Sensitivity Plot	



Note: Sy = Specific yield, Ss = Specific Storage

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 4-8
	DATE 6/30/10	TITLE BH-02 Storage Values Sensitivity Plot	

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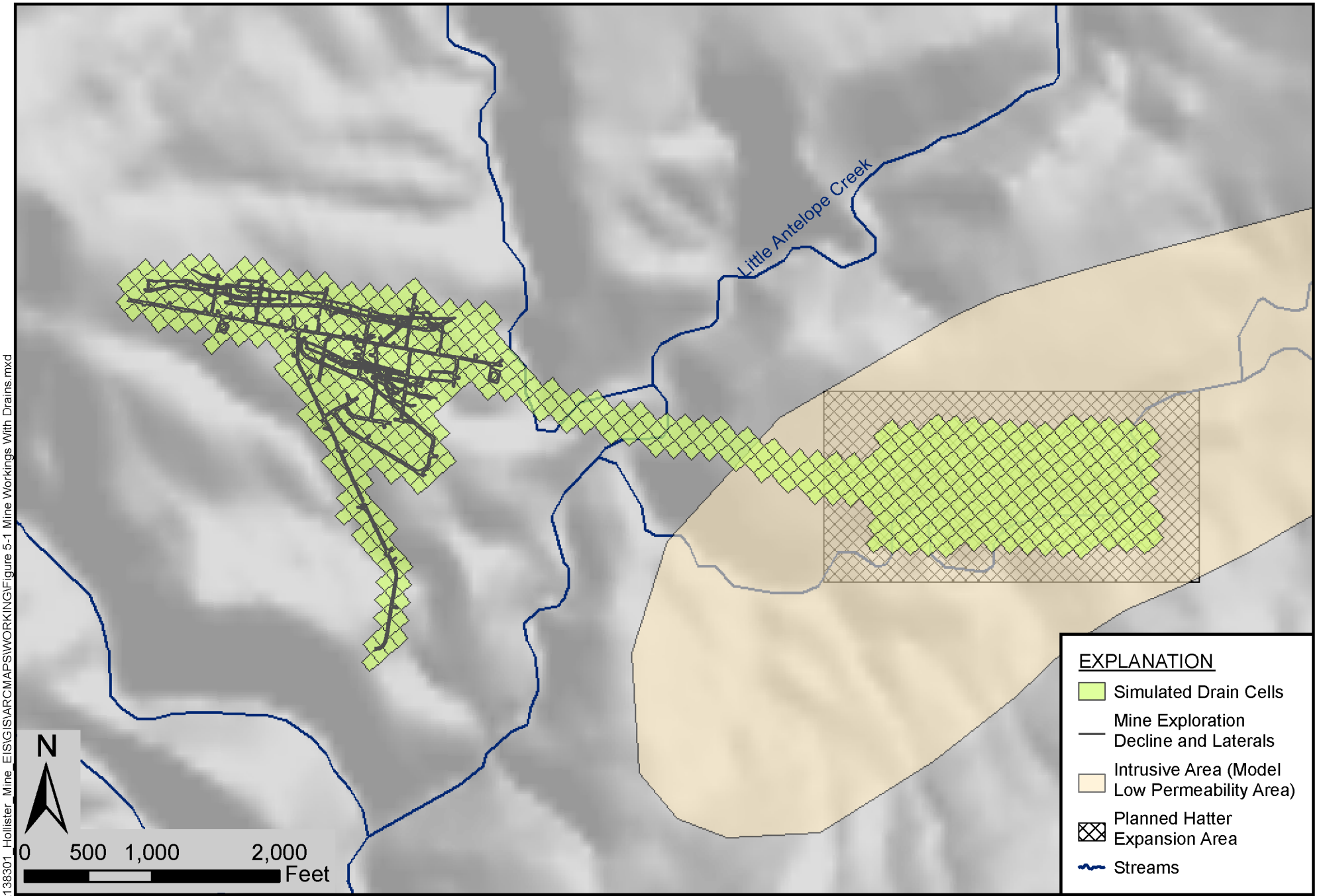
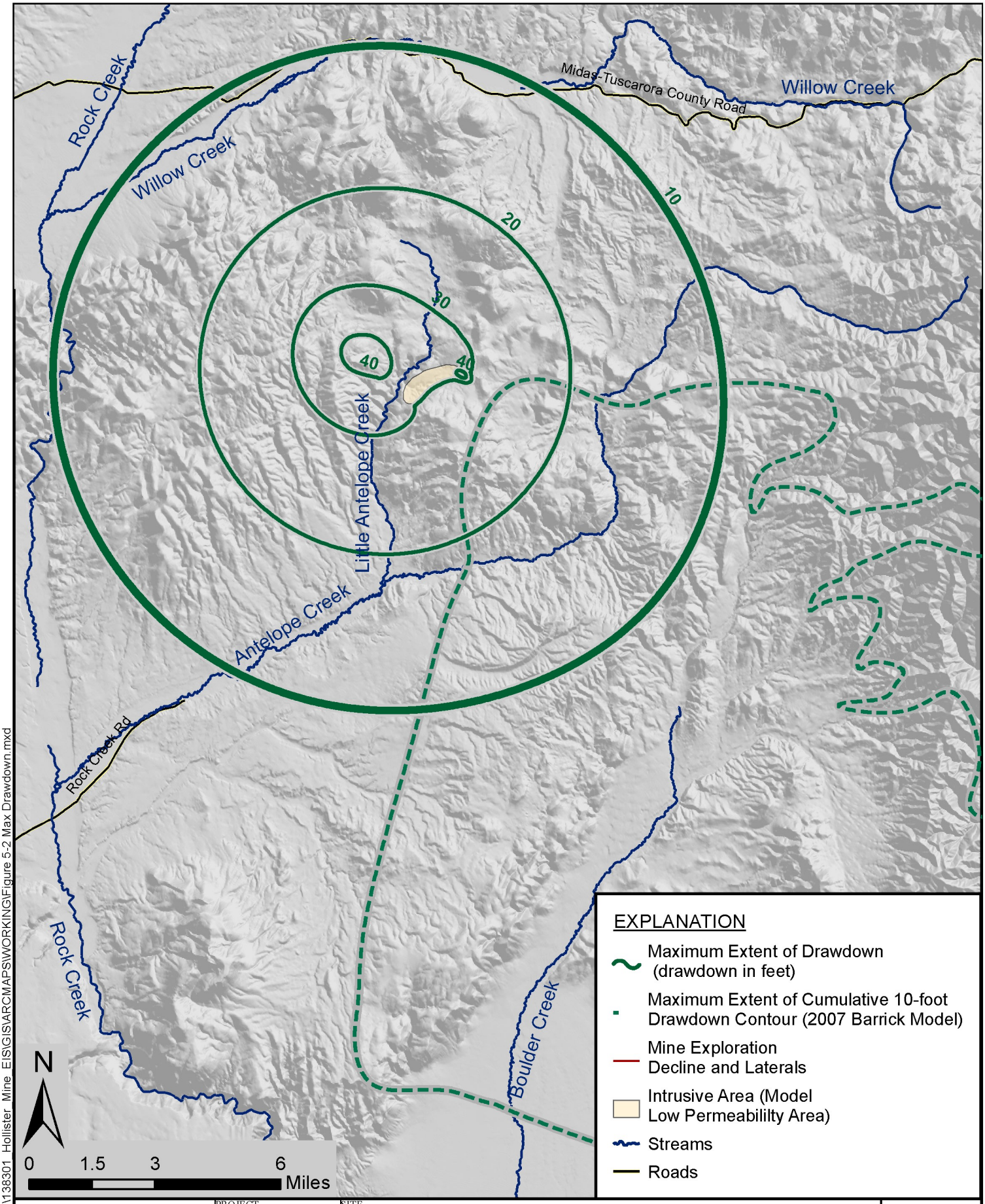


FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-1 Mine Workings With Drains.mxd

BROWN AND CALDWELL

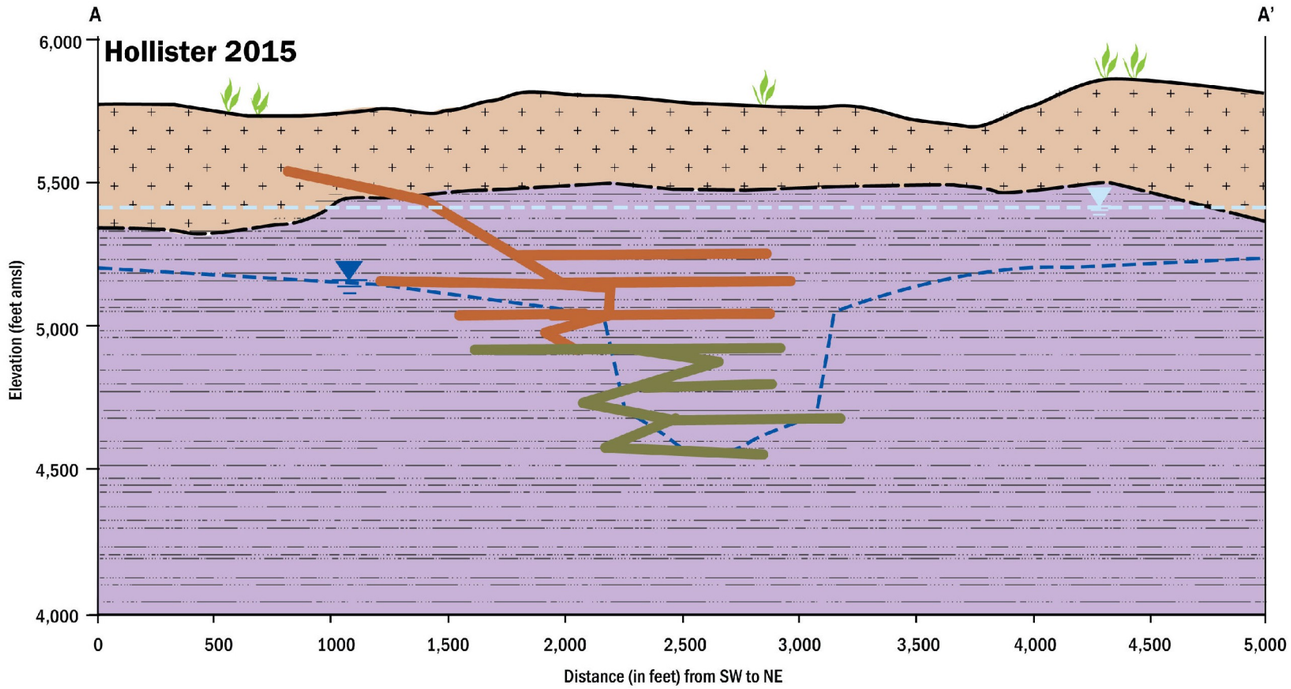
PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	5-1
DATE	TITLE	
6/16/10	Drain Locations - Predictive Simulation	

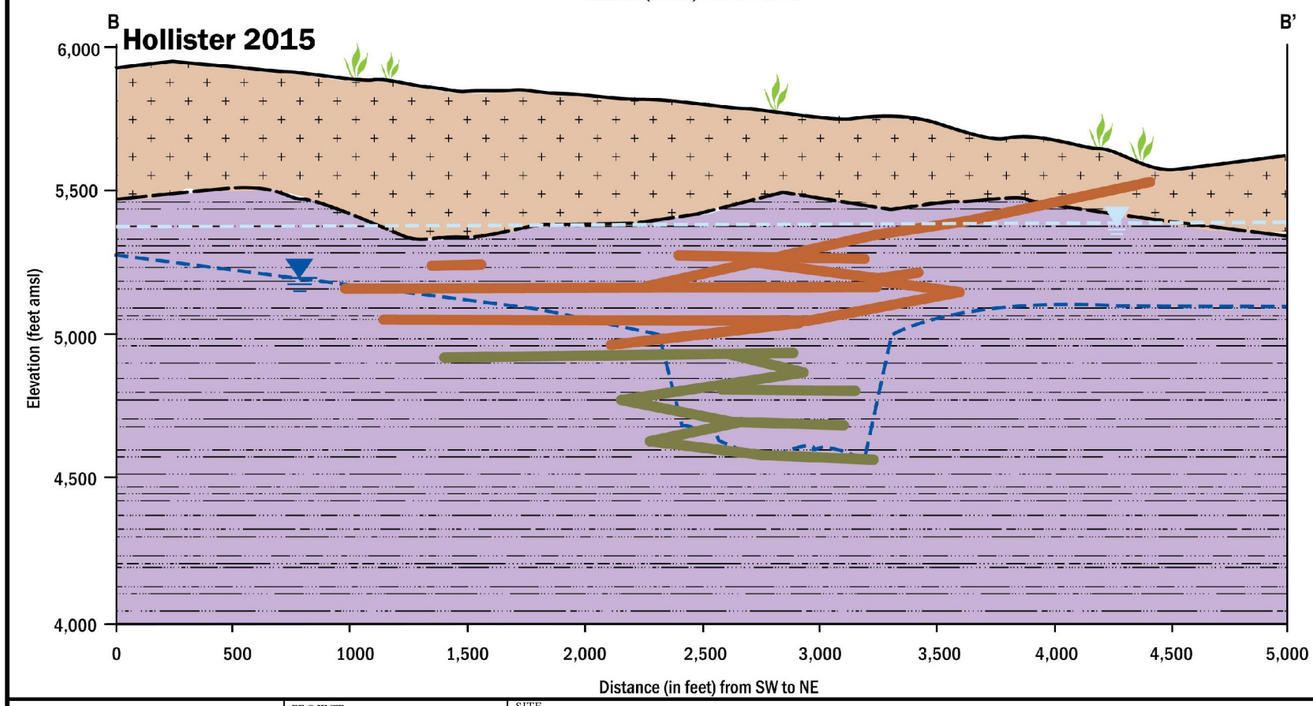


FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-2 Max Drawdown.mxd

BROWN AND CALDWELL

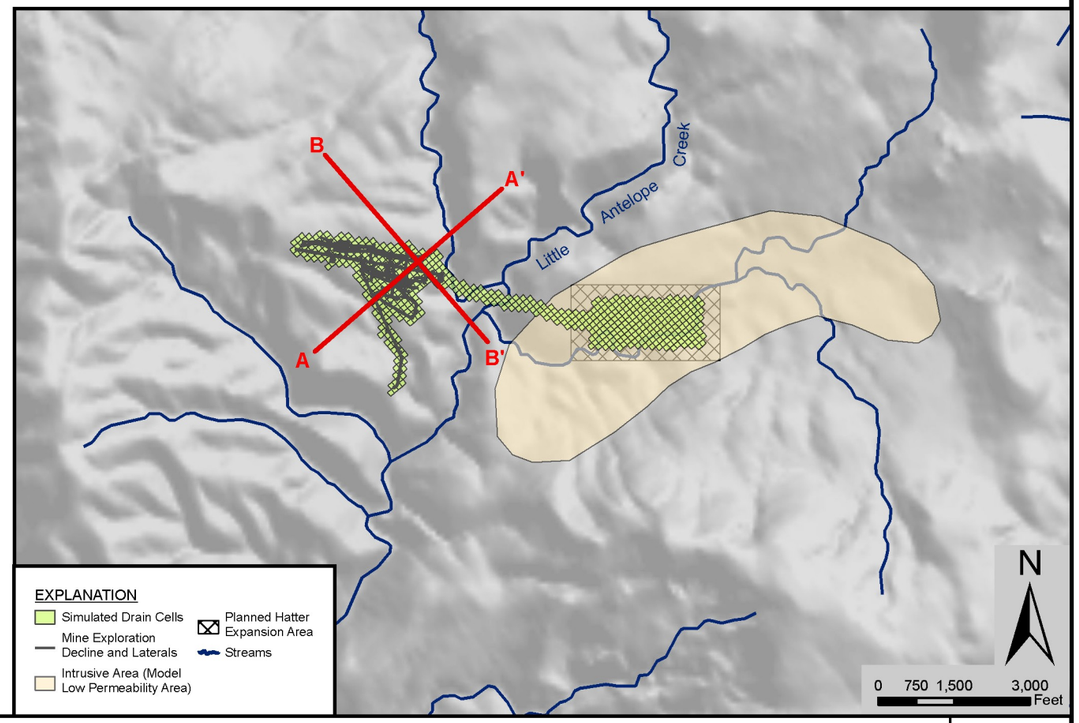
PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
6/16/10	Simulated Maximum Extent of 10-Foot Drawdown (2070)	5-2





EXPLANATION

- Land Surface
- Simulated Groundwater Piezometric Surface (Confined)
- Simulated Recovered Piezometric Surface (Confined)
- Tertiary-Ordovician Contact
- Tertiary Volcanics
- Ordovician Vinini Formation
- Mine Workings, March 2010
- Future Mine Workings

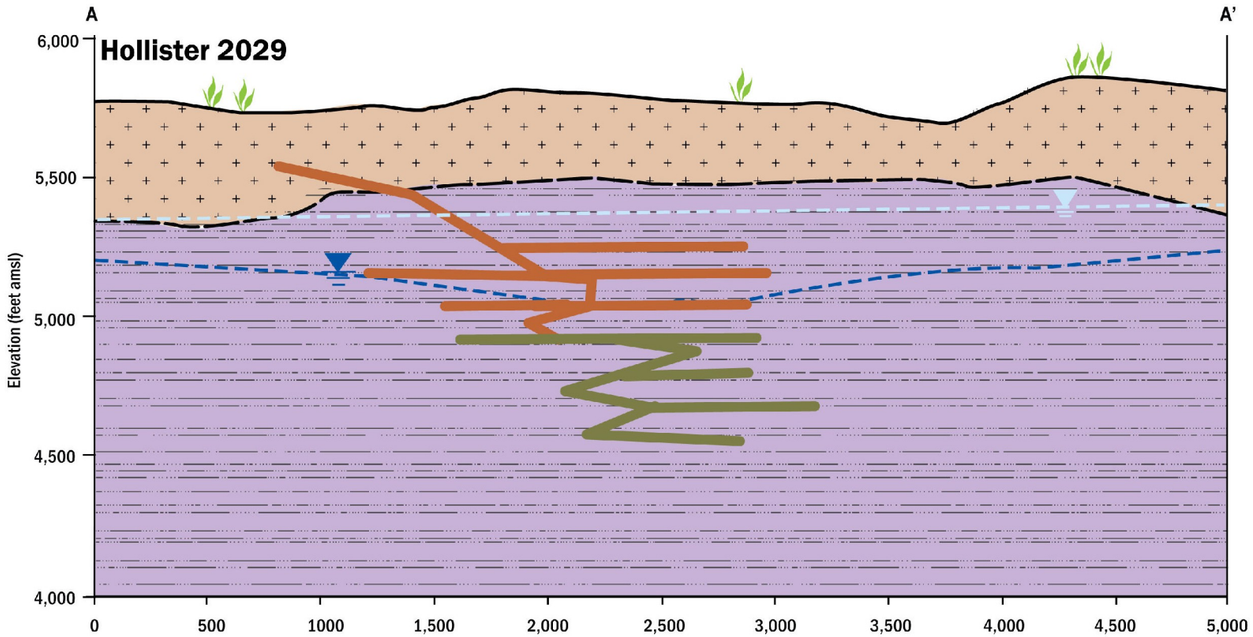


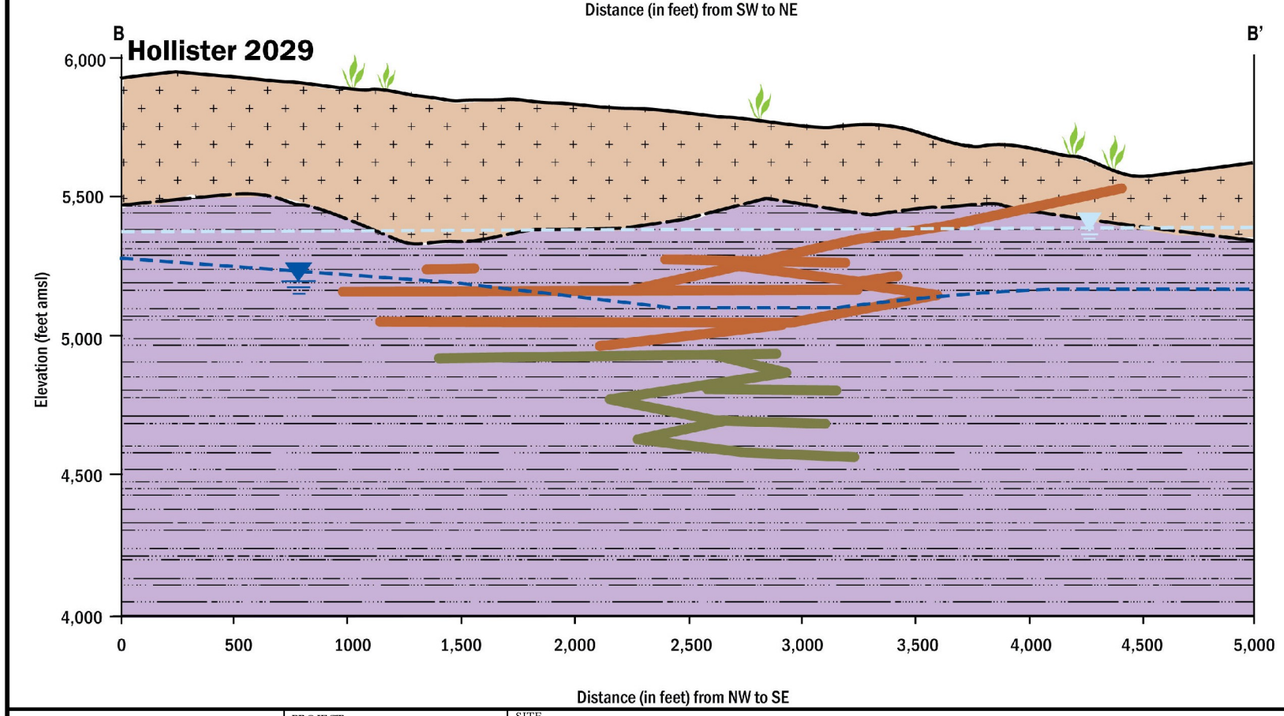
BROWN AND CALDWELL

PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine
DATE 6/16/10	TITLE Hollister Mine Cross Sections - 2015

Figure 5-3

FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-3 Hollister Cross Sections.mxd





EXPLANATION

- Land Surface
- Simulated Groundwater Piezometric Surface (Confined)
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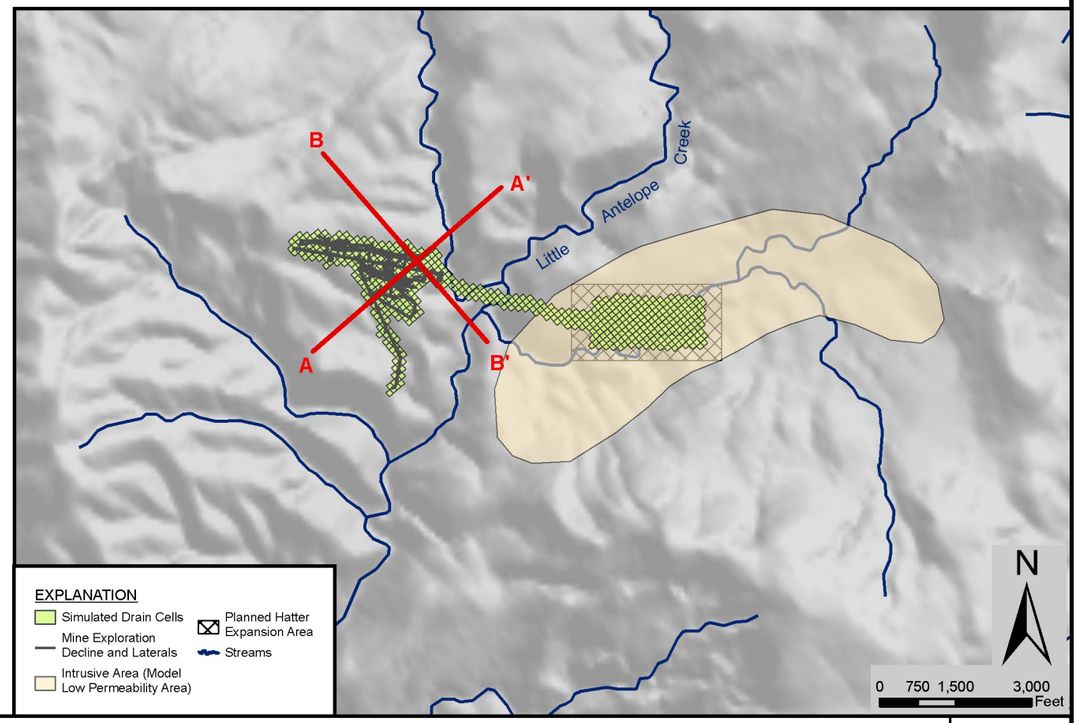
- Future Mine Workings

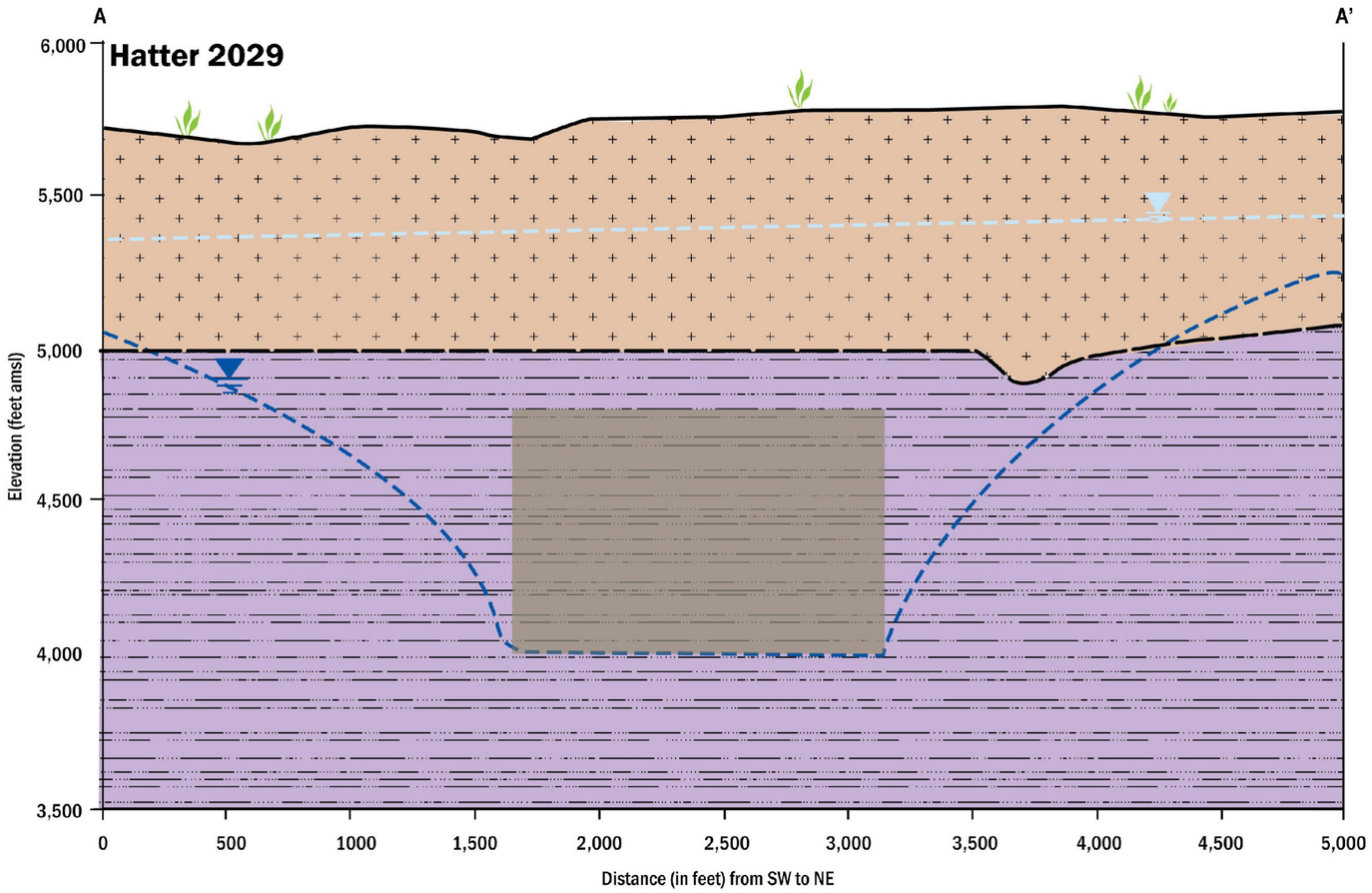


FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-3 Hollister Cross Sections 2.mxd

BROWN AND CALDWELL

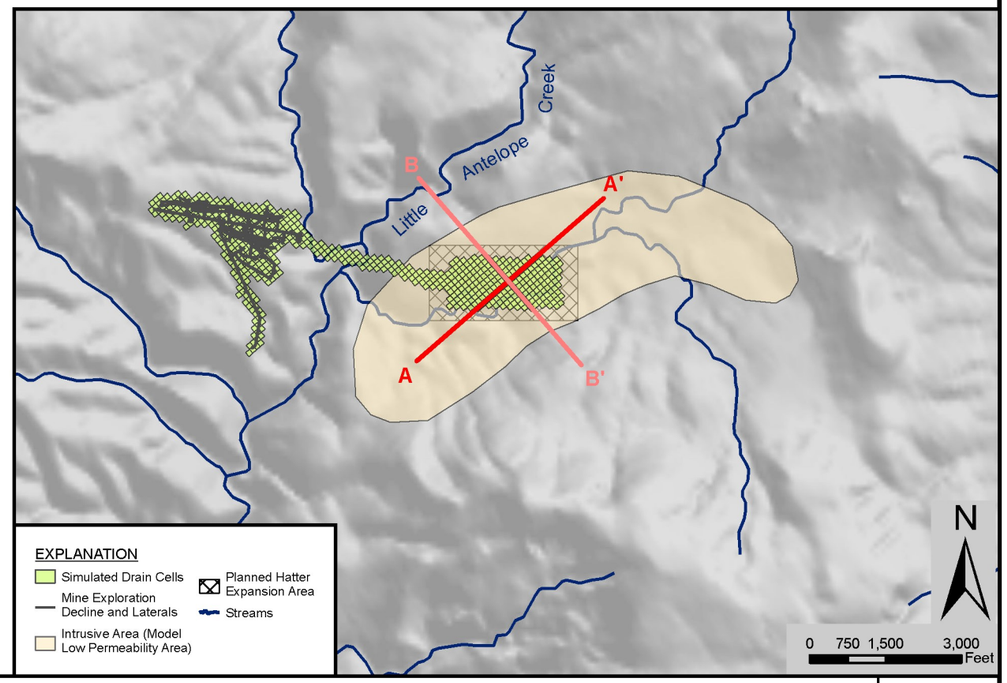
PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine
DATE 6/16/10	TITLE Hollister Mine Cross Sections - 2029

Figure 5-4



EXPLANATION

- Land Surface
- Simulated Groundwater Piezometric Surface (Confined)
- Simulated Recovered Piezometric Surface (Confined)
- Tertiary-Ordovician Contact
- Tertiary Volcanics
- Ordovician Vinini Formation
- Hatter Expansion Mine Workings (generalized)

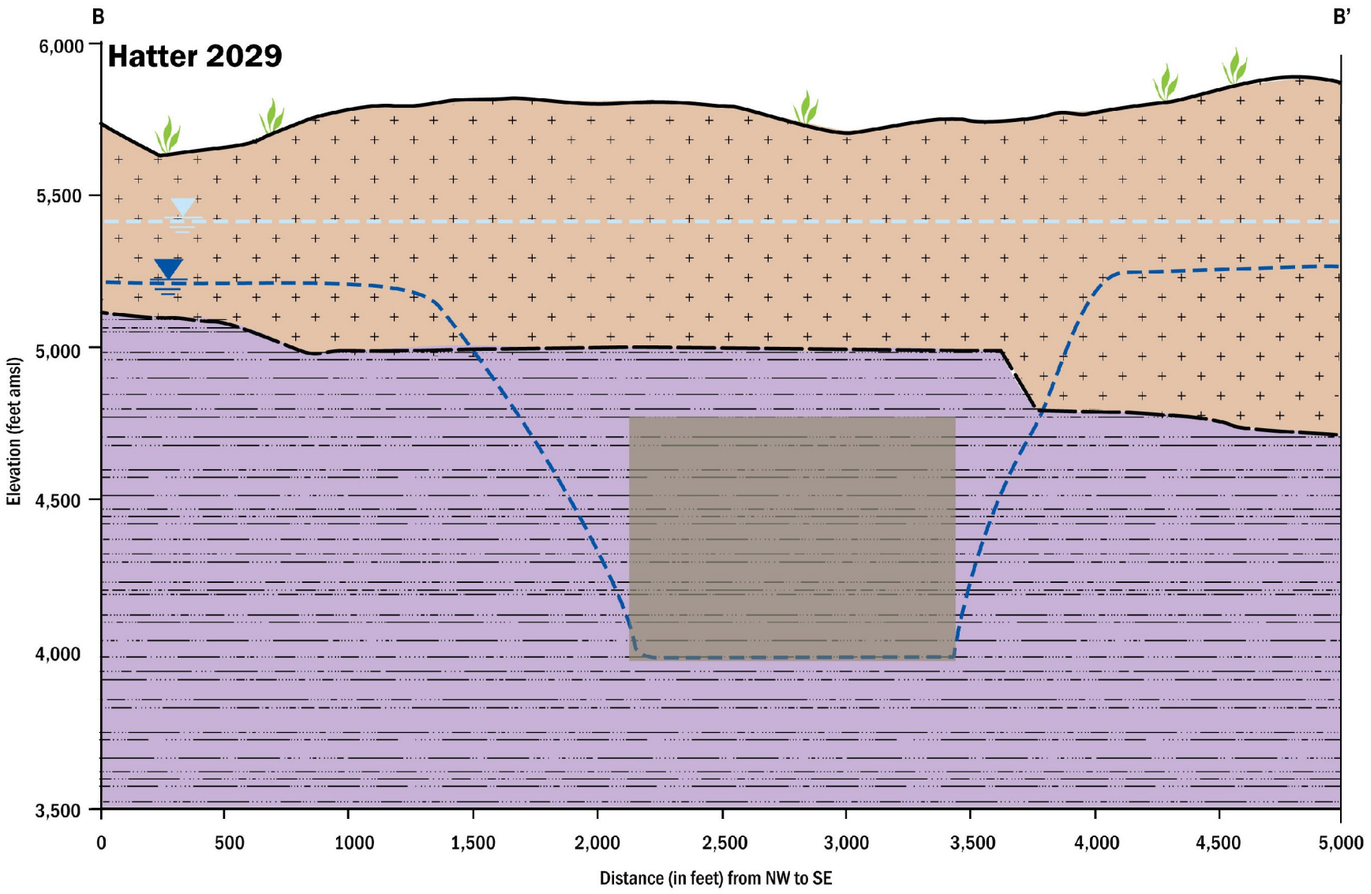


FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-5 Hatter Cross Section.mxd

BROWN AND CALDWELL

PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine
DATE 6/16/10	TITLE Hatter Expansion Area Cross Section - 2029, A-A'

Figure 5-5



EXPLANATION

- Land Surface
- Simulated Groundwater Piezometric Surface (Confined)
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- Tertiary-Ordovician Contact
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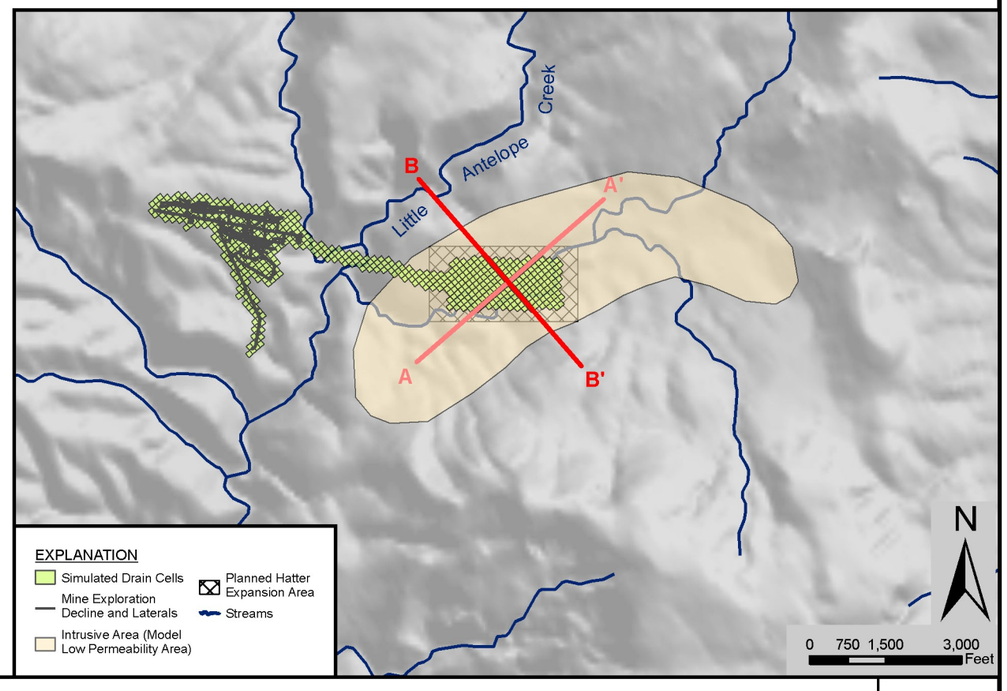
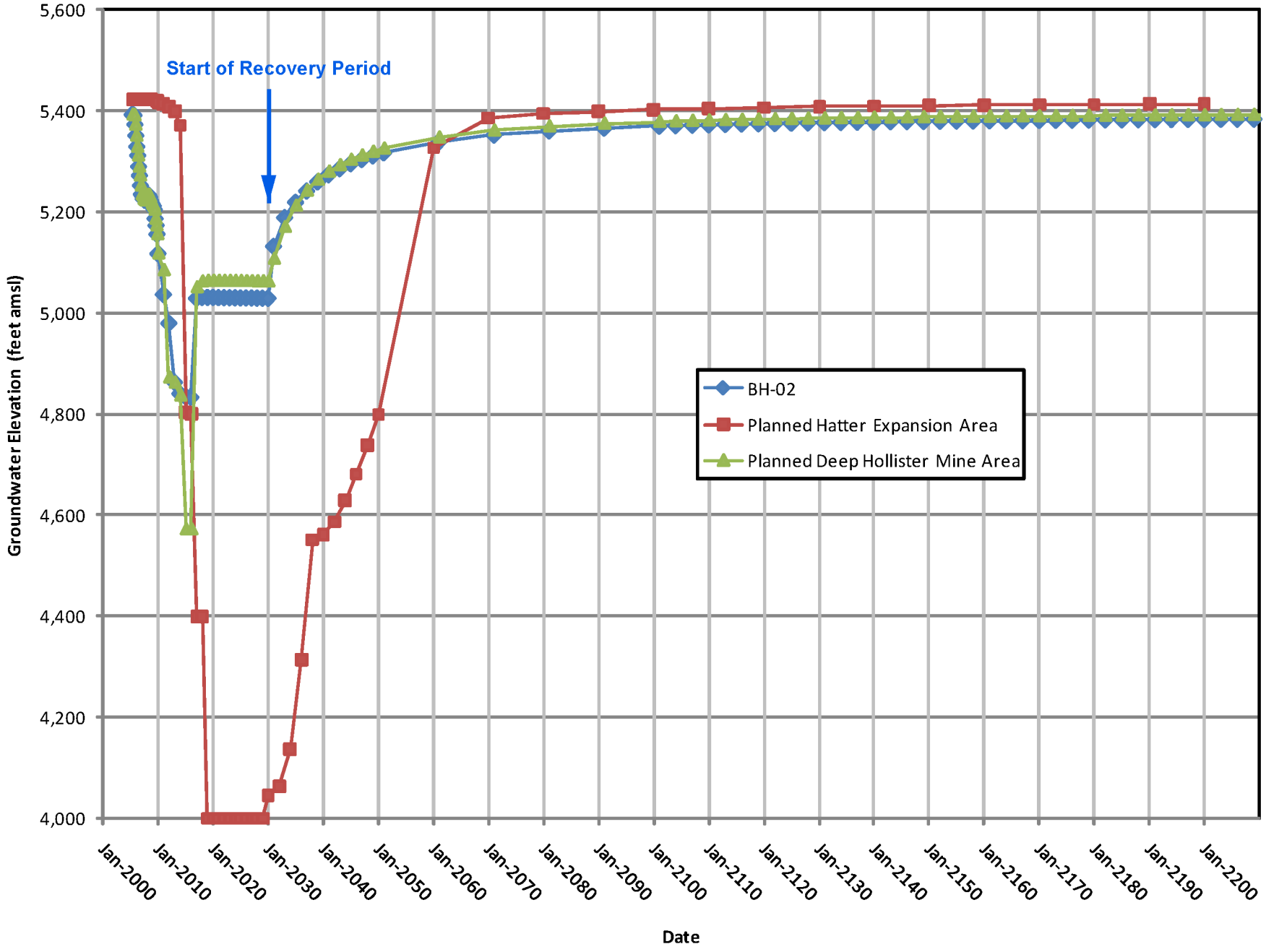
- Ordovician Vinini Formation
- Hatter Expansion Mine Workings (generalized)



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-5 Hatter Cross Section 2.mxd

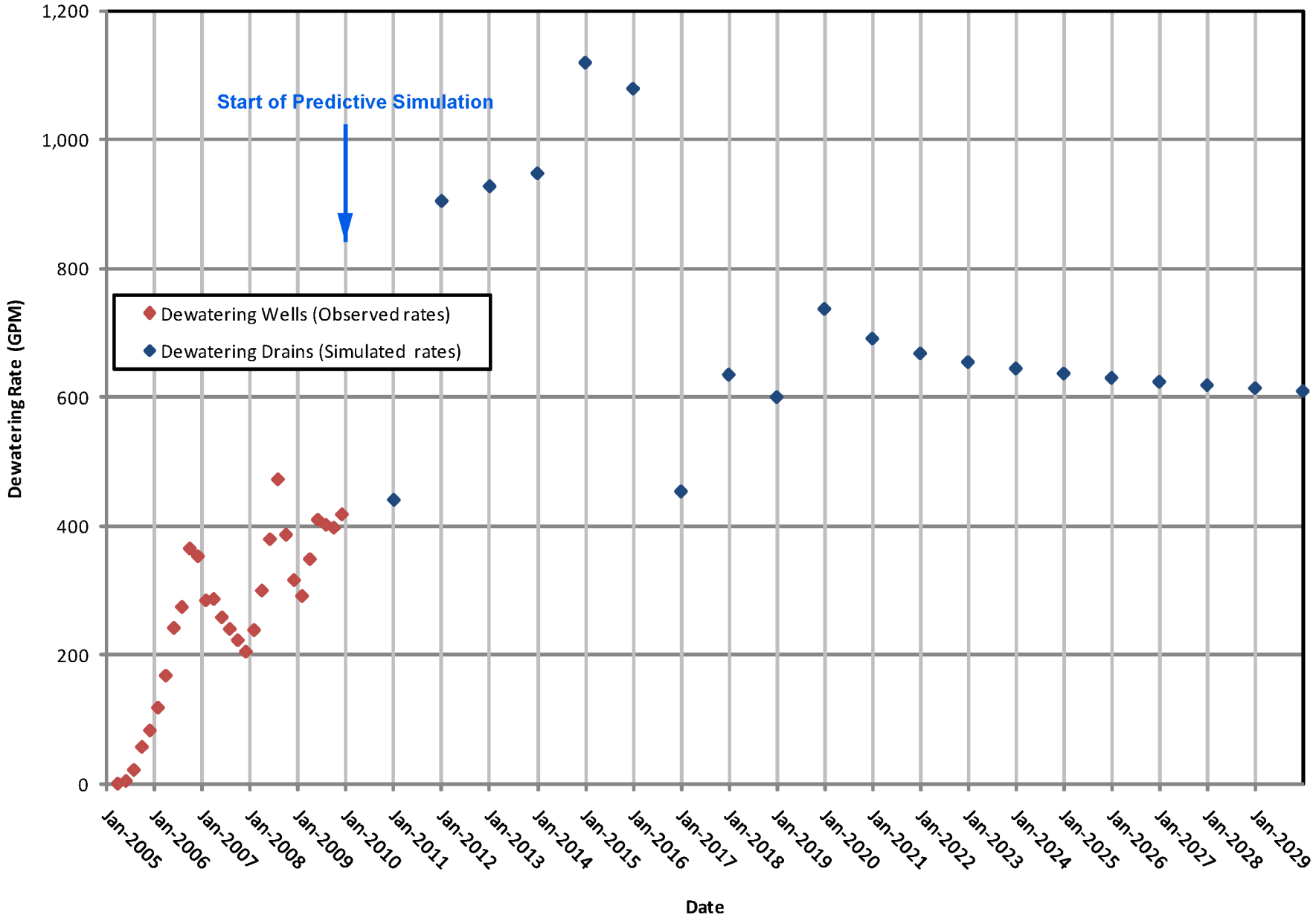
BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 5-6
	DATE 6/16/10	TITLE Hatter Expansion Area Cross Section - 2029, B-B'	



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-7 WL Recoveries.mxd

BROWN AND CALDWELL

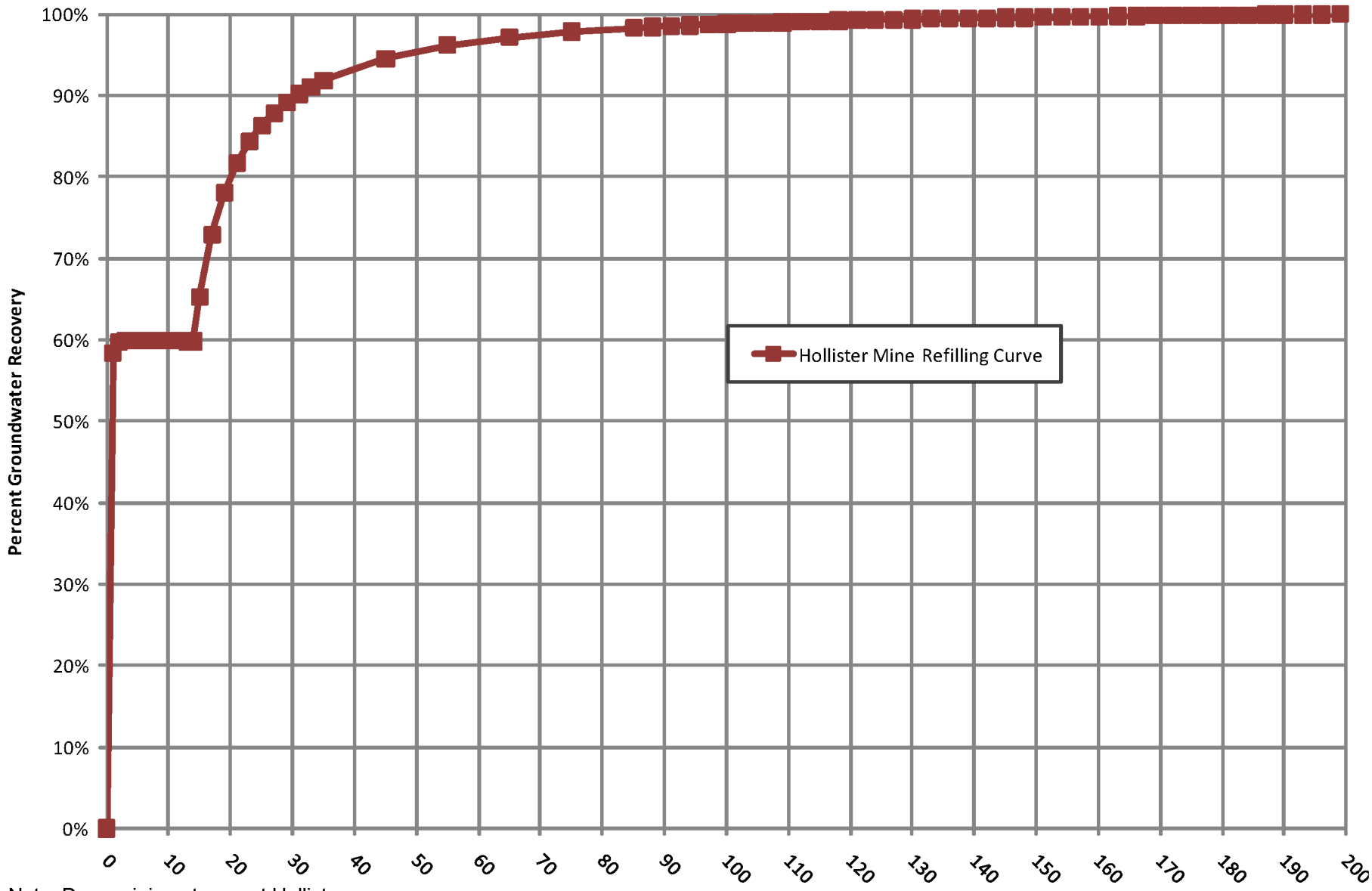
PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	5-7
DATE	TITLE	
6/30/10	Simulated Water Level Drawdown and Recoveries	



BROWN AND CALDWELL

PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	5-8
DATE: 6/30/10	TITLE: Simulated Mine Dewatering – Observed and Predicted Pumping Rates	

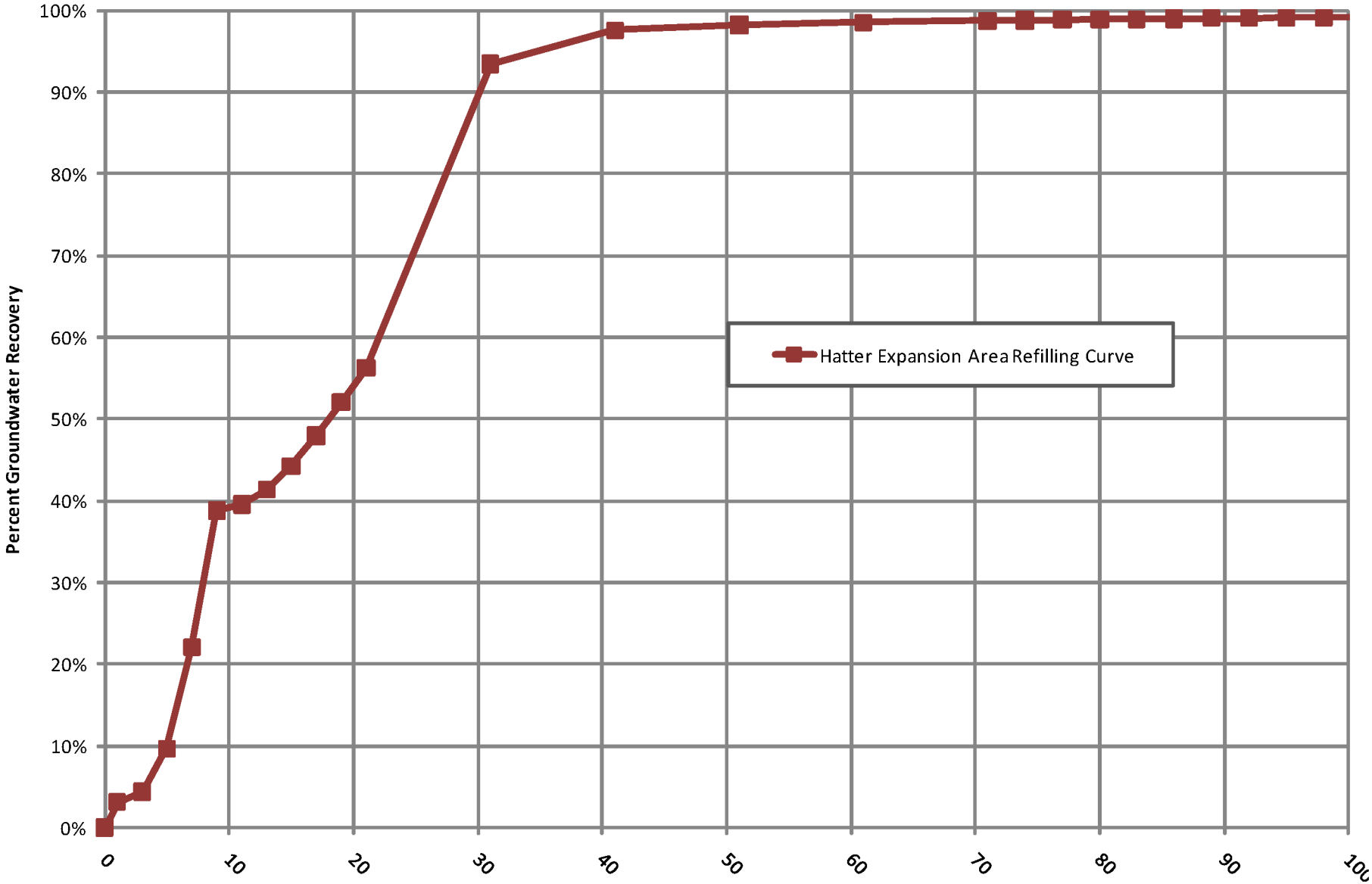
FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-8 Simulated Dewatering.mxd



Note: Deep mining at current Hollister mine simulated to stop in 2016.

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 5-9
	DATE 8/26/2010	TITLE Hollister Mine Workings Refilling Curve	

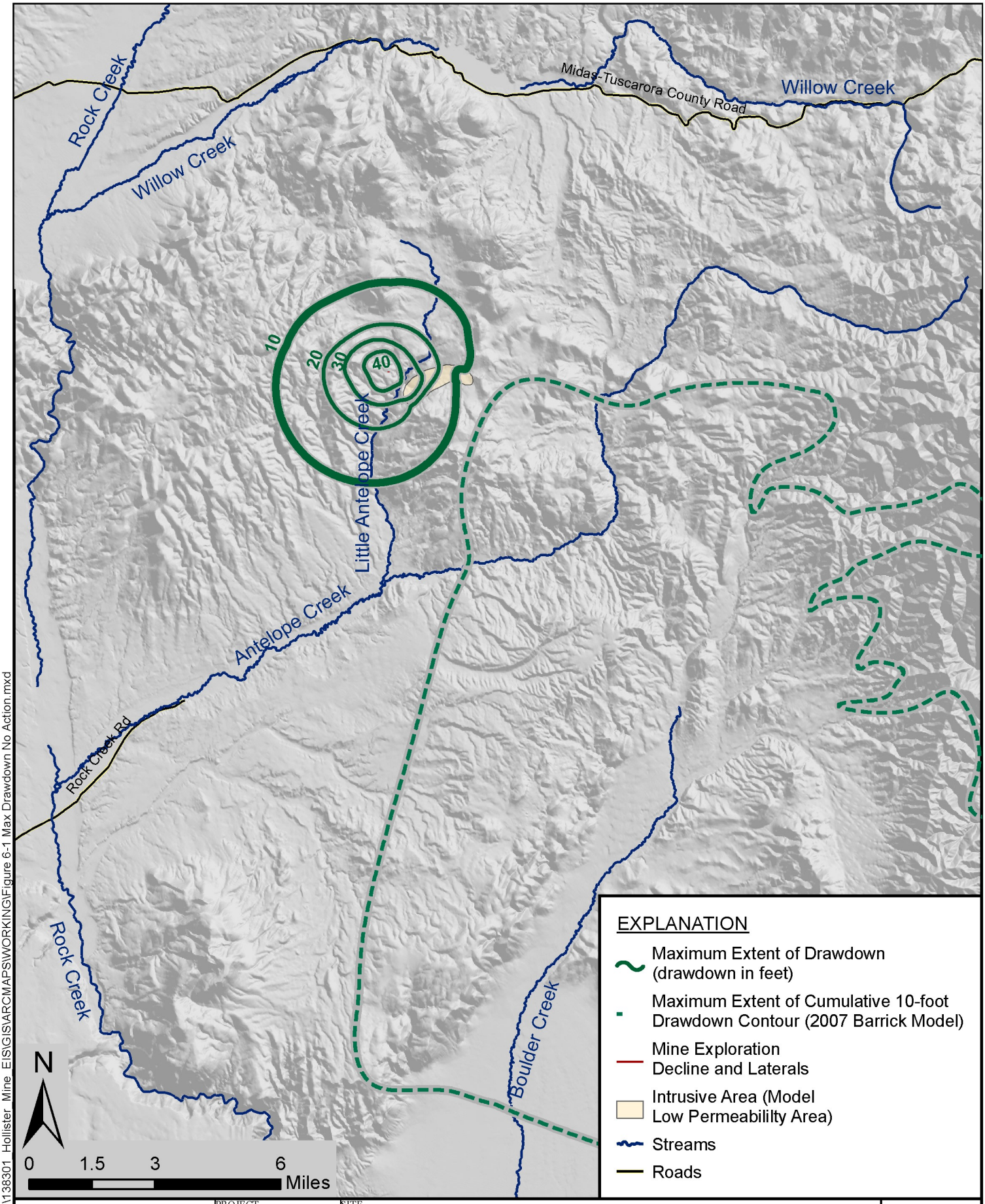
FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-9 Hollister Refilling Curve.mxd



Note: Mining activities at the Hatter Expansion area simulated to stop in 2030

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 5-10
	DATE 8/26/2010	TITLE Hatter Expansion Area Refilling Curve	

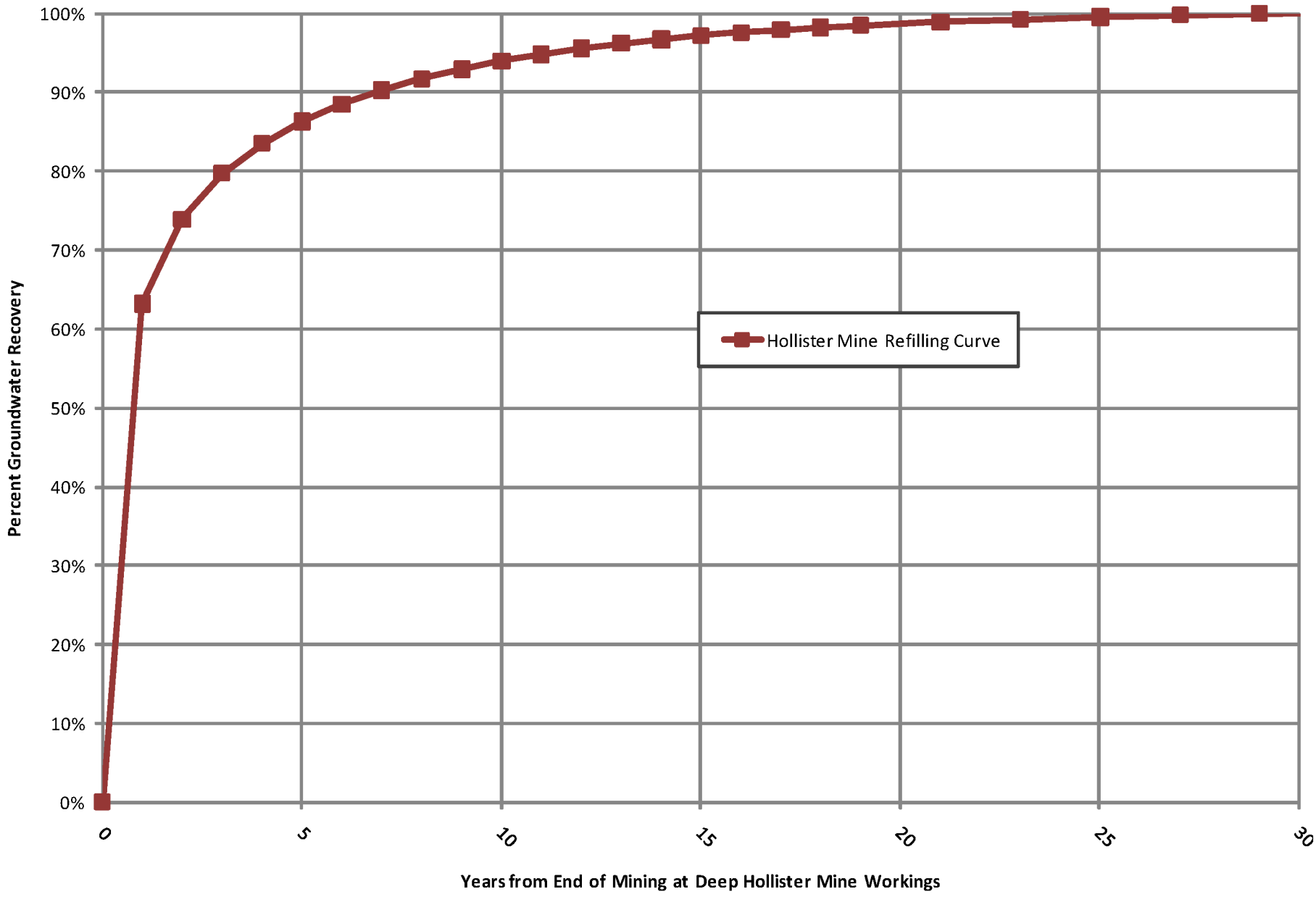
FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 5-10 Hatter Refilling Curve.mxd



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 6-1 Max Drawdown No Action.mxd

BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
10/7/10	No Action Alternative Simulation - Maximum Extent of 10-Foot Drawdown (2020)	6-1



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure 6-2 WL Recoveries No Action.mxd

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 6-2
	DATE 10/7/10	TITLE No Action Alternative Simulation - Hollister Mine Water Level Recovery	

APPENDIX A: SUPPORTING GROUNDWATER MODEL INFORMATION

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Figure A-2. BH-01 & BH-02 Calibrations Plot of Observed versus Simulated Water Levels
Figure A-3. Simulated Water Levels in Vinini Formation in 2016
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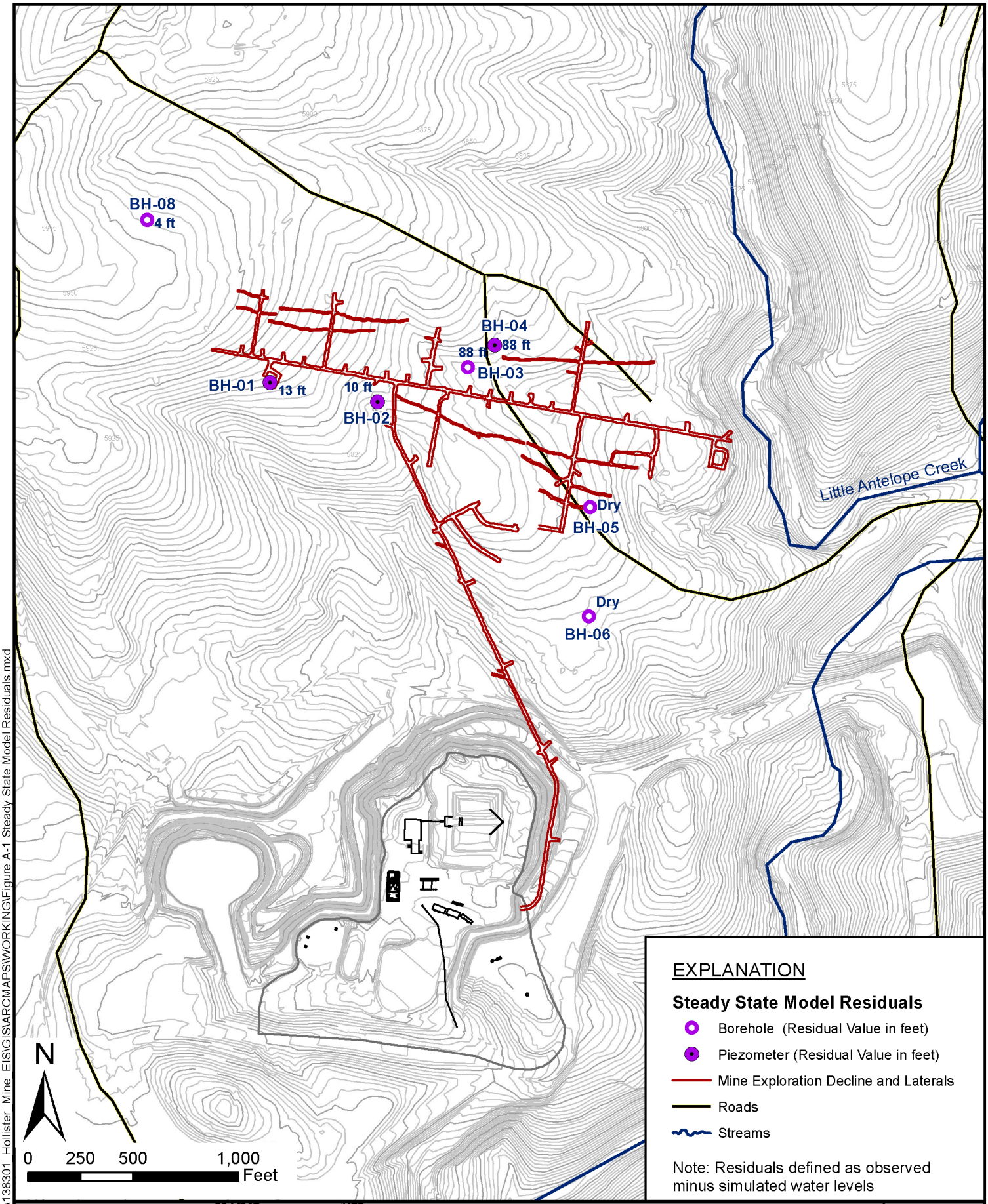
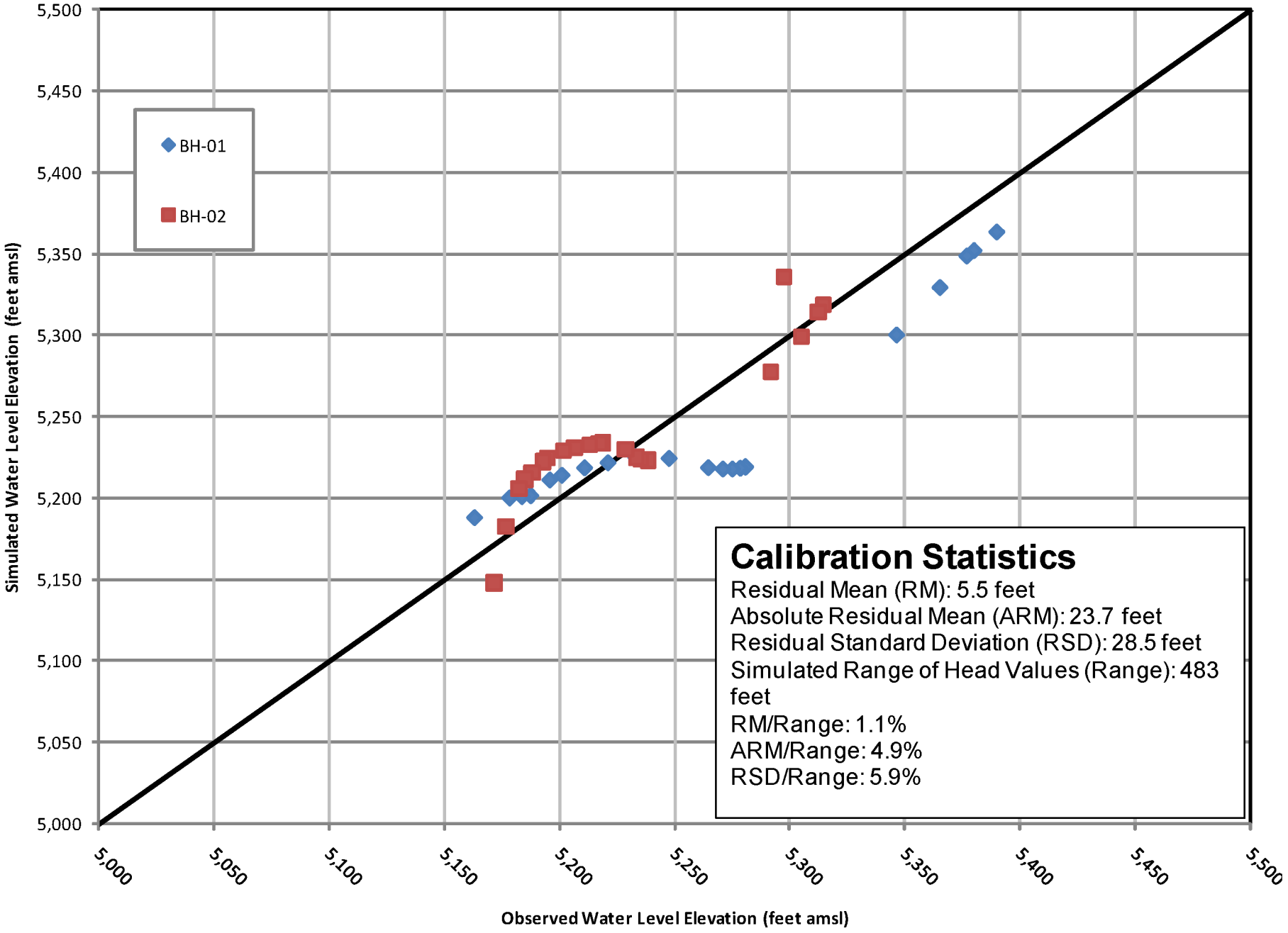
Figure A-5. Simulated Water Levels in Vinini Formation at Time of Maximum Extent of Drawdown (2070)
Figure A-6. Simulated Drawdown in Vinini Formation in 2016
Figure A-7. Simulated Drawdown in Vinini Formation in 2030



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-1 Steady State Model Residuals.mxd

BROWN AND CALDWELL

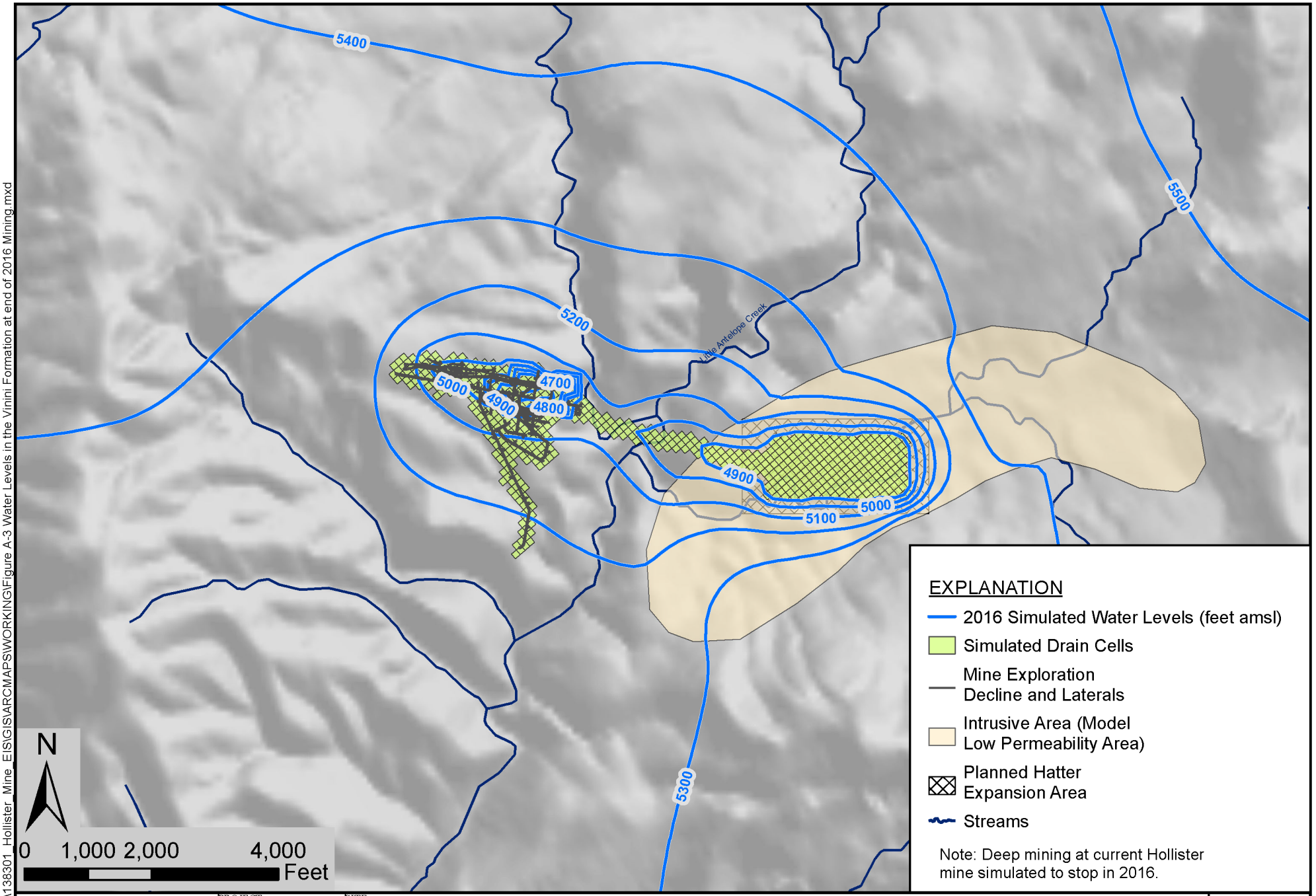
PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
6/30/10	Steady State Model Water Level Residuals	A-1



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-2 BH-01 & BH-02 Calibration Plot.mxd

BROWN AND CALDWELL

PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine	A-2
DATE	TITLE	
8/26/2010	BH-01 & BH-02 Calibrations Plot of Observed versus Simulated Water Levels	

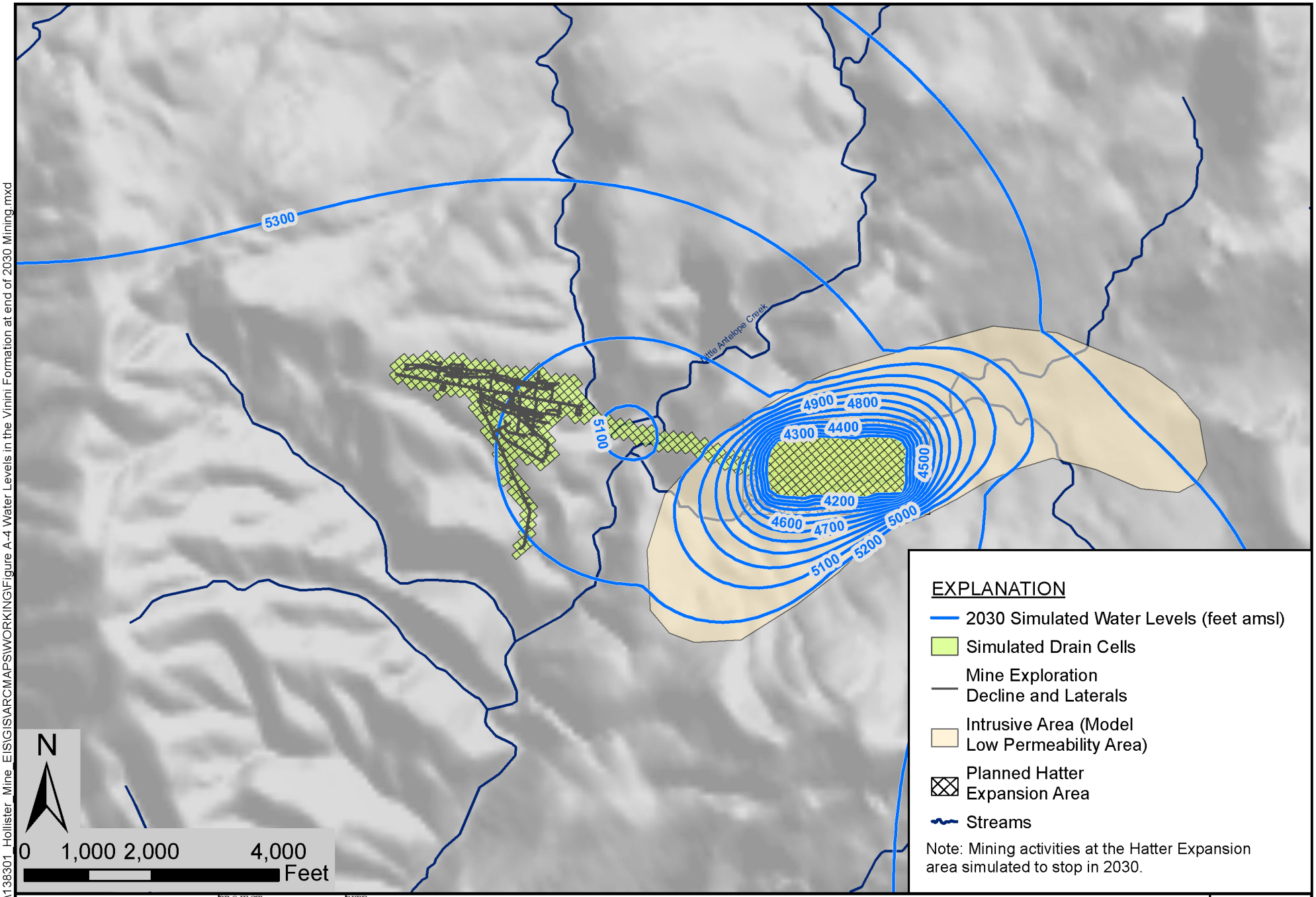


FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-3 Water Levels in the Vinini Formation at end of 2016 Mining.mxd

BROWN AND CALDWELL

PROJECT	SITE
138301	Rodeo Creek Gold - Hollister Mine
DATE	TITLE
8/26/2010	Simulated Water Levels in Vinini Formation in 2016

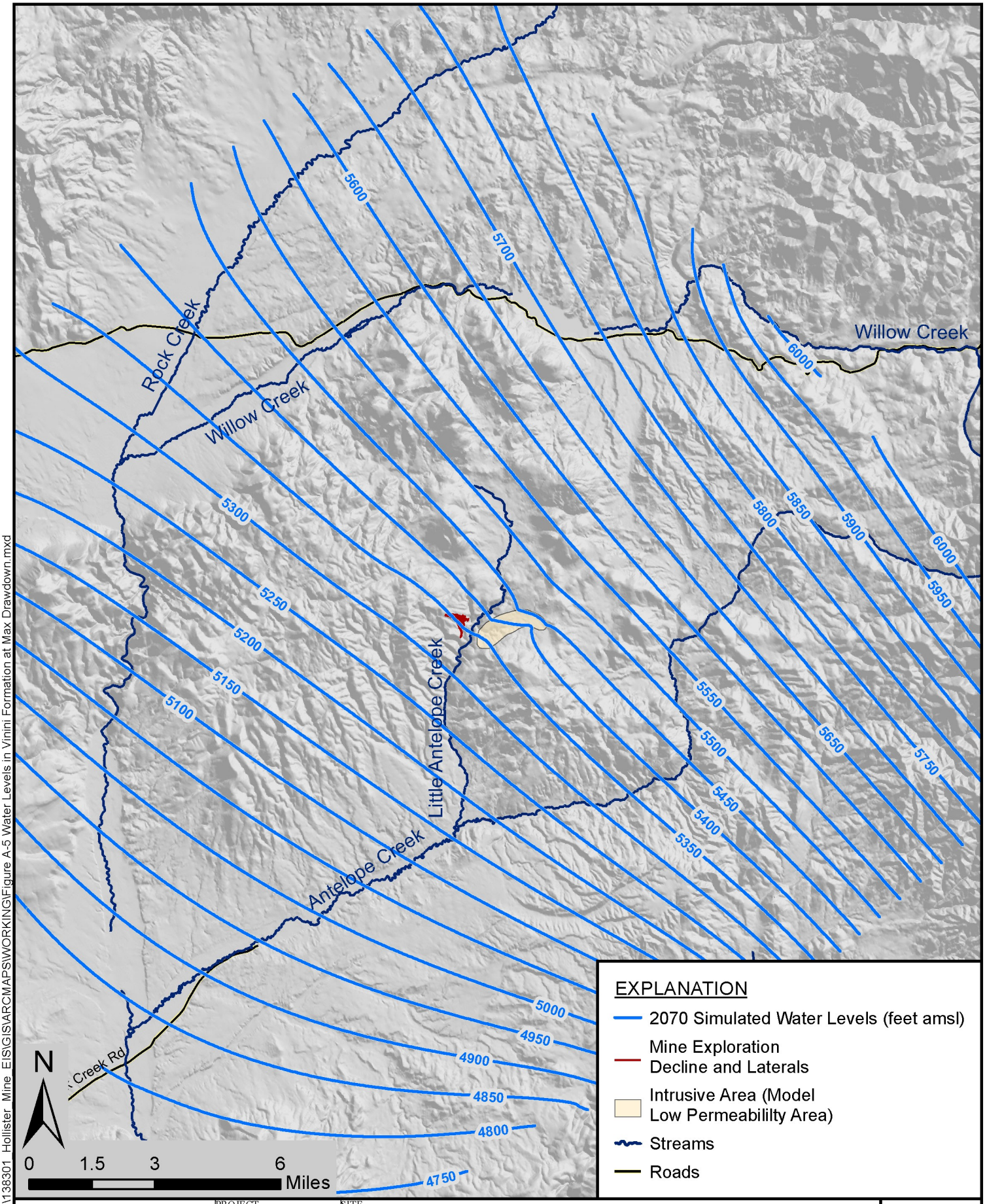
Figure A-3



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-4 Water Levels in the Vinini Formation at end of 2030 Mining.mxd

BROWN AND CALDWELL

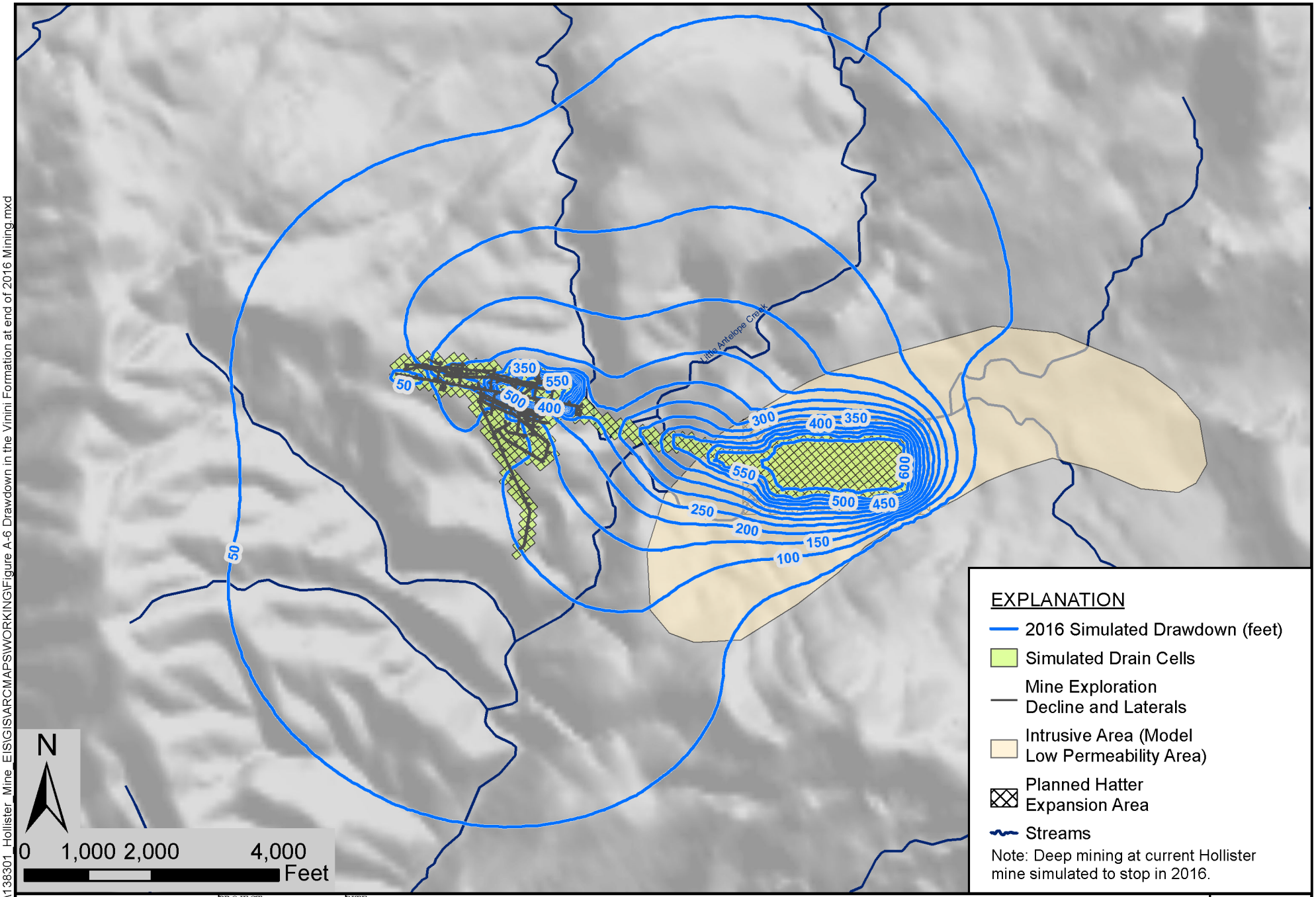
PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine, Hatter Expansion	Figure
DATE	TITLE	
8/26/2010	Simulated Water Levels in Vinini Formation in 2030	A-4



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-5 Water Levels in Vinini Formation at Max Drawdown.mxd

BROWN AND CALDWELL

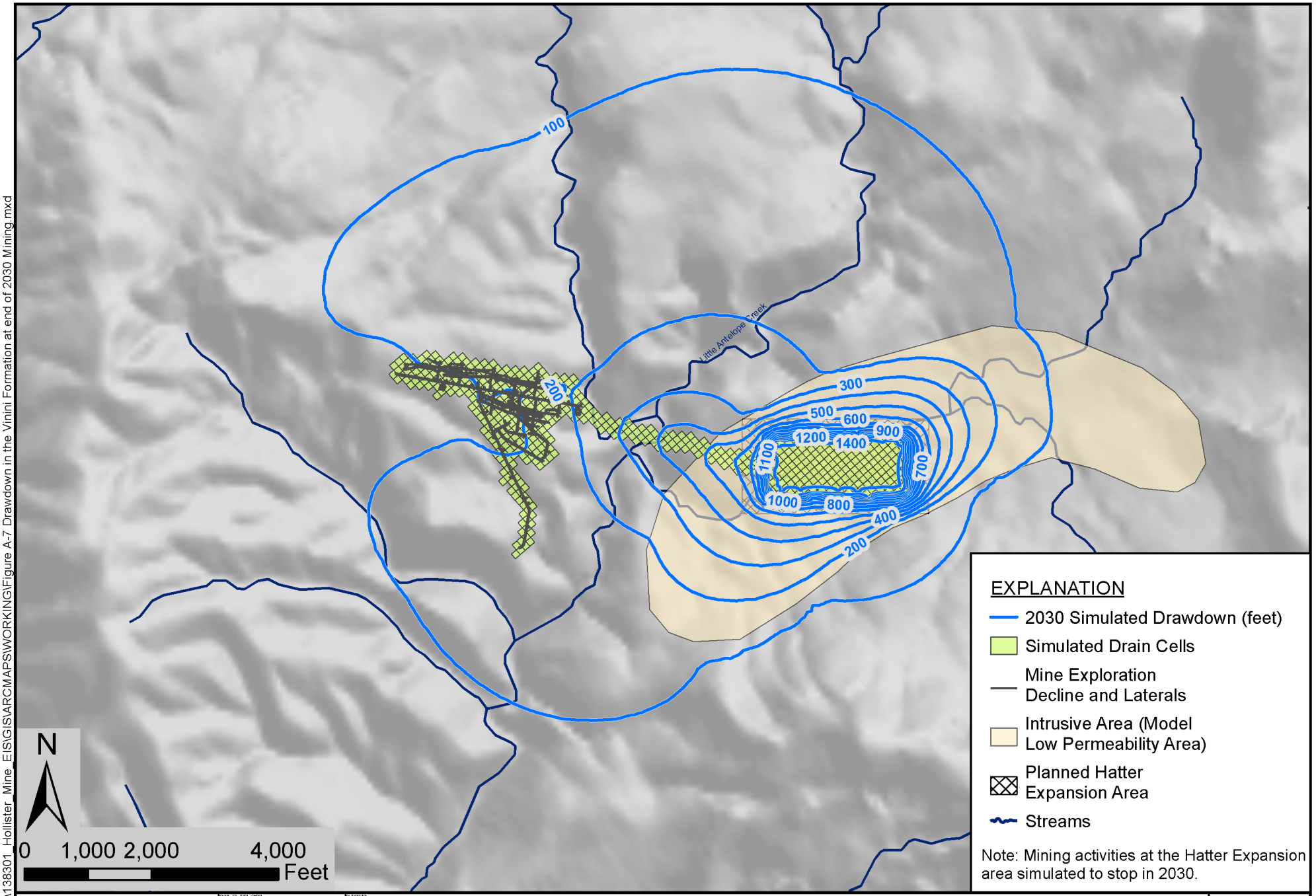
PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
8/26/2010	Simulated Water Levels in the Vinini Formation at Time of Maximum Extent of Drawdown (2070)	A-5



FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-6 Drawdown in the Vinini Formation at end of 2016 Mining.mxd

BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	
8/26/2010	Simulated Drawdown in Vinini Formation in 2016	A-6



BROWN AND CALDWELL

PROJECT	SITE	Figure
138301	Rodeo Creek Gold - Hollister Mine, Hatter Expansion	A-7
DATE 8/26/2010	TITLE Simulated Drawdown in Vinini Formation in 2030	

FILE: P:\BC_CAR\138301_Hollister_Mine_EIS\GIS\ARCMAPS\WORKING\Figure A-7 Drawdown in the Vinini Formation at end of 2030 Mining.mxd

B3 Geochemical Model Report

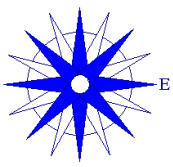
RODEO CREEK HOLLISTER MINE
UNDERGROUND WORKINGS WATER QUALITY PREDICTION

October 13, 2010

Prepared for:

Brown and Caldwell
3264 Goni Road
Suite 153
Carson City, Nevada 89706

Prepared by:



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Appendix B. Geochemical Modeling Calculations

EXECUTIVE SUMMARY

Rodeo Creek Gold Inc. (Rodeo Creek) is constructing an exploration decline and performing test drilling at their Hollister Mine site in Elko County, Nevada. Full scale mining will involve both the Hollister Mine workings and the planned Hatter Expansion. After mining is complete, dewatering will be discontinued and the underground workings will fill with groundwater. An investigation was carried out to predict the water quality in the underground workings after the mine is completely filled.

Available site information, including the geologic setting, mine plan, water quality data, waste rock testing data and hydrologic data were used to develop a geochemical conceptual model of processes at the site. This conceptual model and site data were used to formulate PHREEQC geochemical modeling calculations to predict steady-state water quality in the underground workings.

The geochemical conceptual model includes the assumption that the results of waste rock testing can be extrapolated to the mine wall rock and backfilled waste rock based on the surface areas of the materials. It is also assumed that the first four-week composite from waste rock humidity cell testing is representative of the mine wall rock and waste rock leaching. Because information regarding the distribution of the mine workings, waste rock and cement as a function of depth is unavailable, it is assumed that the mine workings, waste rock and cement will be uniformly distributed over the depth of the workings. Because of the long time period required for groundwater to fill the underground workings and the high sulfate content of the underground workings water, cementitious materials in the concrete are assumed to be completely available for reaction. It is also assumed that the composition of inflowing groundwater can be represented by available borehole water samples, the entire flooded underground workings can be approximated as a single, well-mixed system and the rate of outflow of water from the workings during mine filling will be negligible.

The important chemical processes included in the geochemical conceptual model are: leaching of acidity, metals and other constituents from the mine wall rock and backfilled waste rock; leaching of alkalinity, calcium and silica from the cementitious phases in concrete; influx of dissolved constituents in the groundwater; precipitation/dissolution reactions; and constituent adsorption on precipitated iron hydroxide. The solid phases allowed to precipitate in the geochemical modeling calculations are phases that have been identified in the literature as those that form readily under the relatively low-temperature conditions anticipated in the underground workings.

PHREEQC geochemical modeling calculations were performed assuming two different surface areas for the mine wall rock and backfilled waste rock. For both sets of calculations, redox conditions were relatively oxidizing and the pH of the solution was controlled at approximately 10.2 by precipitation of tobermorite [$(Ca(OH)_2)_2(SiO_2)_{2.4}\bullet 2H_2O(s)$]. This alkaline pH is

consistent with the relatively large neutralizing potential in the cement (10,269 ton $CaCO_3$) compared to the acid-base potential in the waste rock backfill (-3,032 ton $CaCO_3$). Because the neutralizing potential in the cement exceeds the acid-base potential in the waste rock by more than a factor of three, the alkalinity in the cement is more than sufficient to neutralize the acidity released by the waste rock and mine wall rock.

For both mine wall rock and waste rock surface areas used in the calculations, the concentrations of arsenic, barium, cadmium, chloride, copper, fluoride, iron, lead, magnesium, manganese, nickel, nitrate and zinc are less than the NDEP Profile I reference values. The predicted pH value of approximately 10.2 exceeds the Profile I reference value. The predicted concentrations for both mine wall rock and waste rock surface areas exceed the Profile I reference values for aluminum, antimony, chromium, selenium, sulfate, thallium and total dissolved solids. The predicted beryllium concentration exceeds its Profile I reference value for the higher mine wall rock and waste rock surface area, but is below its reference value for the lower surface area.

1.0 INTRODUCTION

Rodeo Creek Gold Inc. (Rodeo Creek) is constructing an exploration decline and performing test drilling at their Hollister Mine site in Elko County, Nevada. Full scale mining will involve both the Hollister Mine workings and the planned Hatter Expansion. After mining is complete, dewatering will be discontinued and the underground workings will eventually fill with groundwater. An investigation was carried out to predict the water quality in the underground workings after the mine is completely filled.

Section 2.0 summarizes the available site data, including the geologic setting, mine plan, water quality data, waste rock testing data and hydrogeologic data. The PHREEQC geochemical modeling code and database used to perform the water quality calculations are described in Section 3.0 and the conceptual model used to formulate the modeling calculations is summarized in Section 4.0. The results of the calculations are described in Section 5.0.

The results of this investigation are summarized in Section 6.0. The results indicate that the neutralizing potential of the cement in concrete used to stabilize the backfill will be more than sufficient to counteract the acidity released by the mine wall rock and waste rock backfill. As a result, the pH of the underground workings water at steady state will be alkaline and controlled by the precipitation of tobermorite [$(Ca(OH)_2)_2(SiO_2)_{2.4}\bullet 2H_2O(s)$] at approximately 10.2. Aqueous concentrations of arsenic, barium, cadmium, chloride, copper, fluoride, iron, lead, magnesium, manganese, nickel, nitrate and zinc are not predicted to exceed NDEP Profile I reference values. Constituents predicted to exceed NDEP Profile I reference values in the underground workings water include pH, aluminum, antimony, chromium, selenium, sulfate, thallium and total dissolved solids and possibly beryllium.

2.0 SITE DATA

Information required for predicting underground workings water quality after groundwater inflow is complete includes the mineralogy and chemistry of the rocks that will be exposed on the mine walls, the mineralogy and chemistry of waste rock that will be backfilled in the mine, the configuration of the workings, the length of time the mine wall rock and waste rock will be exposed to the atmosphere during mining and reflooding of the workings, the length of time cementitious materials will be submerged in the mine water and the sources and chemistry of inflowing groundwater. Site data used to calculate the underground mine water quality are summarized in Table 2-1. The sources of these data are described in the following sections.

Table 2-1. Parameters Used to Calculate Mine Water Quality

Parameter	Value (SI units)	Value (English Units)	Report Section
Total length of Hollister Mine workings	12,649 m	41,500 ft	2.2
Hollister Mine workings volume	141,018 m^3	4,980,000 ft^3	2.2
Radius of Hollister Mine workings	1.88 m	6.18 ft	2.2.1
Mine wall geometric surface area	149,718 m^2	1,611,550 ft^2	2.2.1
Mine wall reactive surface area	14,971,800 m^2	161,155,000 ft^2	2.2.1
Waste rock field volume	42,305 m^3	1,494,000 ft^3	2.2.2
Waste rock field density	1,560 kg/m^3	97.42 lb/ft^3	2.2.2
Assumed waste rock material density	2,650 kg/m^3	165.4 lb/ft^3	2.2.2
Waste rock total mass	65,985,107 kg	72,736 tons	2.2.2
Waste rock particle volume	24,900 m^3	879,337 ft^3	2.2.2
Waste rock geometric surface area	155,479,964 m^2	1,673,572,408 ft^2	2.2.2
Waste rock reactive surface area	1,088,359,751 m^2	11,715,006,856 ft^2	2.2.2
Mine wall rock and waste rock reactive surface area	1,103,331,535 m^2	11,876,161,806 ft^2	2.2.2
Concrete volume	14,158 m^3	500,000 ft^3	2.2.3
Cement volume	3,540 m^3	125,000 ft^3	2.2.3
Cement density	2,340 kg/m^3	146.1 lb/ft^3	2.2.3
Cement mass	8,282,679 kg	18,260,179 lbs	2.2.3
Underground workings water volume	101,959 m^3	3,600,663 ft^3	2.2.4
Mine wall rock and waste rock reactive surface area per volume of water	10,821 m^2/m^3	3,298 ft^2/ft^3	2.2.4

2.1 Geologic Setting

The Rodeo Creek Hollister Mine site is located at the north end of the Carlin Trend, in Elko County, Nevada. The site geology has been described by Walker (2003a, 2003b). A Tertiary volcanic, intrusive and epiclastic complex of rocks crops out at the surface, except for limited areas of Pliocene and younger sediments on the east side of the project. The Ordovician Vinini

Formation underlies the Tertiary rocks. Ore minerals occur in banded quartz veins in the Vinini Formation. Pyrite may reach 1 to 3% by volume in the alteration halos around the veins.

Three rock types were identified for waste-rock testing from the Vinini Formation (Walker 2003a, 2003b): (1) andesite, (2) quartzite, including quartzite, quartzite/siltite and quartzite/argillite and (3) interbedded argillite/siltite, including argillite, argillite/quartzite, argillite/siltite and siltite. Andesite was encountered only in the initial portion of the decline, and the majority of mine wall rock in the underground workings is likely to consist of quartzite and interbedded argillite/siltite.

2.2 Mine Plan Data

The length of the workings, waste rock density, waste rock volume and concrete volumes were obtained from Rodeo Creek (Taylor 2010a, 2010b, 2010c, 2010d) and Brown and Caldwell (Cain 2010). The total vertical depth of mining beneath the water table at the site will extend from around 5,400 ft to 4,000 ft amsl. The Hollister Mine will have 41,500 ft of open workings and 4,980,000 ft^3 total volume of open workings.

A subsurface drift will be constructed to the planned Hatter Expansion, beginning at 5,200 ft amsl in the Hollister Mine workings and ending at approximately 4,800 ft amsl. The Hatter Expansion will extend to approximately 4,000 ft amsl. The Hatter Expansion is expected to increase the length and volume of open workings, volumes of waste rock backfill and cement by 40%. The water quality prediction calculations depend on the proportions of waste rock backfill volume, mine wall surface area and cement volume to the volume of water in the workings. Because these ratios will not change with the planned Hatter Expansion, all calculations were carried out using data for the Hollister Mine workings, but will also be applicable to the planned Hatter Expansion.

2.2.1 Surface Area of the Underground Workings

The mine wall surface area was approximated using the dimensions of the Hollister Mine workings, assuming a cylindrical shape, with a volume (V) of 4,980,000 ft^3 and length (l) of 41,500 ft. A radius (r) of 6.18 ft was calculated for this cylinder using the equation:

$$\frac{}{} \qquad (1)$$

The surface area (S) of a cylinder can be calculated from the radius and length:

$$S = 2\pi rl \qquad (2)$$

Using equation (2), the Hollister Mine wall geometric surface area was calculated to be 1,611,550 ft^2. The reactive surface area of the mine wall will be greater than the geometric surface area because of surface irregularity, natural fracturing and faulting and the effects of

blasting. Morin and Hutt (2006) found that these features can result in a reactive surface area that exceeds the geometric surface area by a factor ranging from 27 to 161. Because site-specific data regarding the increase in surface area are unavailable, the geometric surface area was increased by a factor of 100, which falls near the middle of this range. This increase yielded a reactive mine wall surface area of 161,155,000 ft^2.

2.2.2 Waste Rock

The underground workings will be backfilled with waste rock that will occupy an estimated 25% to 30% of the workings volume. The higher estimate of 30% was used in the calculations to maximize the waste rock surface area and minimize the amount of water in the calculations, thereby increasing calculated constituent concentrations in the underground workings water. The total volume of waste rock was calculated to be 1,494,000 ft^3.

The volume occupied by the waste rock includes both the waste rock particles and the void space between the particles. The volume occupied by the waste rock particles is required to calculate the final volume of water in the mine. The total mass of waste rock is 72,736 tons (145,472,000 lbs), based on an inverse field density of 20.53 ft^3/ton (Taylor 2010c) and the total volume of waste rock. Assuming the waste rock particles have a density equal to quartz (165 lb/ft^3), the volume of the waste rock particles is 879,337 ft^3.

The backfilled waste rock will not be crushed or otherwise treated before placement in the underground workings, so the particle size distribution will equal the run-of-mine size distribution. Knowledge of the particle size distribution is necessary for estimating the surface area of the waste rock particles. The waste rock particle size gradation was determined by Knight Piésold (2010). Coarser size fractions (4 inch to 18 inch) were estimated visually in the field and four samples of the finer materials (less than 4 inch) were collected and composited for laboratory size gradation; these results were combined to generate an overall particle size distribution (Table 2-2).

The weight percentages of waste rock in each particle size range (Table 2-3) were calculated using the particle size gradation data (Table 2-2); the mass of each particle size in a cubic meter of waste rock was calculated using these weight percentages and the reported inverse field density of 20.53 ft^3/ton (1,560 kg/m^3). The surface area and volume of the waste rock particles were calculated for each size fraction assuming spherical particles with a diameter equal to the midpoint of the size range using equations (3) and (4), respectively:

$$4 \quad (3)$$

$$\frac{4}{3} \quad 3 \quad (4)$$

Table 2-2. Particle Size Gradation

Sieve Size	Sieve Size (mm)	Field Results (% finer)	Laboratory Results (% finer)	Overall (% finer)
>18 inch	> 457.2	100	--	100
18 inch	457.2	96	--	96
12 inch	304.8	90	--	90
10 inch	254	85	--	85
8 inch	203.2	77	--	77
6 inch	152.4	70	--	70
4 inch	101.6	65	--	65
3 inch	76.2	--	100	65
2 inch	50.8	--	88.1	57
1.5 inch	38.1	--	77.8	51
1 inch	25.4	--	63.2	41
0.75 inch	19.05	--	52.6	34
0.5 inch	12.7	--	39.7	26
0.375 inch	9.525	--	33.6	22
#4	4.75	--	25.9	17
#8	2.38	--	17.8	12
#16	1.20	--	12.3	8
#40	0.422	--	9.7	6
#50	0.297	--	8.4	5
#100	0.152	--	6	4
#200	0.075	--	4.5	3

Source: Knight Piésold (2010)

For example, the maximum size of the waste rock was reported to be 24 inch (Taylor 2010b), so for the largest size fraction, the size range was assumed to be 18 to 24 inch (0.457 to 0.610 m), with an average 21 inch (0.533 m) diameter and an average radius of 10.5 inch (0.267 m). The surface area of a spherical particle of this radius is 9.62 ft^2 (0.894 m^2) and the volume is 2.81 ft^3 (0.0795 m^3); using the particle volume and the assumed waste rock particle density of 165 lb/ft^3 (2,650 kg/m^3), the mass of each particle is calculated to be 464 lb (211 kg). Using the mass of this size fraction per unit volume of 3.89 lb/ft^3 (62.39 kg/m^3, which is 4% of the total 1,560 kg/m^3), the number of particles of this size would be 0.00839 per ft^3 (0.296 per m^3) of waste rock. Multiplying the surface area per particle by the number of particles provides the geometric surface area per unit volume of waste rock for each size fraction. The results of these calculations are provided in Table 2-3. These results show that approximately 75% of the total

geometric surface area is associated with the smallest particle size waste rock (less than 200 mesh or 0.075 mm) even though this material represents only 3 weight % of the waste rock.

The geometric surface area of the waste rock particles was calculated to be 1,120 ft^2/ft^3 (3,675 m^2/m^3), which yields a total geometric surface area of 1,673,580,448 ft^2 (155,479,964 m^2). White and Peterson (1990) determined a roughness factor of seven to account for surface irregularity associated with freshly fractured minerals. Multiplying the geometric surface area by this roughness factor yields an estimated waste rock backfill reactive surface area of 11,715,063,133 ft^2 (1,088,359,751 m^2). The total mine wall rock and waste rock reactive surface area is 11,876,218,084 ft^2 (1,103,331,535 m^2). The reactive surface area of the waste rock backfill constitutes over 98% of the expected total reactive surface area.

2.2.3 Concrete

The backfilled waste rock will be stabilized by the emplacement of concrete every six feet. The estimated total volume of concrete is 500,000 ft^3 (14,158 m^3) (Taylor 2010b). The concrete will be made up of 25% (by volume) Portland Type II cement and 75% cellular foam. It is assumed that the cementitious material in the concrete will react when submerged in the mine water and the cellular foam will remain inert.

Portland Type II cement has moderate sulfate resistance, with a typical composition listed in Table 2-4. The density of Portland cement is about 146 lb/ft^3 (2,340 kg/m^3), so the expected mass of cement in the mine workings is 18,260,179 lb (8,282,679 kg). The neutralizing potential (NP) of the cement was calculated using the chemical composition in Table 2-4, which provides a CaO concentration in the cement of 63.0 wt%. The NP of the cement was calculated to be 1,125 ton $CaCO_3$/kton.

2.2.4 Underground Workings Water Volume and Rock Surface Area to Volume Ratio

The total volume of water present in the underground workings will equal the volume of the underground workings of 4,980,000 ft^3 (141,018 m^3), minus the volumes occupied by the waste rock particles (879,337 ft^3 or 24,900 m^3) and concrete backfill (500,000 ft^3 or 14,158 m^3). The calculated water volume is 3,600,663 ft^3 (101,959 m^3).

The ratio of mine wall rock and waste rock surface area to water volume is required for the underground workings water quality modeling calculations. The total reactive waste rock and mine wall surface area (Section 2.2.2) divided by the water volume is 3,298 ft^2/ft^3 (10,821 m^2/m^3). Because the mine wall rock and waste rock are assumed to be composed of equal amounts of quartzite and argillite/siltite, the surface area to volume ratio for each of these rock types is 1,649 ft^2/ft^3 (5,411 m^2/m^3).

Table 2-3. Calculation of Geometric Surface Area for Waste Rock Size Fractions

Size Range (mm)	Weight percent	Mass per m^3 (kg)	Particle radius (m)	Particle volume (m^3)	Particle surface area (m^2)	Mass per particle (kg)	Number of particles per m^3 waste rock	Geometric Surface Area (m^2/m^3)	Surface area (% of total)
> 457.2	4.00	62.39	0.2667	0.0795	0.894	211	0.296	0.265	0.01%
304.8 to 457.2	6.00	93.58	0.1905	0.0290	0.456	76.7	1.22	0.556	0.02%
254 to 304.8	5.00	77.99	0.1397	0.114	0.245	30.3	2.58	0.632	0.02%
203.2 to 254	8.00	124.8	0.1143	6.25×10^{-3}	0.164	16.6	7.53	1.24	0.03%
152.4 to 203.2	7.00	109.2	0.08890	2.94×10^{-3}	0.0993	7.80	14.0	1.39	0.04%
101.6 to 152.4	5.00	77.99	0.06350	1.07×10^{-3}	0.0507	2.84	27.4	1.39	0.04%
76.2 to 101.6	0.00	0.00	0.04445	3.68×10^{-4}	0.0248	0.975	0.00	0.00	0.00%
50.8 to 76.2	7.74	120.6	0.03175	1.34×10^{-4}	0.0127	0.355	340	4.30	0.12%
38.1 to 50.8	6.70	104.4	0.02223	4.60×10^{-5}	6.21×10^{-3}	0.122	857	5.32	0.14%
25.4 to 38.1	9.49	148.0	0.01588	1.68×10^{-5}	3.17×10^{-3}	0.0444	3,333	10.56	0.29%
19.05 to 25.4	6.89	107.5	0.01111	5.75×10^{-6}	1.55×10^{-3}	0.0152	7,055	10.95	0.30%
12.7 to 19.05	8.39	130.8	7.938×10^{-3}	2.09×10^{-6}	7.92×10^{-4}	5.55×10^{-3}	23,560	18.65	0.51%
9.525 to 12.7	3.97	61.84	5.556×10^{-3}	7.19×10^{-7}	3.88×10^{-4}	1.90×10^{-3}	32,480	12.60	0.34%
4.75 to 9.525	5.01	78.06	3.569×10^{-3}	1.90×10^{-7}	1.60×10^{-4}	5.05×10^{-4}	1.55×10^{5}	24.76	0.67%
2.38 to 4.75	5.27	82.12	1.783×10^{-3}	2.37×10^{-8}	3.99×10^{-5}	6.29×10^{-5}	1.31×10^{6}	52.15	1.42%
1.2 to 2.38	3.58	55.76	8.950×10^{-4}	3.00×10^{-9}	1.01×10^{-5}	7.96×10^{-6}	7.01×10^{6}	70.53	1.92%
0.422 to 1.2	1.69	26.36	4.055×10^{-4}	2.79×10^{-10}	2.07×10^{-6}	7.40×10^{-7}	3.56×10^{7}	73.59	2.00%
0.297 to 0.422	0.84	13.18	1.798×10^{-4}	2.43×10^{-11}	4.06×10^{-7}	6.45×10^{-8}	2.04×10^{8}	83.01	2.26%
0.152 to 0.297	1.56	24.33	1.123×10^{-4}	5.92×10^{-12}	1.58×10^{-7}	1.57×10^{-8}	1.55×10^{9}	245.4	6.68%
0.075 to 0.152	0.98	15.21	5.675×10^{-5}	7.66×10^{-13}	4.05×10^{-8}	2.03×10^{-9}	7.50×10^{9}	303.4	8.25%
< 0.075	2.93	45.62	1.875×10^{-5}	2.76×10^{-14}	4.42×10^{-9}	7.32×10^{-11}	6.24×10^{11}	2,755	74.95%
Total								3,675	100%

Table 2-4. Chemical Composition of Portland Type II Cement

Chemical Name	Chemical Formula	Weight Percent
Tricalcium silicate	$3CaO•SiO_2$	51
Dicalcium silicate	$2CaO•SiO_2$	24
Tricalcium aluminate	$3CaO•Al_2O_3$	6
Tetracalcium aluminoferrite	$4CaO•Al_2O_3•Fe_2O_3$	11
MgO	MgO	2.9
SO_3	SO_3	2.5
Free CaO	CaO	1

2.2.5 Duration of Mine Wall and Waste Rock Exposure

The Hollister Mine and Hatter Expansion mine drain setup schedule (Table 2-5) indicates the length of time mine wall rock and backfilled waste rock will be exposed to the atmosphere. The total vertical extent of mining at the Hollister Mine began at an elevation of approximately 5,400 ft amsl in 2005 and will be advanced to 4,570 ft amsl in 2016 (Cain 2010). A subsurface drift from the Hollister Mine workings will begin at 5,200 ft amsl in 2014 and will end at 4,800 ft amsl at Hatter. Beginning in 2017 and ending in 2029, the Hatter Expansion workings will be advanced downward to a final elevation of 4,000 ft amsl.

Table 2-5. Hollister Mine and Hatter Expansion Mine Drain Setup Schedule

Year	Hollister Mine Level (Generalized, ft)	Hatter Expansion Level (ft)	Comments
2010	4,979	--	Based upon future Hollister Mine plan
2011	4,930	--	Based upon future Hollister Mine plan
2012	4,810	--	Based upon future Hollister Mine plan
2013	4,690	--	Based upon future Hollister Mine plan
2014	4,570	5,200 – 4,800	Subsurface drift over to Hatter, ending at 4,800 ft elevation at Hatter
2015	4,570	4,800	Hatter Expansion dewatering begins
2016	5,050	4,800	Deep mining stops at Hollister Mine
2017	5,050	4,400	Hatter Expansion workings advanced downwards
2018	5,050	4,400	--
2019 through 2029	5,050	4,000	Hatter Expansion workings advanced downwards to final elevation of 4,000 ft
2030 through 2250	--	--	Water level recovery period

Source: Cain (2010)

2.3 Hydrologic Data

The results of hydrologic modeling performed to simulate drawdown and water level recovery at the Hollister Mine and Hatter Expansion are summarized in Table 2-6. For the Hollister Mine workings, water level recovery will begin in 2016 when deep mining ends. Water levels in the Hollister Mine workings are projected to recover relatively quickly to 58.4% of the total vertical extent of the workings by the end of 2016 (Table 2-6). Water levels will be maintained relatively constant at approximately 5,063 ft amsl in the Hollister Mine workings until 2029 when mining is completed in the Hatter Expansion. Water levels then will increase by an amount sufficient to submerge more than 90% of the vertical extent of the Hollister Mine workings by the end of 2050 and more than 95% of the vertical extent of the workings by 2070. Water levels then gradually approach steady state, reaching 99% of water level recovery by 2130.

Water level recovery is predicted to begin in the Hatter Expansion in 2029 after mining is completed. Water levels are predicted to rise and submerge more than 50% of the vertical extent of the Hatter Expansion workings by 2048. More than 90% of the extent of the Hatter Expansion workings will be submerged by 2060 and more than 95% will be submerged by 2070. Water levels in the Hatter Expansion workings will then gradually approach steady state, reaching 99% of water level recovery by 2115.

Exploratory mining began in 2005 at the Hollister Mine and the percentage of water level recovery in the Hollister Mine workings will reach 99% in the year 2130. Consequently, the majority of the mine wall rock and waste rock in the Hollister Mine and Hatter Expansion workings will be exposed to the atmosphere for a maximum of 125 years.

2.4 Groundwater Quality Data

Composition data for the groundwater entering the workings are available from boreholes emplaced in the Vinini Formation and sampled before exploratory mining began at the site (Table 2-7). In addition, water quality data are available for the drainage currently being discharged from the underground workings during exploratory mining (Table 2-8, Appendix A).

2.5 Waste Rock Testing Data

Acid-base accounting (ABA), Meteoric Water Mobility Testing (MWMP) and kinetic testing (BC Humidity Cell Protocol) were carried out to characterize rock samples obtained from drill core and boreholes in the area of the exploration decline (Walker 2003a, 2003b). The waste rock humidity cell results reported by Walker (2003a) can be used to characterize potential releases of constituents from the mine wall rock and waste rock backfill.

Table 2-6. Predicted Percent Water Level Recovery or Saturated Percentage of the Vertical Extent of the Mine Workings, Hollister Mine and Hatter Expansion

Hollister Mine		Hatter Expansion	
Model Time	Percent Water Level Recovery or Saturated Percentage of Vertical Mine Extent	Model Time	Percent Water Level Recovery or Saturated Percentage of Vertical Mine Extent
4/2005	100.0%	2010	99.8%
12/2005	94.9%	2011	99.5%
12/2006	80.8%	2012	99.1%
12/2007	80.4%	2013	98.5%
12/2008	78.3%	2014	96.5%
12/2009	66.5%	2015	56.5%
12/2010	62.5%	2016	56.4%
12/2011	36.6%	2017	28.2%
12/2012	35.4%	2018	28.2%
12/2013	32.3%	2019	0.0%
12/2014	0.0%	2029	0.0%
12/2015	0.0%	2030	3.1%
12/2016	58.4%	2032	4.4%
12/2017	59.8%	2034	9.7%
12/2018	59.9%	2036	22.1%
12/2019	59.9%	2038	38.8%
12/2020	59.9%	2040	39.5%
12/2030	65.2%	2042	41.3%
12/2040	86.3%	2044	44.3%
12/2050	91.8%	2046	47.9%
12/2060	94.5%	2048	52.0%
12/2070	96.2%	2050	56.3%
12/2080	97.2%	2060	93.4%
12/2090	97.8%	2070	97.6%
12/2100	98.3%	2080	98.2%
12/2130	99.1%	2090	98.5%
12/2151	99.4%	2100	98.7%
12/2181	99.7%	2115	99.0%
12/2196	99.9%	2187	99.5%
12/2217	100.0%	2232	99.7%

Source: Cain (2010)

Table 2-7. Vinini Formation Borehole Water Quality

Borehole	BH-01	BH-01	BH-02[a]	BH-02	BH-04[a]	BH-04
Date	9/29/2002	3/13/2003	10/1/2002	3/13/2003	10/11/2002	3/13/2003
Bicarbonate	127	104	54	51	88	62
Aluminum	<0.02	<0.02	<0.02	<0.02	0.099	<0.02
Antimony	0.0743	<0.003	0.0187	<0.003	<0.003	<0.003
Arsenic	0.0306	<0.005	0.0086	<0.005	0.0155	<0.005
Barium	0.134	0.071	0.134	0.196	0.032	0.031
Beryllium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Boron	0.221	0.10	0.143	<0.01	0.068	<0.01
Cadmium	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	45.3	48	20	23	30	28
Chloride	15	15	24	24	26	25
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoride	0.94	0.9	1.3	1.3	0.85	0.9
Iron	1	0.038	<0.02	0.036	0.0445	0.021
Lead	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
Magnesium	14.3	14.8	6	6.2	9.6	7.9
Manganese	0.219	0.375	0.12	0.01	0.039	0.092
Mercury	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate and Nitrite as N	<1	0	<1	0	<1	0.7
pH, lab (standard units)	8.26	7.29	7.58	7.97	8.27	7.58
Potassium	4.85	4.75	2.58	2.74	2.48	2.29
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	31.4	26	30	68	29.9	32
Sulfate	72	60	50	110	57	58
Thallium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	280	244	180	183	260	283
Zinc	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Speciated Charge Balance (%)	10.6	21.0	4.52	8.84	3.40	8.46

All units mg/L unless otherwise noted

a – water quality analysis used in PHREEQC calculations

Table 2-8. Underground Discharge Water Quality Summary

Constituent	Mean	Maximum	Minimum	Number of Analyses	Nondetects
Bicarbonate	91	150	24	12	0
Aluminum	0.80	5.4	<0.045	12	7
Antimony	0.017	0.026	0.0052	12	0
Arsenic	0.069	0.30	0.006	12	0
Barium	0.054	0.24	0.024	12	0
Beryllium	0.001	0.0017	<0.001	12	9
Boron	0.14	0.38	<0.1	12	5
Cadmium	<0.001	<0.001	<0.001	12	12
Calcium	58	96	30	12	0
Chloride	23	53	7.9	12	0
Chromium	0.006	0.013	<0.005	12	11
Copper	0.055	0.098	<0.05	12	10
Fluoride	1.1	1.6	0.79	12	0
Iron	1.9	17	<0.01	12	2
Lead	<0.01	<0.01	<0.01	12	12
Magnesium	11	16	6.5	12	0
Manganese	0.40	1.5	<0.005	12	1
Mercury	0.0006	0.0017	<0.0001	12	3
Molybdenum	0.010	0.012	<0.01	8	7
Nickel	0.025	0.054	<0.01	12	6
Nitrate + Nitrite as N	1.4	1.7	<0.1	12	6
pH, lab (standard units)	8.3	9.71	6.58	12	0
Potassium	5.9	8.1	4.2	12	0
Selenium	0.0085	0.02	<0.005	12	8
Silver	0.010	0.062	<0.005	12	11
Sodium	30	39	24.00	12	0
Strontium	0.20	0.27	0.14	8	0
Sulfate	164	250	90.00	12	0
Thallium	0.0010	0.0015	<0.001	12	11
Total Dissolved Solids	375	480	240.00	12	0
Vanadium	0.015	0.021	<0.01	8	3
Zinc	0.10	0.35	<0.01	12	6
Conductivity (µS/cm)	594	657	562	4	0
Alkalinity, $CaCO_3$	88	130	40	12	0

All units mg/L unless otherwise noted

The waste rock types identified at the site and tested were andesite, quartzite and interbedded argillite/siltite (Section 2.1). Andesite is only encountered in the first 500 to 600 ft of the decline and does not make up a significant fraction of the mine wall rock or waste rock that will be backfilled in the mine (Walker 2003a). Humidity cell testing of the andesite waste rock also indicates that andesite will not be acid producing. Consequently, the humidity cell test results obtained with andesite were not included in the water quality evaluation. The waste rock and, by extension, the mine wall rock are expected to be 50% quartzite and 50% argillite/siltite (Walker 2003b).

ABA tests were carried out on 40 quartzite rock samples, five argillite rock samples and 15 siltite rock samples (Walker 2003b). The average acid-base potential (ABP) was -29.54 ton $CaCO_3$/kton for quartzite, -35.20 ton $CaCO_3$/kton for argillite and -60.05 ton $CaCO_3$/kton for siltite. Assuming the waste rock and mine wall rock will consist of 50% quartzite, 25% siltite and 25% argillite, the mean ABP is predicted to be -41.69 ton $CaCO_3$/kton.

Humidity cell tests were carried out on 14 quartzite samples and seven argillite/siltite samples representative of the mine waste rock (Walker 2003a, 2003b). The results of the humidity cell tests carried out with quartzite and argillite/siltite were used to predict the release of weathering products from the mine wall rock and waste rock by determining the release of constituents per unit surface area in the humidity cell tests and extrapolating to the predicted surface area of the mine wall rock and waste rock. The mean constituent releases were calculated separately for the quartzite and argillite/siltite samples for input into the geochemical modeling calculations. Constituents of potential concern at the site based on NDEP Profile I analysis of humidity cell effluents appear to be pH, aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, fluoride, iron, lead, manganese, nickel, selenium, sulfate, thallium and zinc.

Each humidity cell test was carried out using approximately 1.2 kg of waste rock crushed to achieve a particle size of less than 0.25 inch (0.635 cm). The solution volumes used to flush the waste rock were approximately 0.5 L per week. The tests were conducted for a maximum of 20 weeks.

The humidity cell test procedure greatly accelerates the weathering rates of mine wall rock and waste rock compared to rates anticipated under field conditions. For example, Walker (2003a) calculated that 1 week of humidity cell testing is equivalent to 110 years of exposure to air and water at the site. Because the mine walls and waste rock are likely to be exposed to air for a maximum of about 125 years (Section 2.3), it is assumed that the composited water sample collected during the first four weeks of the humidity cell tests would adequately represent potential releases of metals and acidity from the quartzite and argillite/siltite. Analyses of composited water samples collected from the quartzite and argillite/siltite humidity cell tests using during the first four weeks of testing are summarized in Table 2-9, with detailed results provided in Appendix A.

Table 2-9. Statistical Summary of Concentrations in First Four-Week Humidity Cell Composite Samples

Rock Type	Quartzite				Argillite/siltite			
Constituent	Mean	Maximum	Minimum	Median	Mean	Maximum	Minimum	Median
Aluminum	10.4	45.3	0.147	1.44	31.0	65.2	0.588	31.0
Antimony	0.002	0.006	<0.001	0.002	0.003	0.01	<0.001	0.002
Arsenic	0.054	0.14	0.010	0.033	0.17	0.66	<0.01	0.058
Barium	0.0388	0.127	0.0093	0.021	0.02	0.05	0.007	0.020
Beryllium	0.023	0.17	<0.002	0.002	0.06	0.27	0.007	0.017
Boron	0.046	0.101	<0.04	<0.04	0.062	0.13	<0.04	<0.04
Cadmium	0.0313	0.318	<0.002	0.005	0.12	0.31	0.003	0.070
Calcium	26.8	95.10	6.19	20.0	90.4	145	9.47	104
Chloride	1.08	1.57	0.620	1.000	1.16	1.41	0.570	1.24
Chromium	0.09	0.43	<0.006	0.0068	0.20	0.61	<0.006	0.157
Copper	0.44	1.64	0.010	0.297	2.48	7.66	0.188	1.66
Fluoride	1.14	3.50	0.19	0.56	3.45	8.15	<0.20	2.24
Iron	67.3	315	0.392	13.4	134	353	4.310	144
Lead	0.01	0.04	<0.005	0.006	0.02	0.05	0.007	0.014
Magnesium	10.4	65.2	0.766	5.98	30.5	56.9	1.730	31.6
Manganese	1.87	7.94	0.0262	0.887	1.64	2.93	0.787	1.41
Mercury	<0.002	<0.002	0.0013	<0.002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	0.74	3.27	0.066	0.410	2.59	5.25	0.469	2.60
Nitrate and Nitrite as N	0.07	0.11	0.030	0.060	0.11	0.33	0.040	0.080
pH (standard units)	3.96	5.44	2.810	3.775	3.28	4.12	2.66	3.12
Potassium	4.62	18.3	<1.0	4.45	13.90	41.70	1.00	4.20
Selenium	0.05	0.14	0.010	0.029	0.10	0.25	0.045	0.091
Silver	0.006	0.0139	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	3.80	7.44	1.95	3.29	8.25	12.2	2.34	9.59
Sulfate	331	1,130	39.8	206	886	1,530	301	1,010
Thallium	0.005	0.010	<0.001	0.004	0.009	0.019	0.003	0.009
Total Dissolved Solids	517	1,690	60.0	331	1,373	2,370	477	1,620
Zinc	2.74	17.5	0.074	0.289	8.74	30.8	0.152	5.47

All units mg/L unless otherwise noted

The release of constituents per unit surface area of the waste rock in the humidity cell tests was calculated using the surface area estimated from the grain size. Based on a grain size of 0.635 cm (0.25 inch), the estimated surface area is 6.54×10^{-3} m^2/cm^3 using the correlation provided by White and Peterson (1990) for freshly fractured materials. Assuming the crushed waste rock had a bulk density consistent with sand (1.60 g/cm^3), the specific surface area of the crushed waste rock used in the humidity cell tests is estimated to be 4.08 m^2/kg. Using the average volume of the first four flushes (approximately 2 L) and the average mass of waste rock in the humidity cells (approximately 1.2 kg) (Walker 2003a) with the gram formula weight of each constituent, the constituent concentrations in the humidity cell leachates (mg/L) can be converted to the mass released per m^2 of waste rock surface area:

Mean constituent release ($mole/m^2$) =

Mean constituent release (mg/L) × solution volume (L)/mass of waste rock (kg) ×

1 kg waste rock/4.08 m^2 ÷ gram formula weight (mg/mole)

The calculated constituent releases are summarized in Table 2-10.

Table 2-10. Mean Constituent Releases from First Four Week Composite Humidity Cell Samples

Constituent	Quartzite (µmoles/m^2)	Argillite/siltite (µmoles/m^2)
Aluminum	156.2	465.2
Antimony	0.007825	0.01142
Arsenic	0.2905	0.907
Barium	0.1141	0.06557
Beryllium	1.032	2.572
Boron	1.725	2.336
Cadmium	0.1124	0.4325
Calcium	270.1	913.7
Chloride	12.29	13.30
Chromium	0.7258	1.545
Copper	2.798	15.85
Fluoride	24.34	73.55
Iron	486.8	970.6
Lead	0.01713	0.04131
Magnesium	173.3	507.9
Manganese	13.78	12.12
Nickel	5.067	17.89
Nitrate and Nitrite (as N)	1.896	3.101
Potassium	47.77	144.1
Selenium	0.2325	0.5185
Sodium	66.73	145.5
Sulfate	1,393	3,738
Thallium	0.01059	0.01757
Zinc	16.95	54.20

3.0 GEOCHEMICAL MODELING CODE AND DATABASE

The PHREEQC geochemical modeling code (version 2.17, Parkhurst and Appelo 1999) was used for this investigation. The MINTEQ.v4 database distributed with the PHREEQC code (USGS 2010) was used because it is well-documented (EPA 1999) and includes aqueous speciation and solid phase solubility data for the potential constituents of concern (Table 3-1). Neither waste rock leachates from the humidity cell tests (Section 2.5) nor groundwater (Section 2.4) had significant concentrations of mercury or silver, so these NDEP Profile I constituents were not included in the modeling calculations.

Table 3-1. Potential Constituents of Concern Included in Modeling Calculations

Constituent	Sources
Aluminum	Waste rock, groundwater
Antimony	Waste rock, groundwater
Arsenic	Waste rock, groundwater
Barium	Waste rock, groundwater
Beryllium	Waste rock
Bicarbonate	Groundwater
Boron	Waste rock, groundwater
Cadmium	Waste rock
Calcium	Waste rock, groundwater
Chloride	Waste rock, groundwater
Chromium	Waste rock
Copper	Waste rock
Fluoride	Waste rock, groundwater
Iron	Waste rock, groundwater
Lead	Waste rock, groundwater
Magnesium	Waste rock, groundwater
Manganese	Waste rock, groundwater
Nickel	Waste rock
Nitrate	Waste rock, groundwater
pH	Waste rock, groundwater
Potassium	Waste rock, groundwater
Selenium	Waste rock
Sodium	Waste rock, groundwater
Sulfate	Waste rock, groundwater
Thallium	Waste rock
Zinc	Waste rock

The MINTEQ.v4 database does not include data for several potentially important solid phases, including hydrozincite [$Zn_5(OH)_6(CO_3)_2$(cr)], which could form as zinc is released by the waste rock. Log K_{sp} data reported for hydrozincite by Eary (1999) were included in the calculations

(Table 3-2). At high pH values that may be caused by dissolution of cementitious materials, the solid phases ettringite [$Ca_6Al_2(SO_4)_3(OH)_{12}•26H_2O(s)$], hydrogarnet [$Ca_3Al_2(OH)_{12}(s)$], Fe-hydrogarnet [$Ca_3Fe_2(OH)_{12}(s)$], tobermorite and monosulfate [$(CaO)_3Al_2O_3CaSO_4•12H_2O(s)$] may form in the hydrated cement paste or during cement leaching. The log K_{sp} values for these phases reported by Lothenbach and Winnefeld (2006) were included in the calculations (Table 3-2).

Table 3-2. Solubility Data Added to the MINTEQ.v4 Database

Phase	Reaction	Log K_{sp}	Source
Hydrozincite	$Zn_5(OH)_6(CO_3)_2(s) + 6\ H^+ =$ $5\ Zn^{2+} + 6\ H_2O + 2\ CO_3^{2-}$	-12.68	Eary (1999)
Ettringite	$Ca_6Al_2(SO_4)_3(OH)_{12}•26H_2O(s) =$ $6\ Ca^{2+} + 2\ Al(OH)_4^- + 3\ SO_4^{2-} + 4\ OH^- + 26\ H_2O$	-45.09	Lothenbach and Winnefeld (2006)
Hydrogarnet	$Ca_3Al_2(OH)_{12}(s) =$ $3\ Ca^{2+} + 2\ Al(OH)_4^- + 4\ OH^-$	-22.46	Lothenbach and Winnefeld (2006)
Fe-hydrogarnet	$Ca_3Fe_2(OH)_{12}(s) =$ $3\ Ca^{2+} + 2\ Fe(OH)_4^- + 4\ OH^-$	-26.78	Lothenbach and Winnefeld (2006)
Tobermorite	$(Ca(OH)_2)_2(SiO_2)_{2.4}•2H_2O(s) + 0.4\ H_2O =$ $2\ Ca^{2+} + 2.4\ H_3SiO_4^- + 1.6\ OH^-$	-18.2	Lothenbach and Winnefeld (2006)
Monosulfate	$(CaO)_3Al_2O_3CaSO_4•12H_2O(s) =$ $4\ Ca^{2+} + 2\ Al(OH)_4^- + SO_4^{2-} + 4\ OH^- + 6\ H_2O$	-27.7	Lothenbach and Winnefeld (2006)

For calculation of adsorption on precipitated ferrihydrite [$Fe(OH)_3(s)$], the default site densities of 0.005 mol/mol Fe and 0.2 mol/mol Fe reported by Dzombak and Morel (1990) for Type 1 and Type 2 sites, respectively, were used. A surface area of 600 m^2/g was assumed for the precipitated ferrihydrite (Dzombak and Morel 1990).

4.0 CONCEPTUAL MODEL

Prediction of the water quality in the underground mine workings requires the development of a realistic conceptual model. This conceptual model must include all important geochemical and hydrologic processes and features expected to significantly influence water quality. The important processes and features identified for predicting the Hollister Mine underground workings water are:

- Quality of inflowing groundwater
- Rates of groundwater inflow and outflow at steady state
- Amount of mixing within the mine and potential for segregation or stratification
- Leaching from exposed mine wall rock, waste rock backfill and cementitious materials
- Dissolution of nitrogen compounds remaining in the workings from blasting
- Chemical reactions, including precipitation of oversaturated minerals and sorption of minor constituents on iron oxyhydroxides

4.1 Hydrogeologic Data and Assumptions

The underground workings water quality is predicted for the fully developed mine after closure, when steady-state hydrologic conditions have been achieved. Based on the hydrologic modeling data, 99% of the final water level will be achieved in the Hollister Mine workings by the year 2130 (Section 2.3). Because the waste rock will be stabilized by emplacement of concrete every 6 ft, the waste rock and concrete will be in close contact. Because information on the distribution of the mine workings, waste rock and cement with depth was not available, it is assumed that the mine workings, waste rock and cement will be uniformly distributed over the depth of the workings. Because there is no information indicating that waste rock or cement will be stratified within the underground workings, it is assumed that the entire flooded underground workings can be approximated as a single, well-mixed system. It is also assumed that the rate of outflow of water from the workings during filling will be negligible.

The source of water to the mine after closure will be groundwater in the surrounding Vinini Formation that flows into the mine in response to the gradient created by the dewatered mine workings. The quality of the groundwater in the formation surrounding the mine workings is available from borehole water quality data (Table 2-7). These data show that groundwater will not be a significant source of beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium or zinc to water in the underground workings.

Aqueous speciation calculations carried out with the data in Table 2-7 resulted in positive charge balances for all borehole samples. Four of the six borehole water samples had charge balances that exceeded the generally acceptable limit of 5% (Table 2-7). Consequently, only the two samples with speciated charge balances of less than 5% (BH-02 10/1/2002 and BH-04 10/11/2002) were used to calculate underground workings water quality.

4.2 Leaching of Mine Wall Rock and Waste Rock

Because the mine wall rock and waste rock backfill will be exposed to air and humidity during mining, oxidation of sulfides in the mine wall rock and waste rock is expected to occur. As a consequence of sulfide mineral oxidation, the mine wall rock and waste rock backfill will be potential sources of acidity and dissolved constituents to the mine water. At the end of mining, the underground workings will flood, and weathering products will be released from the mine wall rock and waste rock to the inflowing groundwater. After the mine wall rock and waste rock are submerged, sulfide oxidation is expected to essentially cease because no atmospheric oxygen will be present and the concentrations of oxygen that can dissolve in water are relatively low. The dissolved oxygen in the mine water was accounted for in the calculations by equilibrating the mine water with atmospheric oxygen during groundwater mixing and reaction of the wall rock and waste rock.

The quantities of chemical constituents released from the humidity cell test results were calculated per unit surface area (μmoles/m^2) (Table 2-10). All calculations in PHREEQC were carried out on the basis of 1 kg of water (essentially 1 L). The total surface area of the mine wall rock and waste rock per liter of water in the underground workings was calculated to be 10,821 m^2/m^3, which is equivalent to 5.411 m^2/L each for quartzite and argillite/siltite (Section 2.2.4). The total amount of each constituent released by mine wall rock and waste rock leaching per liter of solution was calculated by multiplying the concentrations in Table 2-10 for each waste rock type by 5.411 m^2.

4.3 Cementitious Material Leaching

Cementitious materials in the underground workings will include the cement fraction of the concrete used to stabilize the waste rock backfill. These cementitious materials will interact with the mine water, leaching calcium hydroxide [$Ca(OH)_2$(s)], silica and other constituents, neutralizing acidity released by the oxidized mine wall rock and waste rock. The cementitious material in the concrete will be Portland Type II cement. The anhydrous phases in cement (Table 2-4) hydrate to form a variety of minerals. It was assumed that the hydrated phases tobermorite, portlandite, brucite, ettringite, Fe-hydrogarnet and hydrogarnet will be present in the cement, based on the composition in Table 2-4.

The cementitious material in the concrete is unlikely to undergo significant reaction or degradation until submerged in water. The hydrologic data (Section 2.3) indicate that 90% or more of the vertical extent of the Hollister Mine workings and Hatter Expansion workings will be submerged by the year 2060. The water levels in the workings will not reach 99% of the vertical extent until 2115 or later (Table 2-6). Consequently, it was assumed that a substantial majority of the cementitious materials in the mine will be submerged and subjected to leaching by the underground mine water for an extended time period.

Cement dissolution in low-sulfate solutions typically begins with leaching of free lime, followed by long-term dissolution of the calcium silicate minerals (Criscenti et al. 1996, Aviam et al. 2004). However, after the cementitious materials are submerged in the underground workings, reaction between the mine water and the cementitious materials is likely to be influenced by acidity and sulfate leached from the backfilled waste rock and mine wall rock (Attiogbe and Rizkalla 1988, Aviam et al. 2004, Planel et al. 2006, Schmidt et al. 2009). Sulfate created during sulfide oxidation can react with free lime in cement to form gypsum [$CaSO_4 \bullet 2H_2O(s)$]. The volume increase caused by gypsum formation results in cracking of the cement surface. The gypsum further reacts with calcium aluminate in the cement to form ettringite, causing additional volume changes and increased crack formation. Cracking in the cement provides a larger surface area for corrosion to occur, enhancing the degradation rate (Aviam et al. 2004, Planel et al. 2006).

Sulfate attack on cement in the flooded underground workings is expected to initiate cement cracking, increase reactivity, increase the release of calcium to the solution and increase the precipitation of sulfate. Consequently, increased cement degradation in the underground workings after closure is expected to decrease sulfate and TDS through gypsum precipitation and increase solution pH because of the reaction of alkalinity leached from the cement. Because of the length of time available for most cement to react with the mine water and because the sulfate in the mine water is likely to enhance cement leaching rates, it is assumed that the cement will be available to completely react with the underground workings water.

4.4 Sources of Nitrogen Compounds

Relatively low concentrations of nitrate, nitrite and ammonium are likely to remain in the mine wall rock and waste rock because of blasting residues. The majority of these residues will be removed from the underground workings by dewatering during operations. Nitrate plus nitrite-nitrogen concentrations in the underground drainage samples ranged from below detection to 1.7 mg/L (Table 2-8, Appendix A). Because the rock samples used in the humidity cell tests were obtained from cores and boreholes and were collected before exploratory mining began, they were not exposed to blasting residues before testing. Small concentrations of nitrate plus nitrite were released by the waste rock during humidity cell testing, which were used to calculate releases from the waste rock. The mean concentration in the underground discharge (1.4 mg/L) was added to the concentration calculated from waste rock leaching to achieve an estimated nitrate plus nitrate concentration in the underground workings that takes blasting residues into account.

4.5 Chemical Constituents and Reactions Included in Geochemical Model

The modeled constituents include pH and the major elements aluminum, calcium, chloride, iron, magnesium, manganese, nitrate (+ nitrite), potassium, sodium and sulfate. The following minor element metals and metalloids were included in the geochemical modeling calculations based on

reported concentrations in the humidity cell leachates (Walker 2003a): antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, fluoride, lead, nickel, selenium, thallium and zinc. Mercury and silver were included in the Profile I analyses of the humidity cell test leachates, but were not included in the modeling calculations because these constituents were present at non-detectable or very low concentrations in the humidity cell test leachates. Although silica was not included in the humidity cell leachate analyses, silica was included in the geochemical modeling calculations because weathering of both the waste rock and cementitious materials would be expected to release silica to the water in the underground workings. Borehole water quality data used to determine the composition of inflowing groundwater to the underground workings are summarized in Table 2-7. Based on these data, inorganic carbon was also included in the modeling calculations.

The possible sources and sinks of constituents to water in the underground workings are illustrated in Figure 4-1. The reactions of potential importance in the underground workings include oxidation of sulfide minerals, mainly pyrite, which will release metals and acidity to water in the underground workings. Acid neutralization reactions will also occur, including those associated with interaction of acidic water with the cementitious materials in the underground workings. Precipitation of secondary minerals will provide upper limits for the concentrations of a number of constituents released by leaching of the mine wall rock, waste rock and cementitious materials in the underground workings. Aqueous constituent concentrations may also be limited by sorption on iron oxides and hydroxides formed by pyrite oxidation.

The MINTEQ.v4 database contains solubility data for a very large number of solid phases. However, because of the slow precipitation kinetics of some phases, many of these phases may not precipitate from solution if oversaturated. The solid phases that might form in the underground workings (Table 4-1) were identified based on the reported likelihood of their formation in mining-affected aqueous systems (Nordstrom et al. 1990, Eary 1999, Nordstrom and Alpers 1999) and in other low-temperature systems affected by metals (Rai et al. 1987). Potential solubility controls were not identified for boron, chromium, nickel and selenium. Concentrations of these constituents may therefore be controlled by mass balance and possibly by adsorption on ferrihydrite. No likely solubility controls or adsorption data were identified for thallium. Consequently, thallium concentrations in the modeled underground workings water are controlled by mass balance. All modeling calculations were carried out assuming a temperature in the underground workings of 25°C.

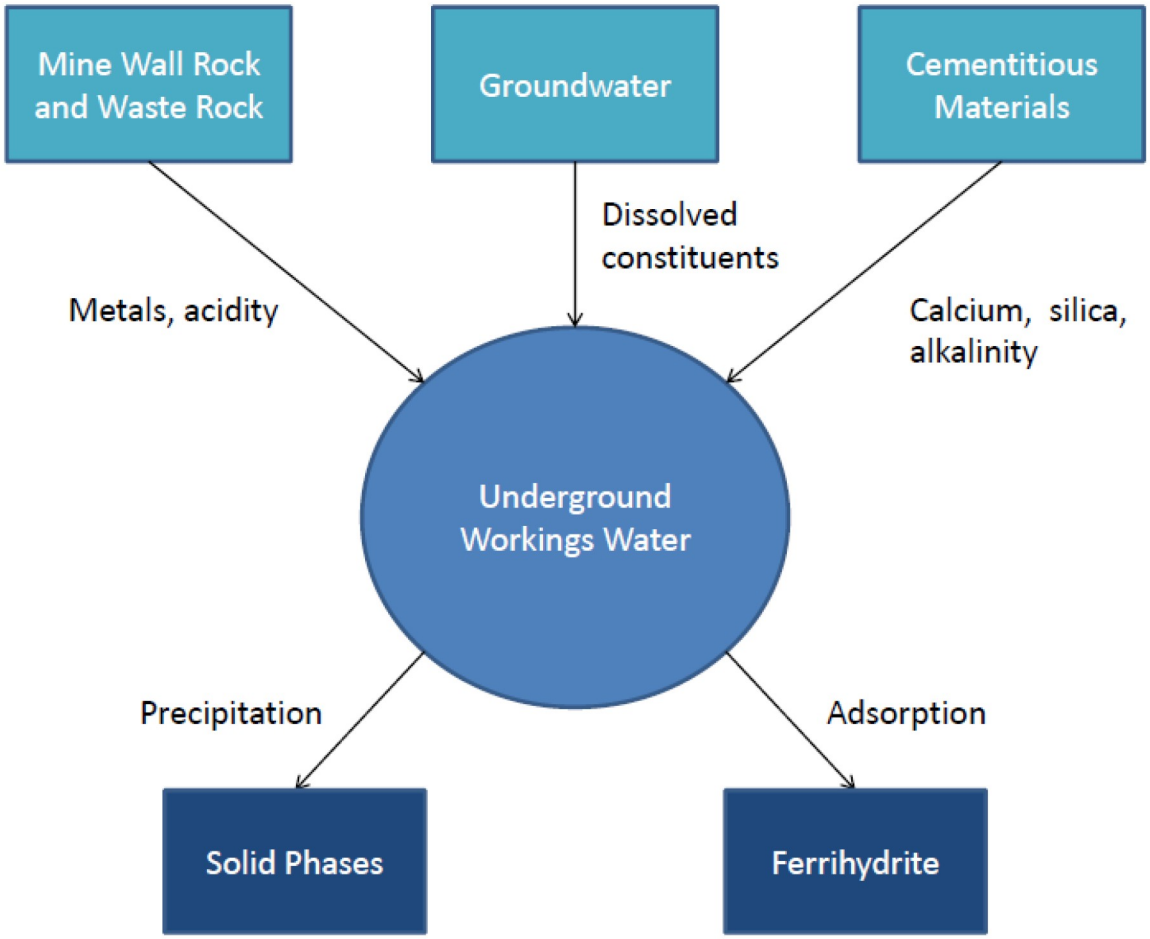

Figure 4-1. Potential Sources and Sinks of Constituents in Underground Workings Water

Table 4-1. Potential Secondary Mineral Phases

Mineral	Formula	Comments	Reference
Gypsum	$CaSO_4 \cdot 2H_2O(s)$	Sulfate concentrations greater than about 2,000 mg/L	Eary (1999), Nordstrom and Alpers (1999)
Calcite	$CaCO_3(s)$	Slightly oversaturated at pH > 7, used saturation index of 0.5	Eary (1999), Nordstrom and Alpers (1999)
Fluorite	$CaF_2(s)$	Fluoride concentrations greater than about 2 mg/L	Eary (1999), Nordstrom and Alpers (1999)
Chalcedony	$SiO_2(s)$	Low-temperature groundwater silica solubility control	Nordstrom et al. (1990)
Alunite	$KAl_3(SO_4)_2(OH)_6(s)$	Reasonable aluminum solubility control for pH < 6	Eary (1999), Nordstrom and Alpers (1999)
Basaluminite	$Al_4(OH)_{10}SO_4(s)$	Reasonable upper bound for aluminum, pH < 6	Eary (1999)
$Al(OH)_3(am)$	$Al(OH)_3(am)$	Reasonable upper bound for aluminum, pH > 6	Eary (1999), Nordstrom and Alpers (1999)
Kaolinite	$Al_2Si_2O_5(OH)_4(s)$	Solubility control for aluminum	Nordstrom and Alpers (1999)
Ferrihydrite	$Fe(OH)_3(s)$	Iron solubility control pH < 5	Eary (1999)
H-jarosite	$HFe_3(SO_4)_2(OH)_6(s)$	Possible iron solubility control	Nordstrom and Alpers (1999)
K-jarosite	$KFe_3(SO_4)_2(OH)_6(s)$	Possible iron solubility control	Nordstrom and Alpers (1999)
Manganite	γ-MnOOH(s)	Upper bound for manganese, pH < 6	Eary (1999), Nordstrom and Alpers (1999)
Birnessite	δ-$MnO_2(s)$	Manganese solubility control, pH < 6	Eary (1999)
Rhodochrosite	$MnCO_3(s)$	Upper bound for manganese, pH > 6	Eary (1999)
$Ba_3(AsO_4)_2(s)$	$Ba_3(AsO_4)_2(s)$	Possible arsenic solubility control in systems with barium ions	Rai et al. (1987)
Barite	$BaSO_4(s)$	Solubility control for barium	Eary (1999), Nordstrom and Alpers (1999)
$Be(OH)_2(am)$	$Be(OH)_2(am)$	Solubility control for beryllium by analogy with aluminum	Fishbein (1981)
Otavite	$CdCO_3(s)$	Solubility control for cadmium, pH 7.5 to 8.5	Eary (1999)
$Cd_4(OH)_6SO_4(s)$	$Cd_4(OH)_6SO_4(s)$	Upper bound for cadmium pH > 9	Eary (1999)
Tenorite	CuO	Solubility control for copper, pH > 7	Eary (1999)
Brochantite	$Cu_4(OH)_6SO_4(s)$	Solubility control pH > 7; upper bound for copper for pH < 7	Eary (1999)
Malachite	$Cu_2(OH)_2CO_3(s)$	Solubility control for copper in carbonate systems, pH > 7	Eary (1999)
Sepiolite	$Mg_2Si_3O_{7.5}OH \cdot 3H_2O$	Solubility control for magnesium	Nordstrom and Alpers (1990)
$Ni(OH)_2(s)$	Ni(OH)(s)	Upper bound for nickel at high pH	Peltier et al. (2006)
Larnakite	PbO:$PbSO_4(s)$	Solubility control for lead, pH > 7.5	Eary (1999)
Cerrusite	$PbCO_3(s)$	Upper bound for lead, pH > 6	Eary (1999)
Zincite	ZnO(s)	Solubility control for zinc, pH > 7.5	Eary (1999)
Hydrozincite	$Zn_5(OH)_6(CO_3)_2(s)$	Solubility control for zinc, pH from 4.5 to 7.5	Eary (1999)
Portlandite	$Ca(OH)_2(s)$	Forms at high pH during cement leaching	Criscenti et al. (1996)
Brucite	$Mg(OH)_2(s)$	Forms at high pH during cement leaching	Lothenbach and Winnefeld (2006)
Ettringite	$Ca_6Al_2(SO_4)_3(OH)_{12} \cdot 26H_2O(s)$	Forms at high pH during cement leaching	Lothenbach and Winnefeld (2006)
Monosulfate	$(CaO)_3Al_2O_3CaSO_4 \cdot 12H_2O(s)$	Forms at high pH during cement leaching	Criscenti et al. (1996)

5.0 GEOCHEMICAL MODELING RESULTS

The geochemical modeling calculations were performed using the following steps:

1. Mixing of two borehole water compositions (BH-02 10/1/2002 and BH-04 10/11/2002) in equal proportions to simulate the water quality of the inflowing groundwater
2. Leaching of constituents from the mine wall rock and waste rock and equilibration of the solution with atmospheric oxygen
3. Reaction of the solution with hydrated cement phases and chalcedony [SiO_2(s)], precipitation of solid phases and adsorption of constituents by ferrihydrite

The calculated surface area of the waste rock backfill is much larger than the surface area of the mine wall rock, so it is expected to dominate releases of constituents of potential concern to water in the underground workings. The surface area calculated for the waste rock backfill was approximated based on the particle size distribution and is a somewhat uncertain parameter. The sensitivity of the water quality calculation results to the mine wall rock plus waste rock reactive surface area was evaluated in a second set of calculations by increasing the surface area by a factor of 10, i.e., to 54.11 m^2/L each for quartzite and argillite/siltite.

The calculated changes in the amounts of solid phases for the two mine wall rock and waste rock reactive surface areas are provided in Table 5-1. The aqueous constituent concentrations are summarized in Table 5-2 and the concentrations of adsorbed species are provided in Table 5-3. The initial solid phase assemblage included chalcedony and the cementitious phases brucite, ettringite, Fe-hydrogarnet, hydrogarnet, portlandite and tobermorite. Reaction of the mine wall rock, waste rock and cementitious phases with the groundwater caused brucite, chalcedony, ettringite, Fe-hydrogarnet, hydrogarnet and portlandite to dissolve and $Ba_3(AsO_4)_2$(s), ferrihydrite, fluorite, gypsum, hydrozincite, kaolinite, sepiolite, tenorite and tobermorite to precipitate in the calculations with both surface areas. Precipitation of birnessite and calcite was observed in the calculation with the lower mine wall rock and waste rock surface area but not in the calculation with the higher surface area. The calculation carried out with the higher mine wall rock and waste rock surface area also resulted in the precipitation of manganite, $Ni(OH)_2$(s) and zincite.

For both sets of calculations, the pH of the solution was controlled by precipitation of tobermorite at pH 10.2 to 10.3 via the reaction:

$$(Ca(OH)_2)_2(SiO_2)_{2.4}\bullet 2H_2O(s) + 0.4\ H_2O = 2\ Ca^{2+} + 2.4\ H_3SiO_4^- + 1.6\ OH^- \qquad (5)$$

This pH exceeds the NDEP Profile I reference value. The redox conditions were relatively oxidizing in the calculation with the lower surface area, with slightly lower redox conditions predicted by the calculations with the higher surface area.

Table 5-1. Solid Phase Changes

Mine wall rock and waste rock surface area	5.411 m^2/L		54.11 m^2/L	
Phase	Initial	Final	Initial	Final
$Ba_3(AsO_4)_2(s)$	0.00	5.206×10^{-7}	0.00	3.441×10^{-6}
Birnessite	0.00	1.416×10^{-4}	0.00	0.00
Brucite	0.05844	0.00	0.05844	0.00
Calcite	0.00	9.852×10^{-4}	0.00	0.00
Chalcedony	10.00	9.090	10.00	9.240
Ettringite	0.008455	0.00	0.008455	0.00
Fe-Hydrogarnet	0.01839	0.00	0.01839	0.00
Ferrihydrite	0.00	0.04467	0.00	0.1156
Fluorite	0.00	2.419×10^{-4}	0.00	0.002615
Gypsum	0.00	0.03728	0.00	0.2801
Hydrogarnet	0.02797	0.00	0.02797	0.00
Hydrozincite	0.00	7.700×10^{-5}	0.00	5.819×10^{-4}
Kaolinite	0.00	0.03810	0.00	0.05324
Manganite	0.00	0.00	0.00	0.001403
$Ni(OH)_2(s)$	0.00	0.00	0.00	8.876×10^{-4}
Portlandite	0.4775	0.00	0.4775	0.00
Sepiolite	0.00	0.03122	0.00	0.04781
Tenorite	0.00	9.989×10^{-5}	0.00	0.001007
Tobermorite	0.1228	0.4306	0.1228	0.3349
Zincite	0.00	0.00	0.00	8.919×10^{-4}

All units moles/kg water

The alkaline pH of the solutions is consistent with the relatively large NP of the cement compared to the ABP of the waste rock. Multiplying the NP of 1,125 ton $CaCO_3$/kton cement by the mass of cement (9.130 kton) in the Hollister Mine yields a total NP of 10,269 ton $CaCO_3$. In comparison, the average ABP of the waste rock (-41.69 ton $CaCO_3$/kton) multiplied by the 72.7 kton mass of waste rock yields a total ABP of -3,032 ton $CaCO_3$. This ABP neglects the ABP in the mine wall rock, but the mine wall rock is expected to have relatively little effect because of the much greater surface area associated with the waste rock. Because the NP in the cement (10,269 ton $CaCO_3$) is more than a factor of three greater than the ABP in the waste rock (-3,032 ton $CaCO_3$), the alkalinity in the cement is more than sufficient to neutralize the acidity released by the waste rock and mine wall rock.

Table 5-2. Predicted Aqueous Concentrations

Mine wall rock and waste rock surface area	5.411 m^2/L	54.11 m^2/L	NDEP Profile I reference value
pH (standard units)	10.24	10.32	6.5 to 8.5
pe (dimensionless)	10.32	3.04	--
Aluminum	0.2164	0.2641	0.2
Antimony	0.02222	0.1381	0.006
Arsenic	5.477×10^{-7}	4.100×10^{-6}	0.01
Barium	0.001997	6.134×10^{-4}	2.0
Beryllium	0.002037	0.01684	0.004
Boron	0.3461	2.516	--
Total inorganic carbon (as CO_3^{2-})	1.491	5.111×10^{-9}	--
Cadmium	1.427×10^{-4}	0.001451	0.005
Calcium	638.6	548.8	--
Chloride	30.17	75.12	400
Chromium	0.2253	0.4303	0.1
Copper	2.685×10^{-4}	2.880×10^{-4}	1
Fluoride	1.964	2.367	4
Iron	4.929×10^{-4}	5.948×10^{-4}	0.6
Lead	9.402×10^{-7}	1.055×10^{-5}	0.015
Magnesium	0.004043	0.003428	150
Manganese	3.004×10^{-8}	6.367×10^{-4}	0.1
Nickel	0.02087	0.05370	0.1
Nitrate as N	1.782	5.241	10
Potassium	43.48	414.1	--
Selenium	0.3231	0.08062	0.05
Silica	68.80	80.27	--
Sodium	56.83	298.2	--
Sulfate	1,602	2,277	500
Thallium	0.03141	0.3158	0.002
Zinc	1.935×10^{-5}	0.05634	5
Total Dissolved Solids	2,473	3,736	1,000
Ionic Strength (moles/L)	0.04528	0.06398	--

All units mg/L unless otherwise noted
-- indicates no NDEP Profile I standard

Table 5-3. Surface Species

5.411 m^2/L			54.11 m^2/L		
Species	Mole Fraction	Molality	Species	Mole Fraction	Molality
Hfo_sONi+	0.479	1.079×10^{-4}	Hfo_sONi+	0.424	2.484×10^{-4}
Hfo_sOHCa+2	0.275	6.192×10^{-5}	Hfo_sOCrOH+	0.163	9.565×10^{-5}
Hfo_sO-	0.166	3.729×10^{-5}	Hfo_sOBe+	0.145	8.480×10^{-5}
Hfo_sOBe+	0.059	1.327×10^{-5}	Hfo_sOHCa+2	0.096	5.635×10^{-5}
Hfo_sOCd+	0.013	2.831×10^{-6}	Hfo_sOZn+	0.061	3.587×10^{-5}
Hfo_sOH	0.003	7.695×10^{-7}	Hfo_sO-	0.058	3.411×10^{-5}
Hfo_sOCu+	0.003	6.384×10^{-7}	Hfo_sOCd+	0.045	2.621×10^{-5}
Hfo_sOPb+	0.001	3.173×10^{-7}	Hfo_sOPb+	0.005	3.160×10^{-6}
Hfo_sOHSO4-2	0.001	1.352×10^{-7}	Hfo_sOH	0.001	7.023×10^{-7}
Hfo_sOHCrO4-2	0.000	6.843×10^{-8}	Hfo_sOCu+	0.001	5.817×10^{-7}
Hfo_sOHAsO4-3	0.000	4.796×10^{-8}	Hfo_sOHAsO4-3	0.000	1.784×10^{-7}
Hfo_sOZn+	0.000	1.527×10^{-8}	Hfo_sOHSO4-2	0.000	1.239×10^{-7}
Hfo_sOH2+	0.000	3.638×10^{-10}	Hfo_sOHSeO3-2	0.000	1.217×10^{-7}
Hfo_sOHBa+2	0.000	2.711×10^{-10}	Hfo_sOHCrO4-2	0.000	6.261×10^{-8}
Hfo_sOHSeO4-2	0.000	5.175×10^{-11}	Hfo_sOH2+	0.000	3.313×10^{-10}
Hfo_wOCa+	0.501	4.513×10^{-3}	Hfo_wOCa+	0.495	1.160×10^{-2}
Hfo_wO-	0.483	4.353×10^{-3}	Hfo_wO-	0.479	1.122×10^{-2}
Hfo_wOH	0.010	8.984×10^{-5}	Hfo_wOH	0.010	2.311×10^{-4}
Hfo_wONi+	0.002	1.7005×10^{-5}	Hfo_wOBe+	0.005	1.111×10^{-4}
Hfo_wOHSO4-2	0.002	1.579×10^{-5}	Hfo_wONi+	0.005	1.102×10^{-4}
Hfo_wOHCrO4-2	0.001	7.989×10^{-6}	Hfo_wOHAsO4-3	0.003	5.871×10^{-5}
Hfo_wOBe+	0.001	6.169×10^{-6}	Hfo_wOHSO4-2	0.002	4.077×10^{-5}
Hfo_wOHAsO4-3	0.001	5.559×10^{-6}	Hfo_wOHSeO3-2	0.002	4.003×10^{-5}
Hfo_wOMg+	0.000	8.786×10^{-7}	Hfo_wOHCrO4-2	0.001	2.060×10^{-5}
Hfo_wOCu+	0.000	3.823×10^{-7}	Hfo_wOZn+	0.001	1.236×10^{-5}
Hfo_wOCd+	0.000	1.410×10^{-7}	Hfo_wOCd+	0.000	3.678×10^{-6}
Hfo_wOH2+	0.000	4.247×10^{-8}	Hfo_wOMg+	0.000	2.258×10^{-6}
Hfo_wOHSeO4-2	0.000	6.041×10^{-9}	Hfo_wOCu+	0.000	9.815×10^{-7}
Hfo_wSO4-	0.000	3.743×10^{-9}	Hfo_wOH2+	0.000	1.090×10^{-7}
Hfo_wOZn+	0.000	1.866×10^{-9}	Hfo_wOPb+	0.000	4.645×10^{-8}
Hfo_wCrO4-	0.000	1.727×10^{-9}	Hfo_wSeO3-	0.000	3.210×10^{-8}
Hfo_wOPb+	0.000	1.655×10^{-9}	Hfo_wH2BO3	0.000	1.143×10^{-8}
Hfo_wH2BO3	0.000	7.036×10^{-10}	Hfo_wSO4-	0.000	9.648×10^{-9}
Hfo_wOBa+	0.000	2.855×10^{-10}	Hfo_wCrO4-	0.000	4.446×10^{-9}
Hfo_wSeO4-	0.000	1.247×10^{-12}	Hfo_wOBa+	0.000	2.885×10^{-10}
Hfo_wOHSbO(OH)4-	0.000	7.017×10^{-13}	Hfo_wOHSeO4-2	0.000	1.097×10^{-10}

Hfo_s species represent Type 1 surface site adsorption on ferrihydrite
Hfo_w species represent Type 2 surface site adsorption on ferrihydrite

The predicted aqueous concentrations are compared to the NDEP Profile I reference values in Table 5-2. For both reactive surface areas used in the modeling calculations, the concentrations of arsenic, barium, cadmium, chloride, copper, fluoride, iron, lead, magnesium, manganese, nickel, nitrate and zinc are less than the NDEP Profile I reference values. The predicted concentrations for both the lower and higher mine wall rock and waste rock surface areas exceed the Profile I reference values for aluminum, antimony, chromium, selenium, sulfate, thallium and total dissolved solids. The predicted beryllium concentration exceeds the Profile I reference value for the higher mine wall rock and waste rock surface area, but is below the reference value for the lower surface area.

In both calculations, gypsum precipitation limits sulfate concentrations, and chalcedony, fluorite, kaolinite, sepiolite and tobermorite precipitation control silica, fluoride, aluminum, magnesium and calcium concentrations, respectively. Barium and arsenic aqueous concentrations are controlled by precipitation of $Ba_3(AsO_4)_2(s)$ and copper concentrations are controlled by tenorite precipitation in calculations with both surface areas. Iron concentrations are controlled by the solubility of ferrihydrite, with manganese concentrations controlled by the solubility of birnessite in the lower surface area calculations and by manganite in the higher-surface-area calculations. Aqueous zinc concentrations are controlled by the solubility of hydrozincite in the lower surface area calculations, and by hydrozincite plus zincite in the higher surface area calculations. Total inorganic carbon is precipitated in calcite and hydrozincite in the lower surface area calculations and in hydrozincite in the higher surface area calculations.

The aqueous nickel concentration is controlled by $Ni(OH)_2(s)$ in the higher surface area calculations. There are no predicted solubility-controlling solids for nickel when the lower surface area is used in the calculations and the aqueous nickel concentration is controlled by adsorption.

No solubility-controlling solids are predicted to form based on the calculations carried out using either of the surface areas for antimony, beryllium, boron, cadmium, chloride, chromium, lead, nitrate, potassium, selenium, sodium and thallium. Beryllium, cadmium, chromium and lead concentrations are significantly reduced by adsorption. The selenium concentration is controlled by the quantity leached from the mine wall rock and waste rock for the lower-surface area calculation, but the selenium concentration is controlled by adsorption for the higher-surface-area calculation. Adsorption has no effect on antimony, boron, chloride, nitrate, potassium, sodium or thallium concentrations, which are mainly controlled by the quantities leached from the mine wall rock and waste rock. For the lower-surface-area calculations, antimony, boron, chloride and sodium concentrations are also significantly affected by the concentrations in the inflowing groundwater.

6.0 SUMMARY AND CONCLUSIONS

The water quality in the underground workings of the Hollister Mine and Hatter Expansion will be affected by: the chemical composition of the inflowing groundwater; leaching of metals, acidity and other constituents from oxidized mine wall rock and backfilled waste rock; leaching of alkalinity, calcium and silica from cement in concrete used to stabilize the waste rock backfill; and resulting mineral precipitation and adsorption reactions.

The neutralizing potential of cement in the backfill will exceed the acid-base potential of the mine wall rock and waste rock. Consequently, the pH of the underground workings water will be alkaline and controlled by the precipitation of tobermorite at approximately 10.2, which exceeds the NDEP Profile I reference value. Aqueous concentrations of arsenic, barium, cadmium, chloride, copper, fluoride, iron, lead, magnesium, manganese, nickel, nitrate and zinc are not predicted to exceed NDEP Profile I reference values. Concentrations of aluminum, antimony, chromium, selenium, sulfate, thallium and total dissolved solids are predicted to exceed NDEP Profile I reference values. Beryllium may also exceed its reference value, depending on the reactive surface area of the mine wall rock and waste rock.

Discharge of water from the underground workings directly to the surface will not occur at the Hollister Mine because pre-mining groundwater levels were at a lower elevation than the decline portal, and under any foreseeable conditions the water levels will not recover to a higher elevation. After closure, the underground workings will act as a groundwater sink (i.e., groundwater flow directions will be inward toward the dewatered underground workings) for greater than 200 years until the workings are completely filled and hydrologic conditions return to steady state. Downgradient flow of groundwater following the completed refilling of the underground mine workings is expected to be relatively slow because of the low hydraulic conductivity of the Vinini Formation. The effects of elevated constituent concentrations in the underground workings water on downgradient groundwater are expected to be reduced by the effects of dilution (dispersion) and chemical attenuation.

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APPENDIX A

UNDERGROUND DRAINAGE WATER QUALITY DATA AND WASTE ROCK HUMIDITY CELL DATA

Table A-1. Underground Drainage Water Quality

Date	2/21/2007	4/4/2007	8/14/2007	12/11/2007	3/6/2008	5/7/2008
Bicarbonate	24	71	85	85	88	88
Aluminum	<0.045	<0.045	1.6	<0.045	<0.045	<0.045
Antimony	0.010	0.016	0.014	0.0052	0.01	0.024
Arsenic	0.021	0.047	0.086	0.0060	0.026	0.065
Barium	0.029	0.026	0.087	0.049	0.029	0.024
Beryllium	<0.001	<0.001	0.0017	<0.001	<0.001	<0.001
Boron	<0.1	<0.1	<0.1	<0.1	<0.1	0.12
Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium	30	38	61	40	56	84
Chloride	29	7.9	53	16	41	17
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride	0.88	0.96	1.5	1.1	1.4	1.2
Iron	0.015	<0.01	2	0.02	0.22	<0.05
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	6.7	8.3	14	12	14	6.5
Manganese	<0.005	0.017	1.1	0.93	1.5	0.0076
Mercury	<0.0001	<0.0001	<0.0001	0.00012	0.00063	0.00024
Molybdenum	<0.01	<0.01	<0.01	<0.01	<0.01	0.012
Nickel	<0.01	<0.01	0.047	0.040	0.034	<0.01
Nitrate + Nitrite as N	<1	<0.1	<1	<1	<1	0.77
pH, lab (standard units)	9.44	9.11	7.30	7.03	7.09	9.71
Potassium	4.4	4.2	5.2	4.5	5.4	5.7
Selenium	<0.005	<0.01	<0.005	<0.005	<0.005	0.0088
Silver	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	24	24	30	26	32	32
Strontium	0.14	0.15	0.22	0.17	0.2	0.27
Sulfate	90	98	200	140	180	250
Thallium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	240	270	390	310	450	440
Vanadium	0.021	0.012	0.018	<0.01	<0.01	0.021
Zinc	<0.01	<0.01	0.35	0.16	0.11	<0.01
Conductivity (µS)	--[a]	--	--	--	580	562
Alkalinity, $CaCO_3$	40	74	70	70	72	76

All units mg/L unless otherwise noted
-- = not reported

Table A-1. Underground Drainage Water Quality (contd)

Date	8/22/2008	12/2/2008	1/14/2009	4/21/2009	8/25/2009	10/27/2009
Bicarbonate	120	140	150	110	80	45
Aluminum	1.9	<0.045	5.4	<0.045	0.12	0.27
Antimony	0.022	0.011	0.026	0.023	0.02	0.02
Arsenic	0.052	0.036	0.3	0.03	0.07	0.09
Barium	0.035	0.028	0.24	0.04	0.03	0.03
Beryllium	0.0013	<0.001	0.0015	<0.001	<0.001	<0.001
Boron	0.14	0.15	0.38	0.15	0.13	0.12
Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium	52	63	96	77	48	53
Chloride	17	12	27	17	19	19
Chromium	<0.005	<0.005	0.013	<0.005	<0.005	<0.005
Copper	0.061	<0.05	0.098	<0.05	<0.05	<0.05
Fluoride	1.2	0.79	1.2	1.6	0.84	0.92
Iron	2.9	0.47	17	0.09	0.09	0.09
Lead	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	12	9.7	15	16	9.9	9.9
Manganese	0.28	0.049	0.38	0.36	0.02	0.1
Mercury	0.00061	0.00087	0.00088	0.00071	0.0017	0.0013
Molybdenum	<0.01	<0.01	--[a]	--	--	--
Nickel	0.054	0.012	0.047	<0.01	<0.01	<0.01
Nitrate + Nitrite as N	1.7	<5.05	1.46	0.42	1.5	1.7
pH, lab (standard units)	8.75	8.37	8.71	6.58	8.73	9.11
Potassium	6.1	5.2	8.1	7.4	7.7	7
Selenium	0.0075	0.0055	0.02	<0.01	<0.01	<0.01
Silver	<0.005	<0.005	0.062	<0.005	<0.005	<0.005
Sodium	26	34	35	30	29	39
Strontium	0.18	0.26	--	--	--	--
Sulfate	160	160	210	210	120	150
Thallium	<0.001	<0.001	0.0015	<0.001	<0.001	<0.001
Total Dissolved Solids	370	480	480	400	320	350
Vanadium	<0.010	0.018	--	--	--	--
Zinc	0.24	0.027	0.3	<0.01	<0.01	<0.01
Conductivity (µS)	578	657	--	--	--	--
Alkalinity, $CaCO_3$	100	120	130	92	90	120

All units mg/L unless otherwise noted
-- = not reported

Table A-2. Concentrations in First Four Week Humidity Cell Composite Samples

	IH020 330-335' Quartzite	IH020 285-295' Quartzite	IH020 340-350' Quartzite	IH208 514-522.4' Quartzite	IH112 308-318' Quartzite	IH057 528-538' Quartzite	IH013 700-710' Quartzite
Alkalinity, CaCO3 (Acidity)	<1.0	338	<1.0	253	53.6	-300	957
CO3, CaCO3	<1.0	NA	<1.0	NA	NA	NA	NA
HCO3	<1.0	NA	<1.0	NA	NA	NA	NA
Aluminum	0.415	8.85	0.159	14.1	0.381	16.6	35.6
Antimony	0.002	<0.002	0.001	0.002	0.006	0.002	0.003
Arsenic	0.02	0.07	0.028	0.033	0.102	0.032	0.14
Barium	0.0192	0.0147	0.0203	0.013	0.0217	0.0114	0.0093
Beryllium	<0.002	<0.002	<0.002	0.0056	<0.002	0.0056	0.0061
Boron	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium	<0.002	0.0234	<0.002	0.0052	<0.002	0.024	0.318
Calcium	22.8	25.3	11.5	7.58	22.7	31.5	12.5
Chloride	0.73	<2.0	0.62	0.75	0.79	<1.0	1.34
Chromium	<0.006	0.18	<0.006	0.0807	<0.006	0.103	0.427
Copper	0.0104	0.161	0.0235	0.395	0.0272	0.651	1.52
Fluoride	0.38	<1.0	0.23	2.52	0.32	3.14	0.62
Iron	0.897	131	2.03	63.9	5.35	74	315
Lead	<0.005	0.0149	0.0056	0.0065	0.0075	0.0087	0.0352
Magnesium	6.83	6.49	3.32	1.44	5.72	10	7.36
Manganese	0.0262	1.79	0.545	0.8	0.521	0.456	4.33
Mercury	<0.002	<0.002	0.0013	<0.002	<0.002	<0.002	<0.002
Nickel	0.183	0.535	0.066	0.345	0.094	0.596	2.71
Nitrate and Nitrite as N	0.08	0.03	0.03	0.06	0.08	0.1	0.11
pH (standard units)	4.77	3.38	4.92	3.36	4.14	3.19	2.81
Potassium	5.5	4.6	4.5	1.6	4.4	<1.0	<1.0
Selenium	0.051	0.034	0.015	0.023	0.135	0.03	0.027
Silver	<0.005	0.0139	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	3.6	3.2	2.65	1.96	4.22	3.14	2.25
Sulfate	99.1	415	57.6	246	109	385	1,010
Thallium	0.003	<0.01	0.002	<0.001	<0.01	<0.01	<0.01
Total Dissolved Solids	159	676	89	400	163	611	1,630
Zinc	0.223	0.231	0.079	0.212	0.656	3.37	17.5
Sample weight (kg)	1.1943	1.1957	1.1871	1.1743	1.1852	1.1869	1.1964
Sample volume (L)	2.007	1.962	1.978	1.960	2.019	1.979	2.056

All units mg/L unless otherwise noted, NA = not analyzed

Table A-2. Concentrations in First Four Week Humidity Cell Composite Samples (contd)

Sample (units mg/L)	IH149 198-206' Quartzite	IH070 695-705' Quartzite	IH083 587-596' Quartzite	BH-02 665' Quartzite	BH-03 605' Quartzite	BH-04 610' Quartzite	Sample BH-06 400' Quartzite
Alkalinity, CaCO3 (Acidity)	(26.9)	(627)	(431)	92.9	<1.0	81.4	3.9
CO3, CaCO3	NA	NA	NA	NA	<1.0	NA	<1.0
HCO3	NA	NA	NA	NA	<1.0	NA	3.9
Aluminum	0.386	45.3	20.4	1.46	0.147	0.806	1.42
Antimony	<0.001	<0.002	0.003	<0.001	<0.001	<0.001	0.006
Arsenic	<0.01	0.13	0.049	0.019	<0.01	<0.01	0.101
Barium	0.105	0.0439	0.0117	0.0241	0.0976	0.0237	0.127
Beryllium	<0.002	0.117	<0.002	0.17	<0.002	<0.002	<0.002
Boron	<0.04	<0.04	<0.04	0.043	0.062	<0.04	0.101
Cadmium	<0.002	0.0326	0.011	0.0061	<0.002	0.0049	0.0023
Calcium	7.22	95.1	6.19	69.2	17.2	30.6	15.6
Chloride	0.84	1.22	1.24	1.05	1	1.57	0.94
Chromium	0.0075	0.216	0.251	<0.006	<0.006	<0.006	<0.006
Copper	0.337	1.64	0.456	0.639	0.0299	0.256	0.0122
Fluoride	0.19	1.13	1.88	0.5	0.3	0.31	3.5
Iron	3.75	162	156	12.4	0.667	14.3	0.392
Lead	<0.005	<0.005	<0.005	0.0081	<0.005	0.0064	<0.005
Magnesium	0.766	65.2	1.3	22.1	4.75	6.24	4.46
Manganese	0.973	1.15	1.12	5.73	0.575	7.94	0.261
Mercury	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nickel	0.076	3.27	0.685	0.798	0.329	0.475	0.142
Nitrate and Nitrite as N	0.05	0.08	0.05	0.05	0.05	0.06	0.09
pH (standard units)	4.42	3.14	3.21	3.68	5.13	3.87	5.44
Potassium	<1.0	<1.0	<1.0	18.3	5.9	5	9.9
Selenium	<0.01	0.111	0.085	0.051	0.021	0.021	0.022
Silver	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	2.16	4.36	1.95	7.44	5.57	3.38	7.26
Sulfate	39.8	1,130	443	354	84.8	166	94.8
Thallium	0.002	<0.005	0.01	0.004	0.002	0.002	0.004
Total Dissolved Solids	60	1,690	676	545	122	262	154
Zinc	0.0738	13.7	0.132	1.26	0.213	0.347	0.377
Sample weight (kg)	1.1754	1.1917	1.162	1.181	1.2219	1.2341	1.1979
Sample volume (L)	1.904	1.903	1.893	1.981	1.962	2.016	1.921

All units mg/L unless otherwise noted, NA = not analyzed

Table A-2. Concentrations in First Four Week Humidity Cell Composite Samples (contd)

	IH208 530' Argillite	IH059 641' Argillite	IH013 690-700' Siltite	IH083 596-605' Siltite	BH-01 745' Siltite	BH-02 650' Siltite	BH05 510' Siltite
Acidity	678	901	654	(804)	53.2	152	(117)
Aluminum	55.2	50.6	31	65.2	0.588	4.04	10.1
Antimony	0.002	0.002	0.014	0.002	0.001	0.002	<0.001
Arsenic	0.058	0.225	0.66	0.168	<0.01	0.023	0.03
Barium	0.0101	0.0068	0.0082	0.033	0.0197	0.0246	0.0531
Beryllium	0.0166	0.0469	0.0065	0.0112	0.0161	0.268	0.0349
Boron	<0.04	<0.04	<0.04	0.083	<0.04	0.061	0.132
Cadmium	0.248	0.0703	0.165	0.308	0.003	0.0299	0.0153
Calcium	91.6	145	9.47	104	59.4	117	106
Chloride	1.24	1.35	1.06	1.41	1.12	0.57	1.39
Chromium	0.157	0.401	0.61	0.2	<0.006	<0.006	0.007
Copper	1.57	7.66	1.66	2.72	0.188	2.75	0.84
Fluoride	6.21	2.24	<0.50	8.15	<0.20	0.91	5.92
Iron	144	206	353	189	4.31	27	12.7
Lead	0.039	0.0118	0.0144	0.0076	0.0208	0.0071	0.0471
Magnesium	34.6	56.9	1.73	31.6	22.1	36.4	29.9
Manganese	0.963	1.41	1.59	0.787	2.56	2.93	1.26
Mercury	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	3.04	5.25	3.69	2.6	0.469	1.43	1.66
Nitrate and Nitrite as N	0.12	0.08	0.08	0.33	0.05	0.04	0.05
pH (standard units)	3.12	2.66	2.7	3.03	4.12	3.5	3.85
Potassium	2.2	2.5	1.0	4.2	20.6	25.1	41.7
Selenium	0.061	0.247	0.107	0.052	0.045	0.091	0.104
Silver	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sodium	5.76	9.59	2.34	10.3	7.66	9.92	12.2
Sulfate	1,010	1,530	1,030	1,160	301	599	570
Thallium	<0.01	<0.01	0.019	0.009	0.003	0.004	0.007
Total Dissolved Solids	1,620	2,370	1,660	1,750	477	922	814
Zinc	10	30.8	5.47	6.58	0.152	4.68	3.5
Sample weight (kg)	1.1835	1.1882	1.1866	1.1872	1.2026	1.2076	1.1933
Sample volume (L)	2.013	2.021	1.995	1.952	1.976	2.003	1.863

All units mg/L unless otherwise noted

APPENDIX B

GEOCHEMICAL MODELING CALCULATIONS

The geochemical modeling calculations are described in detail, including the input file data, constituent concentrations after each modeling step and final results. In addition, example calculations are provided for a conservative constituent that is not adsorbed or precipitated, a constituent with a concentration affected by precipitation and a constituent that is adsorbed but not precipitated. Additional information is also provided for the calculation of the nitrogen (nitrate plus nitrate) concentration.

B.1 Details of Geochemical Modeling Calculations

The first step in the geochemical modeling calculations was to estimate the water quality of the inflowing Vinini Formation groundwater. This was accomplished by using PHREEQC to mix equal amounts of the two groundwater compositions with adequately small charge balances of less than 5% (BH-02 10/1/2002 and BH-04 10/11/2002, Table 2-7). The compositions listed in Table B-1 were calculated using PHREEQC from the data in Table 2-7 using the gram formula weight (mg/mole) for the various species and the mass of water in the mixture (1 kg). The groundwater composition in the final column of Table B-1 was saved in the PHREEQC calculations for use in the subsequent calculation step.

The next step in the PHREEQC calculations was to simulate the changes that will occur as groundwater enters the underground workings, flushes oxidation products from the wall rock and waste rock and equilibrates with atmospheric oxygen. The oxygen concentration in the airspace in the underground workings was assumed to be 0.20 atm. The amount of oxidation products flushed from the humidity cell tests in the first 4-week composite sample are provided in units of mg/L (Walker 2003a). This concentration was converted to moles of each constituent per unit surface area of waste rock in the test using the expression:

Mean constituent release (mole/m^2) =
Mean constituent release (mg/L) × solution volume (L)/mass of waste rock (kg) ×
1 kg waste rock/4.08 m^2 ÷ gram formula weight (mg/mole)

The solution volumes and waste rock masses used in the humidity cell tests are provided in Table B-2. The mean solution volume divided by the mean mass of waste rock for the quartzite and argillite/siltite tests were 1.651 L/kg and 1.656 L/kg, respectively. The 4.08 m^2/kg surface area of the waste rock in the humidity cell tests was determined from the grain size, as described in Section 2.5.

Table B-1. Vinini Formation Borehole Water Quality and Calculated Average Water Quality

Borehole	BH-02	BH-04	Calculated Vinini Formation Water Quality
Date	10/1/2002	10/11/2002	
Bicarbonate	8.851×10^{-4}	1.443×10^{-3}	1.164×10^{-3}
Aluminum	b.d.	3.670×10^{-6}	1.835×10^{-6}
Antimony	1.536×10^{-7}	b.d.	7.681×10^{-8}
Arsenic	1.148×10^{-7}	2.069×10^{-7}	1.609×10^{-7}
Barium	9.759×10^{-7}	2.331×10^{-7}	6.045×10^{-7}
Beryllium	b.d.	b.d.	0.00
Boron	1.323×10^{-5}	6.292×10^{-6}	9.761×10^{-6}
Cadmium	b.d.	b.d.	0.00
Calcium	4.991×10^{-4}	7.487×10^{-4}	6.239×10^{-4}
Chloride	6.771×10^{-4}	7.335×10^{-4}	7.053×10^{-4}
Chromium	b.d.	b.d.	0.00
Copper	b.d.	b.d.	0.00
Fluoride	6.844×10^{-5}	4.475×10^{-5}	5.660×10^{-5}
Iron	b.d.	7.970×10^{-7}	3.985×10^{-7}
Lead	b.d.	b.d.	0.00
Magnesium	2.469×10^{-4}	3.951×10^{-4}	3.210×10^{-4}
Manganese	2.185×10^{-6}	7.101×10^{-7}	1.447×10^{-6}
Mercury	b.d.	b.d.	0.00
Nickel	b.d.	b.d.	0.00
Nitrate and Nitrite as N	b.d.	b.d.	0.00
pH, lab (standard units)	7.58	8.27	7.96
Potassium	6.600×10^{-5}	6.345×10^{-5}	6.472×10^{-5}
Selenium	b.d.	b.d.	0.00
Silver	b.d.	b.d.	0.00
Sodium	1.305×10^{-3}	1.301×10^{-3}	1.303×10^{-3}
Sulfate	5.206×10^{-4}	5.935×10^{-4}	5.570×10^{-4}
Thallium	b.d.	b.d.	0.00
Zinc	b.d.	b.d.	0.00
Speciated Charge Balance (%)	4.52	3.40	3.89

All units moles/kg water (molality) unless otherwise specified
b.d. = below detection

Table B-2. Calculation of Solid Masses and Solution Volumes Used in First 4 Week Composite Samples for Humidity Cell Tests With Quartzite and Argillite/Siltite

Quartzite			Argillite/Siltite		
Sample ID	Sample Mass (kg)	Cumulative Sample Volume (L)	Sample ID	Sample Mass (kg)	Cumulative Sample Volume (L)
IH020 330-335	1.1943	2.007	IH208 (530')	1.1835	2.013
IH020 285-295	1.1957	1.962	IH059 (641')	1.1882	2.021
IH020 340-350	1.1871	1.978	IH013 690-700	1.1866	1.995
IH208 514-522.4	1.1743	1.960	IH083 596-605	1.1872	1.952
IH112 308-318	1.1852	2.019	BH-01 (745')	1.2026	1.976
IH057 528-538	1.1869	1.979	BH-02 (650')	1.2076	2.003
IH013 700-710	1.1964	2.056	BH05 (510')	1.1933	1.863
IH149 198-206	1.1754	1.904	--	--	--
IH070 695-705	1.1917	1.903	--	--	--
IH083 587-596	1.162	1.893	--	--	--
BH-02 (665')	1.181	1.981	--	--	--
BH-03 (605')	1.2219	1.962	--	--	--
BH-04 (610')	1.2341	2.016	--	--	--
Sample BH-06 (400')	1.1979	1.921	--	--	--
Mean	1.1917	1.967	Mean	1.1927	1.975

The calculations used to derive the constituent release in mole/m^2 are summarized in Tables B-3 and B-4. The mean concentration in mg/L was converted to moles/L by dividing by the gram formula weight. The mean release per kilogram was calculated by multiplying by the mean solution volume divided by the mean mass of rock in the humidity cell tests. This value was converted to units of μmoles/m^2 by dividing by the calculated surface area per kg of the rock in the humidity cell tests (4.08 m^2/kg, Section 2.5) and multiplying by 10^6 μmoles/mole. The values in the final columns of Tables B-3 and B-4, multiplied by the surface area per liter of water for each rock type (either 5.411 m^2 or 54.11 m^2), were added to the inflowing groundwater composition as reactant phases in the PHREEQC calculations.

Table B-3. Constituent Release Calculations Using Quartzite Humidity Cell Test Data

Constituent	Mean Concentration (mg/L)	Formula weight (mg/mole)	Mean Concentration (mole/L)	Mean Release (mole/kg)	Mean Release (μmoles/m^2)
Aluminum	10.43	26,981.5	3.866×10^{-4}	6.382×10^{-4}	156.2
Antimony	0.002357	121,750	1.936×10^{-8}	3.196×10^{-8}	0.007825
Arsenic	0.05386	74,921.6	7.188×10^{-7}	1.187×10^{-6}	0.2905
Barium	0.03876	137,340	2.822×10^{-7}	4.659×10^{-7}	0.1141
Beryllium	0.02302	9,012.2	2.554×10^{-6}	4.217×10^{-6}	1.032
Boron	0.04614	10,811	4.268×10^{-6}	7.046×10^{-6}	1.725
Cadmium	0.03125	112,400	2.780×10^{-7}	4.590×10^{-7}	0.1124
Calcium	26.79	40,085	6.682×10^{-4}	1.103×10^{-3}	270.1
Chloride	1.078	35,453	3.040×10^{-5}	5.019×10^{-5}	12.29
Chromium	0.09337	51,996	1.796×10^{-6}	2.965×10^{-6}	0.7258
Copper	0.4399	63,540	6.923×10^{-6}	1.143×10^{-5}	2.798
Fluoride	1.144	18,998.4	6.023×10^{-5}	9.943×10^{-5}	24.34
Iron	67.26	55,847	1.204×10^{-3}	1.988×10^{-3}	486.8
Lead	0.008779	207,190	4.237×10^{-8}	6.995×10^{-8}	0.01713
Magnesium	10.43	24,312	4.289×10^{-4}	7.080×10^{-4}	173.3
Manganese	1.873	54,938	3.409×10^{-5}	5.627×10^{-5}	13.78
Mercury	<0.002	200,590	--	--	--
Nickel	0.7360	58,710	1.254×10^{-5}	2.070×10^{-5}	5.067
Nitrate and Nitrite as N	0.06571	14,006.7	4.692×10^{-6}	7.745×10^{-6}	1.896
pH, standard units	3.961	--	--	--	--
Potassium	4.621	39,102	1.182×10^{-4}	1.951×10^{-4}	47.77
Selenium	0.0454	78,960	5.753×10^{-7}	9.498×10^{-7}	0.2325
Silver	0.00564	107,870	--	--	--
Sodium	3.796	22,989.8	1.651×10^{-4}	2.726×10^{-4}	66.73
Sulfate	331.0	96,061.6	3.446×10^{-3}	5.689×10^{-3}	1,393
Thallium	0.005357	204,370	2.621×10^{-8}	4.327×10^{-8}	0.01059
Total Dissolved Solids	516.9	--	--	--	--
Zinc	2.741	65,370	4.193×10^{-5}	6.922×10^{-5}	16.95

Table B-4. Constituent Release Calculations Using Argillite/Siltite Humidity Cell Test Data

Constituent	Mean Concentration (mg/L)	Formula weight (mg/mole)	Mean Concentration (mole/L)	Mean Release (mole/kg)	Mean Release (μmoles/m^2)
Aluminum	30.96	26,981.5	1.147×10^{-3}	1.900×10^{-3}	465.2
Antimony	0.003429	121,750	2.816×10^{-8}	4.663×10^{-8}	0.01142
Arsenic	0.1677	74,921.6	2.239×10^{-6}	3.706×10^{-6}	0.907
Barium	0.02221	137,340	1.617×10^{-7}	2.678×10^{-7}	0.06557
Beryllium	0.05717	9,012.2	6.344×10^{-6}	1.050×10^{-5}	2.572
Boron	0.06229	10,811	5.761×10^{-6}	9.539×10^{-6}	2.336
Cadmium	0.1199	112,400	1.067×10^{-6}	1.767×10^{-6}	0.4325
Calcium	90.35	40,085	2.254×10^{-3}	3.732×10^{-3}	913.7
Chloride	1.163	35,453	3.280×10^{-5}	5.431×10^{-5}	13.30
Chromium	0.1981	51,996	3.811×10^{-6}	6.310×10^{-6}	1.545
Copper	2.484	63,540	3.909×10^{-5}	6.473×10^{-5}	15.85
Fluoride	3.447	18,998.4	1.814×10^{-4}	3.004×10^{-4}	73.55
Iron	133.7	55,847	2.394×10^{-3}	3.964×10^{-3}	970.6
Lead	0.02111	207,190	1.019×10^{-7}	1.687×10^{-7}	0.04131
Magnesium	30.46	24,312	1.253×10^{-3}	2.075×10^{-3}	507.9
Manganese	1.643	54,938	2.990×10^{-5}	4.951×10^{-5}	12.12
Mercury	<0.0002	200,590	--	--	--
Nickel	2.591	58,710	4.414×10^{-5}	7.308×10^{-5}	17.89
Nitrate and Nitrite as N	0.1071	14,006.7	7.649×10^{-6}	1.267×10^{-5}	3.101
pH, standard units	3.283	--	--	--	--
Potassium	13.90	39,102	3.555×10^{-4}	5.886×10^{-4}	144.1
Selenium	0.1010	78,960	1.279×10^{-6}	2.118×10^{-6}	0.5185
Silver	<0.005	107,870	--	--	--
Sodium	8.253	22,989.8	3.590×10^{-4}	5.944×10^{-4}	145.5
Sulfate	885.7	96,061.6	9.220×10^{-3}	1.527×10^{-2}	3,738
Thallium	0.008857	204,370	4.334×10^{-8}	7.176×10^{-8}	0.01757
Total Dissolved Solids	1,373	--	--	--	--
Zinc	8.740	65,370	1.337×10^{-4}	2.214×10^{-4}	54.20

The underground workings water quality results obtained using PHREEQC after adding the oxidation products released from the wall rock and waste rock and equilibration with atmospheric oxygen are summarized in Table B-5. This solution was saved in the PHREEQC calculations for use in subsequent modeling of the interaction of the water with cement phases. The results summarized in Table B-5 are not representative of the constituent concentrations that would be observed in the underground workings in the absence of cement phases because some phases, such as H-jarosite and barite, were oversaturated in these solutions but were not allowed to precipitate in this calculation step.

The final step in the PHREEQC calculations was equilibration of the underground workings water with the cementitious phases in the concrete, precipitation of oversaturated solid phases that could form under the low temperature conditions in the underground workings and adsorption of constituents on precipitated ferrihydrite.

The total amount of cement in the underground workings was calculated based on a cement volume of 125,000 ft^3 (3,540 m^3), which is 25% of the total concrete volume. The cement density will be 146.1 lb/ft^3 (2,340 kg/m^3), resulting in a total mass of cement of 18,260,179 lbs (8,282,679 kg). The oxide composition of the Portland Type II cement (Table 2-4) is converted to its elemental composition in Table B-6.

The quantities of hydrated cementitious phases in the concrete used in the PHREEQC calculations were calculated from the elemental composition (Table B-6) based on the following data and assumptions:

- The hydrated phases in the cement will be ettringite, hydrogarnet, Fe-hydrogarnet, tobermorite, brucite and portlandite (Table B-7)
- All sulfate in the cement will be contained in ettringite
- All aluminum in the cement that is not in ettringite will be present in the hydrogarnet
- All iron in the cement will be present in Fe-hydrogarnet
- All silica in the cement will be present in tobermorite
- All magnesium in the cement will be present in brucite
- The calcium in the cement in excess of the amount in ettringite, hydrogarnet and Fe-hydrogarnet will be present in portlandite

All calculations in PHREEQC are carried out on the basis of 1 kg of water, which is essentially equal to 1 liter of solution at the conditions of the calculations, i.e., 25°C and low ionic strength. The amounts of each hydrated cement phase in the final column of Table B-7 were calculated by dividing the total moles by the total volume of solution (101,949,448 L) and were added to the solution compositions listed in Table B-5 in the final step of the PHREEQC calculations.

Table B-5. Solution Composition after Release of Constituents from Wall Rock and Waste Rock and Equilibration with Atmospheric Oxygen

Surface Area per kg Water	5.411 m^2	54.11 m^2
Constituent	Concentration (moles/kg water)	Concentration (moles/kg water)
Aluminum	3.364×10^{-3}	0.03366
Antimony	1.810×10^{-7}	1.119×10^{-6}
Arsenic	6.641×10^{-6}	6.502×10^{-5}
Barium	1.577×10^{-6}	1.034×10^{-5}
Beryllium	1.950×10^{-5}	1.952×10^{-4}
Boron	3.174×10^{-5}	2.297×10^{-4}
Cadmium	2.949×10^{-6}	2.951×10^{-5}
Calcium	7.030×10^{-3}	0.06474
Carbon, total inorganic	1.164×10^{-3}	1.165×10^{-3}
Chloride	8.438×10^{-4}	2.092×10^{-3}
Chromium	1.229×10^{-5}	1.230×10^{-4}
Copper	1.009×10^{-4}	1.010×10^{-3}
Fluoride	5.863×10^{-4}	5.359×10^{-3}
Iron	7.887×10^{-3}	0.07894
Lead	3.163×10^{-7}	3.166×10^{-6}
Magnesium	4.007×10^{-3}	0.03722
Manganese	1.416×10^{-4}	1.404×10^{-3}
Nickel	1.242×10^{-4}	1.243×10^{-3}
Nitrate and Nitrite as N	2.704×10^{-5}	2.707×10^{-4}
pe	17.582	18.519
pH, standard units	3.015	2.079
Potassium	1.103×10^{-3}	0.01046
Selenium	4.064×10^{-6}	4.068×10^{-5}
Sodium	2.452×10^{-3}	0.01280
Sulfate	0.02832	0.2785
Thallium	1.524×10^{-7}	1.525×10^{-6}
Zinc	3.850×10^{-4}	3.854×10^{-3}

Table B-6. Total Moles of Cement Constituents in 8,282,679 kg of Portland Type II Cement

Chemical Formula	Percent by Weight	Total (moles)	Calcium (moles)	Silica (moles)	Aluminum (moles)	Iron (moles)	Magnesium (moles)	Sulfate (moles)
$3CaO•SiO_2$	51	18,500,835	55,502,504	18,500,835	0.00	0.00	0.00	0.00
$2CaO•SiO_2$	24	11,540,881	23,081,762	11,540,881	0.00	0.00	0.00	0.00
$3CaO•Al_2O_3$	6	1,839,237	5,517,711	0.00	3,678,474	0.00	0.00	0.00
$4CaO•Al_2O_3•Fe_2O_3$	11	1,874,792	7,499,169	0.00	3,749,584	3,749,584	0.00	0.00
MgO	2.9	5,958,555	0.00	0.00	0.00	0.00	5,958,555	0.00
SO_3	2.5	2,586,326	0.00	0.00	0.00	0.00	0.00	2,586,326
CaO	1	1,476,956	1,476,956	0.00	0.00	0.00	0.00	0.00
Total	98.4	--	93,078,101	30,041,716	7,428,058	3,749,584	0.00	0.00

Table B-7. Calculation of Hydrated Cement Phases

Minerals	Formula	Proportions	Total Amount of Phase in Underground Workings (moles)	Total Amount of Phase per Liter Underground Workings Water (mole/L)
Ettringite	$Ca_6Al_2(SO_4)_3(OH)_{12}•26H_2O(s)$	1 mole ettringite per 3 moles sulfate	862,109	0.008455
Hydrogarnet	$Ca_3Al_2(OH)_{12}(s)$	1 moles hydrogarnet per 2 moles aluminum	2,851,920	0.02797
Fe-hydrogarnet	$Ca_3Fe_2(OH)_{12}(s)$	1 mole Fe-hydrogarnet per 2 moles iron	1,874,792	0.01839
Tobermorite	$(Ca(OH)_2)_2(SiO_2)_{2.4}(H_2O)(s)$	1 mole tobermorite per 2.4 mole silica	12,517,382	0.1228
Brucite	$Mg(OH)_2(s)$	1 mole brucite per mole magnesium	5,958,555	0.05844
Portlandite	$Ca(OH)_2(s)$	1 mole portlandite per mole calcium	48,690,548	0.4775

The final results of the PHREEQC calculations after reaction of the underground workings water with the hydrated cement phases, precipitation of solid phases and adsorption on precipitated ferrihydrite are summarized in Tables 5-1 through 5-3.

B.2 Example Calculations

The PHREEQC calculations are illustrated using chloride as an example of a conservative constituent, fluoride as an example of a constituent with a final solution concentration controlled by precipitation of a solid phase and beryllium as an example of a constituent with a final solution concentration controlled by adsorption. The calculation of the total nitrogen concentration is also explained in detail, because this calculation differed from those carried out for other constituents because of the potential effects of blasting residues on nitrogen concentrations.

B.2.1 Conservative Constituent Example

Because it is not precipitated as a solid phase or significantly sorbed by ferrihydrite, chloride is a conservative constituent in the geochemical modeling calculations of the underground workings water quality. Consequently, chloride concentrations in the underground workings water will be controlled by the concentrations in the inflowing groundwater and the concentrations released by the mine wall rock and backfilled waste rock. The cementitious material in the underground workings will not be a significant source of chloride.

The chloride concentration calculations are summarized in Table B-8. The average chloride concentration in the Vinini Formation groundwater is 7.053×10^{-4} moles/kg (Table B-1). The mean constituent releases from quartzite and argillite/siltite are calculated using the expressions:

Mean chloride release from quartzite (moles/m^2) = 1.229×10^{-5} mole/m^2 =
1.078 mg/L × 1.651 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/35,453 mg

Mean chloride release from argillite/siltite (moles/m^2) = 1.330×10^{-5} mole/m^2 =
1.163 mg/L × 1.656 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/35,453 mg

These results are converted to moles by multiplying by the surface area of the waste rock per liter of underground workings water, either 5.411 m^2 or 54.11 m^2 (Table B-8). The aqueous concentration (moles/kg water) can be calculated by dividing the concentration by the final calculated mass of water, which is decreased by the modeled reactions because small amounts are consumed by mineral precipitation (Table B-8). The final concentrations, converted to units of mg/L, are summarized in Table B-8. These results illustrate that for the lower mine wall rock and waste rock surface area, the largest source of chloride is the inflowing groundwater. The higher mine wall rock and waste rock surface area, however, results in more significant chloride contributions from the mine wall rock and waste rock.

Table B-8. Chloride Calculations

Mine wall rock and waste rock surface area	5.411 m^2	54.11 m^2	Units
Groundwater concentration	7.05×10^{-4}	7.05×10^{-4}	moles/kg water
Mean release from quartzite	6.65×10^{-5}	6.65×10^{-4}	moles
Mean release from argillite/siltite	7.20×10^{-5}	7.20×10^{-4}	moles
Total chloride	8.44×10^{-4}	2.09×10^{-3}	moles
Total chloride	29.9	74.1	mg
Final mass of water	0.9915	0.9862	kg
Chloride concentration	30.2	75.1	mg/L

B.2.2 Precipitated Constituent Example

The average fluoride concentration in Vinini Formation groundwater is predicted to be 5.660×10^{-5} moles/kg water (Table B-1). Fluoride release from the quartzite and argillite/siltite mine wall rock and waste rock is calculated per m^2 using the expressions:

Mean fluoride release from quartzite (moles/m^2) = 2.434×10^{-5} mole/m^2 =
1.144 mg/L × 1.651 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/18,998.4 mg

Mean fluoride release from argillite/siltite (moles/m^2) = 7.364×10^{-5} mole/m^2 =
3.447 mg/L × 1.656 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/18,998.4 mg

These results are converted to moles by multiplying by the surface area of the waste rock per liter of underground workings water, either 5.411 m^2 or 54.11 m^2 (Table B-9). Fluoride is removed from solution by the precipitation of fluorite, which consumes two moles of fluoride per mole of fluorite. The aqueous concentration (moles/kg water) can be calculated by dividing the concentration by the final calculated mass of water, which is decreased because small amounts are consumed by mineral precipitation (Table B-9). The final concentrations, converted to units of mg/L, are summarized in Table B-9. The results of these calculations illustrate that fluoride concentrations remain relatively low compared to the NDEP reference value of 4 mg/L because of fluorite precipitation.

Table B-9. Fluoride Calculations

Mine wall rock and waste rock surface area	5.411 m^2	54.11 m^2	Units
Groundwater concentration	5.66×10^{-5}	5.66×10^{-5}	moles/kg water
Mean release from quartzite	1.32×10^{-4}	1.32×10^{-3}	moles
Mean release from argillite/siltite	3.98×10^{-4}	3.98×10^{-3}	moles
Moles precipitated as fluorite	-4.84×10^{-4}	-5.23×10^{-3}	moles
Total aqueous fluoride	1.02×10^{-4}	1.23×10^{-4}	moles
Total aqueous fluoride	1.95	2.34	mg
Final mass of water	0.9915	0.9862	kg
Fluoride concentration	1.96	2.38	mg/L

B.2.3 Adsorbed Constituent Example

Beryllium concentrations were below detection in all Vinini Formation water samples (Table 2-7), so groundwater is not expected to be a source of beryllium to the underground workings water. Beryllium release from the quartzite and argillite/siltite mine wall rock and waste rock is calculated per m^2 using the expressions:

Mean beryllium release from quartzite (moles/m^2) = 1.032×10^{-6} mole/m^2 =
0.02302 mg/L × 1.651 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/9,012.2 mg

Mean beryllium release from argillite/siltite (moles/m^2) = 2.572×10^{-6} mole/m^2 =
0.05717 mg/L × 1.656 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/9,012.2 mg

These results are converted to moles by multiplying by the surface area of the waste rock per liter of underground workings water, either 5.411 m^2 or 54.11 m^2 (Table B-10). The moles of beryllium removed from solution by adsorption are subtracted to calculate the total moles of beryllium remaining in solution. The aqueous concentration (moles/kg water) can be calculated by dividing the concentration by the final calculated mass of water, which is decreased because small amounts are consumed by mineral precipitation (Table B-10). The final concentrations, converted to units of mg/L, are summarized in Table B-10. These results illustrate that adsorption significantly affects the final calculated aqueous beryllium concentrations.

Table B-10. Beryllium Calculations

Mine wall rock and waste rock surface area	5.411 m^2	54.11 m^2	Units
Groundwater concentration	0.00	0.00	moles/kg water
Mean release from quartzite	5.59×10^{-6}	5.59×10^{-5}	moles
Mean release from argillite/siltite	1.39×10^{-5}	1.39×10^{-4}	moles
Moles Hfo_sOBe+	-1.39×10^{-5}	-8.36×10^{-5}	moles
Moles Hfo_wOBe+	-6.12×10^{-6}	-1.10×10^{-4}	moles
Total aqueous beryllium	2.28×10^{-7}	1.91×10^{-6}	moles
Total aqueous beryllium	0.00205	0.0172	mg
Final mass of water	0.9915	0.9862	kg
Beryllium concentration	0.00207	0.0174	mg/L

B.2.4 Nitrogen

Nitrate-N concentrations ranged from below detection to 0.7 mg/L in the Vinini Formation water samples (Table 2-7), so groundwater is not expected to be a significant source of nitrate-N to the underground workings water. Precipitation of a nitrate-N solid is not predicted to take place and significant adsorption of nitrate-N is not expected to occur. Consequently, the nitrate-N concentration in the underground workings water will be controlled by leaching from the mine wall rock and waste rock and the release of blasting residues.

Nitrate-N concentrations in the Vinini Formation groundwater used in the geochemical modeling calculations were below analytical detection limits (Table B-11). The mean constituent releases from quartzite and argillite/siltite are calculated using the expressions:

Mean nitrate-N release from quartzite (moles/m^2) = 1.896×10^{-6} mole/m^2 =
0.06571 mg/L × 1.651 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/14,006.7 mg

Mean nitrate-N release from argillite/siltite (moles/m^2) = 3.101×10^{-6} mole/m^2 =
0.1071 mg/L × 1.656 L/kg waste rock × 1 kg waste rock/4.08 m^2 × mole/14,006.7 mg

These results are converted to moles by multiplying by the surface area of the waste rock per liter of underground workings water, either 5.411 m^2 or 54.11 m^2 (Table B-11). The mass of nitrate-N is calculated by multiplying by the gram formula weight. The aqueous concentration (mg/kg water) can be calculated by dividing the concentration by the final calculated mass of water, which is decreased by the modeled reactions because small amounts are consumed by mineral precipitation (Table B-11). The concentrations leached from the mine wall rock and waste rock, in units of mg/L, are summarized in Table B-11. The mean concentration of nitrate-N in the underground workings water is 1.4 mg/L (Table 2-8). This mean concentration was

added to the nitrate-N concentrations calculated from mine wall rock and waste rock leaching to account for nitrate-N that may be derived from blasting residues (Table B-11).

Table B-11. Nitrate-N Calculations

Mine wall rock and waste rock surface area	5.411 m^2	54.11 m^2	Units
Groundwater concentration	0.00	0.00	moles/kg water
Mean release from quartzite	1.03×10^{-5}	1.03×10^{-4}	moles
Mean release from argillite/siltite	1.68×10^{-5}	1.68×10^{-4}	moles
Total leached nitrate-N	2.71×10^{-5}	2.71×10^{-4}	moles
Total leached nitrate-N	0.380	3.80	mg
Final mass of water	0.9915	0.9862	kg
Nitrate-N concentration from mine wall rock and waste rock leaching	0.383	3.83	mg/L
Mean nitrate-N in underground workings water	1.4	1.4	mg/L
Total nitrate-N	1.78	5.25	mg/L

B4 Hollister Mine West Pit Shallow Groundwater Technical Memorandum

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Technical Memorandum

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Date: October 4, 2010

To: Teresa Conner, Environmental Manager

From: Brad Hart, Principal Hydrogeologist

1. Introduction

Rodeo Creek Gold, Inc. (RCG) is in the process of permitting the Hollister Mine for full-scale production. The Hollister Mine is an underground gold mining operation located in Elko County, Nevada (Figure 1) that is currently operating under an exploration permit, which allows for bulk sampling and limited test mining. Surface mining was conducted in two pits at the Hollister Mine site in the early 1990s by Cornucopia Resources and Galactic Resources. RCG is considering utilizing one of the previously mined pits, known as the West Pit (Figure 2), as a waste rock storage facility in support of future underground mining operations. The West Pit waste rock facility would be lined to keep groundwater from entering the waste rock, and equipped with an under-drain system to control drainage of water from the waste rock.

The gold-bearing vein system of the Hollister Mine is hosted in the Ordovician Vinini Formation, which is comprised of orthoquartzite, siltite and argillite. The Vinini Formation is unconformably overlain by a succession of Tertiary volcanic rocks that range in thickness from 60 to 200 feet thick in the area (HSI, 1989). Clays and re-worked quartzite characterize the contact between the Vinini Formation and the Tertiary volcanic rocks (HCI, 1997). The Vinini Formation hosts the regional aquifer in the Hollister Mine area, and is the unit that will be locally dewatered to accommodate subsurface mining. The Tertiary volcanic rocks host a shallow aquifer that is separated from the regional aquifer in the vicinity of the Hollister Mine by an aquitard, which consists of clay along the unconformity between the Vinini Formation and the Tertiary volcanic rocks.

A shallow pit lake typically occurs for approximately nine months a year (typically November to July) in the bottom of the West Pit (Figure 2) when groundwater levels in the Tertiary volcanic-hosted shallow aquifer in the vicinity of the West Pit rise sufficiently in response to recharge from precipitation (MWH, 2007). Water quality in the pit lake is characterized by high TDS and generally low pH values (pH values have returned to within acceptable limits from August to December 2008 before declining to slightly below the acceptable limits in April 2009; Montgomery, 2010). Previous studies have characterized this pit lake as an evaporative sink that causes groundwater in the Tertiary volcanic-hosted in the immediate vicinity of the pit lake to flow radially inward (HCI, 1997, MWH, 2007), thereby preventing the movement of mine-impacted shallow groundwater away from the West Pit area. Establishment of a waste rock facility in the West Pit is anticipated to locally affect groundwater conditions in the Tertiary volcanic-hosted shallow aquifer by eliminating infiltration of direct precipitation in the area that would be covered by the new waste rock facility, and elimination of evaporation from the pit lake.

This analysis provides a review of previous West Pit studies and an update of current hydrogeologic conditions in the West Pit area. Also included are the results of an analysis of geochemical data from monitoring wells installed in the shallow Tertiary volcanic aquifer. These analyses were conducted to determine whether the construction of the waste rock facility in the West Pit and potential resultant changes to the groundwater flow regime in the Tertiary volcanic aquifer may affect Little Antelope Creek.

The MA-1 seep (Figure 3) has been identified as the monitoring location to identify potential effects to Little Antelope Creek from anticipated changes in West Pit groundwater conditions, The MA-1 seep emanates from the East Overburden Stockpile (Figure 3), and is located hydraulically upgradient of Little Antelope Creek.

2. Background

The shallow groundwater and the West Pit lake were characterized in 1996 (HCI, 1997) and in 2007 (MWH, 2007) to determine the relationship of the pit lake with the shallow Tertiary volcanic aquifer. As previously stated, these reports characterized the West Pit as a groundwater sink (i.e., cone of depression) resulting from the depression of the pit lake surface due to evaporation. Groundwater elevation contours are presented in these reports to demonstrate that the groundwater level in the pit lake is lower than that measured in piezometers located to the south and east of the pit lake, thereby creating a localized groundwater flow field where water in the surrounding shallow aquifer flows toward the pit lake. Figure 4 depicts water level contours from HCI (1997), and Figures 5 and 6 present water level contours from MWH (2007) for December 2006 and April 2007, respectively.

The HCI (1997) and MWH (2007) reports also provide a water balance analysis that considers pit lake inflows and outflows. Inflows to the pit lake include groundwater inflow from up-gradient areas, direct precipitation to the surface of the pit lake, and runoff to the pit lake from the surrounding pit floor and highwall area. The HCI (1997) report considered the pumping of water from the South Overburden Stockpile to the West Pit as an inflow component, and assumed that this pumping would continue, which it did not. Although groundwater outflow from the West Pit was indicated for the short-term analysis, the long-term analysis indicated that, without the pumping of water from the South Overburden Stockpile to the West Pit, groundwater would not flow outward from the cone of depression surrounding the pit lake (HCI, 1997). The MWH report indicates no groundwater outflow from the West Pit. Therefore, both of these analyses indicate that the only outflow component of water from the West Pit is by evaporation.

3. Additional Analyses

In order to further characterize the groundwater conditions in the Tertiary aquifer in the vicinity of the West Pit, additional water level, water budget, and geochemical analyses were conducted. The objectives of these additional analyses were to determine: 1) whether shallow groundwater in the West Pit area has the potential to migrate to surface water in Little Antelope Creek; and 2) whether the construction of a waste rock facility in the West Pit may alter groundwater flow directions such that shallow groundwater beneath the West Pit would migrate to Little Antelope Creek.
Groundwater flow directions presented on Figures 5 and 6 indicate that groundwater flow directions are to the southeast from areas located south of the 5,550-foot elevation contour. The following sections present groundwater elevation contours from 2010, and the geochemical analysis of the West Pit, the MA-1 seep, and groundwater monitoring wells between the pit and the seep (Figure 3).

3.1 Tertiary Aquifer Flow Directions

Although the general direction of groundwater flow in the Tertiary volcanic aquifer is from north to southeast, localized flow directions vary due to past surface mining activities in the area. These activities included diversion and capture of surface water runoff, disturbance of land surfaces leading to enhanced permeability, and collection of storm and process water in unlined pits, ponds and depressions. These disturbances have resulted in enhanced infiltration that produced localized near-surface groundwater accumulation in the vicinity of the open pits (Montgomery, 2010).

Figures 5 and 6 show water level conditions following the unusually high precipitation year of 2005, when water levels in the Tertiary aquifer rose several feet. Groundwater elevation contours based on January 2010 water level data (Figure 7) indicate the same general flow directions across the East and West Pit areas, except that an embayment in the contours occurs along an axis between monitor wells W-E-1 and DGW-2. At the time of collection of the January 2010 water level data, the West Pit had been dry for a period of approximately five months, but the groundwater contours still indicate groundwater flow toward the West Pit from the area approximately defined by a line between the locations of monitor wells P2 and H6-224WW (Figure 7). To the east and southeast of this line, groundwater flows eastward and southeastward, respectively. The southeasterly component of groundwater flow depicted in Figure 7 is aligned with a historic drainage that was buried by the East Waste Dump during previous surface mining activities.

Although the specific hydrogeologic condition that creates the groundwater divide and the steep hydraulic gradient between the West and East pits has not been identified, a fault in the Tertiary volcanics (depicted on Figure 4) has been mapped during previous geologic investigations. Structural influences on groundwater flow in the Tertiary volcanic aquifer within the Hollister Mine area have been observed (e.g., inflows to the exploration decline from the Tertiary volcanic aquifer were noted during the first several months of decline construction, but these inflows eventually ceased, suggesting that the source area responsible for these inflows had been depleted).

3.2 Changes to West Pit Water Budget

Utilizing the West Pit as a waste rock storage facility would affect the groundwater budget of the West Pit area and may influence groundwater flow directions in the immediate vicinity of the West Pit. The West Pit would be lined to accommodate the waste rock storage facility, which would eliminate both the direct precipitation to the pit lake surface and, to some extent, the runoff contribution to West Pit groundwater budget inflow components. A groundwater budget inflow component that was not considered explicitly in either the MWH or HCI studies is the contribution to groundwater from precipitation falling on the floor of the West Pit outside of the pit lake. This infiltrated volume would be a portion of the groundwater inflow component that would be removed from the total groundwater budget if the area were covered with the waste rock facility. Backfilling the West Pit would also eliminate evaporation from the pit lake surface, which is the outflow component of the West Pit groundwater budget.

The MWH (2007) report is based on a more extensive monitor well network and utilizes site-specific precipitation data than the HCI (1997) report. Therefore, groundwater budget values from the MWH report are cited here. Specifically, the groundwater budget components for the West Pit from the MWH (2007) report are:

- Evaporation (outflow): 192,545 cubic feet per year (cu. ft/yr);
- Runoff from the West Pit catchment (inflow): 4,233 cu. ft/yr;
- Direct precipitation (inflow): 74,973 cu. ft/yr; and
- Groundwater inflow (inflow): 130,660 cu. ft/yr;

Elimination of the evaporation outflow component of the water budget and the runoff and direct precipitation components of the inflow budget would leave a net groundwater through-flow of approximately 130,660 cu. ft/yr. As previously discussed, infiltration of precipitation to groundwater

through the floor of the West Pit catchment area was not considered in the MWH report. However, using the 442,000 square foot (ft^2) catchment area and 13.5-inch average annual precipitation for the six years considered in the MWH (2007) study, and assuming that five percent of the precipitation infiltrates to groundwater, approximately 24,750 cu. ft/yr would infiltrate to groundwater. If that area is covered by the waste rock facility, this quantity would be removed from the groundwater budget, yielding a net groundwater through-flow in the West Pit of approximately 106,000 cu. ft/yr.

Changes in the groundwater flow directions in the immediate vicinity of the West Pit resulting from the water balance change can not be predicted with certainty. However, the persistence of lower water levels in the West Pit area several months after the pit lake dried up (Figure 7) suggests groundwater in this area that is west of the groundwater divide depicted in Figure 7 will continue to flow in a westerly direction.

3.3 Geochemical Analyses

Groundwater geochemical data were evaluated to determine whether these data would support the existence of a hydraulic link between the West Pit pit Lake and groundwater emanate from the MA-1 seep. The geochemical analysis, prepared by Geochemical Solutions, LLC (2010), is attached as Appendix A, and is summarized in this technical memorandum. The approach used for this evaluation was to use the sulfate/chloride (SO4/Cl) ratio to fingerprint the West Pit pit Lake, the MA-1 seep, and the monitoring wells completed in the Tertiary volcanic aquifer that lie between these two points (P1, P2, W-E-1, H6-226WW, H6-224WW, DGQ-1R and DGW-2B; Figure 3). Sulfate is a conservative chemical constituent (i.e., not readily attenuated by aquifer solids) that is associated with the weathering of sulfide minerals, and chloride is a largely natural, chemically conservative constituent that was used to normalize the sulfate concentration. The SO4/Cl ratio for the West Pit, the MA-1 seep and the intervening monitoring wells were plotted as a function of the relative distance from the West Pit to the MA-1 seep (Figure 8). The relative distance corresponds to the order in which the monitoring wells occur along a path from the West Pit to MA-1, without regard to absolute distance. Figure 8 shows that the SO4/Cl ratio varies as a function of relative distance from the West Pit, and that the ratio decreases to a value that is lower than MA-1 at a location (P2/H6-226) between the two end points. This suggests that the two end points (i.e., the West Pit and MA-1) are not hydraulically connected unless significant mixing with lower-quality water occurs between the P2/H6-226 and the MA-1 seep.

The analysis of potential relationships among the sampling locations between the West Pit and the MA-1 seep was refined by plotting the SO4/Cl fingerprint as a function of the associated SO4 concentration (Figure 9), which allows for the interpretation of dilution effects. For any sampling location, the position of its plotted points depicted on Figure 9 may only be produced by mixing two or more of the other sampling locations that bound it. For example, the cluster of points associated with the MA-1 seep on Figure 9 may be produced by mixing of the water chemistry of the clusters of points that are on either side of it. Therefore, the MA-1 chemistry can be produced by mixing P2/H6-226 and West Pit area water (either P1, H6-224, or the West Pit) or DGW-1R. While similar to MA-1 with respect to the SO4/Cl fingerprint, W-E-1 has lower sulfate, which by the location of W-E-1 (Figure 3) suggests that there is not a flow path between West Pit and the MA-1 seep that is north of P2 and H6-226.

West Pit values plot on Figure 9 as a generally horizontal line, indicating changes in total composition while maintaining a constant fingerprint. This horizontal alignment characteristic of the West Pit water is consistent with evaporation that does not involve significant, if any, mineral precipitation. MA-1 seep values do not exhibit this behavior, which suggests a lack of connectivity between the MA-1 seep and the West Pit. Although the MA-1 point cluster presented on Figure 9 can be reproduced using either West Pit water or DGW-1R water to mix with an intermediate water (e.g., P2), Figure 8

illustrates that the SO4/Cl ratio at points between West Pit and MA-1 drops below that of MA-1, and Figure 9 illustrates that the sulfate concentration does as well. Therefore, another input of water (e.g. DGW-1R) would be required to boost these parameters at the intervening monitoring well locations to values associated with the MA-1 seep. The higher SO4/Cl ratio at the MA-1 seep relative to P2 cannot be reproduced by evaporation alone (i.e., evaporation that may occur at the MA-1 seep). If a water is evaporated (e.g., West Pit lake), the resulting water chemistry would shift horizontally (i.e., the SO4/Cl ratio would not increase), as both sulfate and chloride would concentrate proportionally and the ratio would not be expected to increase.

The relative proportions of P2 and DGW-1R water required to produce water similar to MA-1 were estimated using a mixing model that calculates the concentrations of sulfate and chloride for a range of mixing proportions between the two waters. The SO4/Cl ratio was then calculated and plotted versus sulfate. Figure 10 illustrates the result of calculations of mixing DGW-1R water with P2 water. The black line on Figure 10 represents the binary mixing of P2 and DGW-1R water, with the points in yellow along the line representing 10 percent mixing increments. The MA-1 seep data points lie at a position along this line that corresponds to a mixing proportion of about 95 percent P2 water and 5 percent DGW-1R water. A similar calculation (Figure 11) indicates that a mixture of 30 percent P1 water to 70 percent P2 water is necessary to achieve the same effect as using 5 percent DGW-1R water. Given the analysis presented in Figure 8 (i.e., the dip in the SO4/Cl ratio), this magnitude of mixing does not appear to be likely.

4. Summary and Conclusions

The following summarizes the current understanding of the flow conditions in the Tertiary volcanics aquifer in the vicinity of the West Pit and between the West Pit and the MA-1 seep.

- Previous studies (HCI, 1997; MWH, 2007) have characterized the West Pit lake as an evaporative groundwater sink (i.e., cone of depression) that causes groundwater in the vicinity of the West Pit to flow radially inward, thereby preventing the migration of this water southeastward along the larger-scale groundwater flow path.
- Groundwater elevation data suggest that there is a groundwater divide located between monitoring well P1and the P2/H6-224WW.
- Recent groundwater elevation data from 2010 suggest groundwater continues to flow toward the West Pit from areas west of the groundwater divide, even after the pit lake disappeared.
- Construction of a waste rock facility in the West Pit would affect the water budget in the West Pit area, which could affect groundwater flow directions.
- Construction of the West Pit waste rock facility would reduce direct precipitation, runoff, and infiltration contributions to the West Pit area by approximately 104,000 cu. ft/yr.
- Geochemical analyses presented here do not support existence of a groundwater flow path from the West Pit to the MA-1 seep.

Evidence presented in this technical memorandum indicates that, although groundwater flow conditions may be altered as a result of the construction of a waste rock facility in the West Pit, it is not likely to affect Little Antelope Creek or other surface waters because the direction of groundwater flow from the West Pit area is not toward Little Antelope Creek with or without the presence of the West Pit lake. Some improvement of groundwater quality in the West Pit vicinity may occur as a result of eliminating infiltration of precipitation through the pit walls and pit floor with construction of the waste rock facility.

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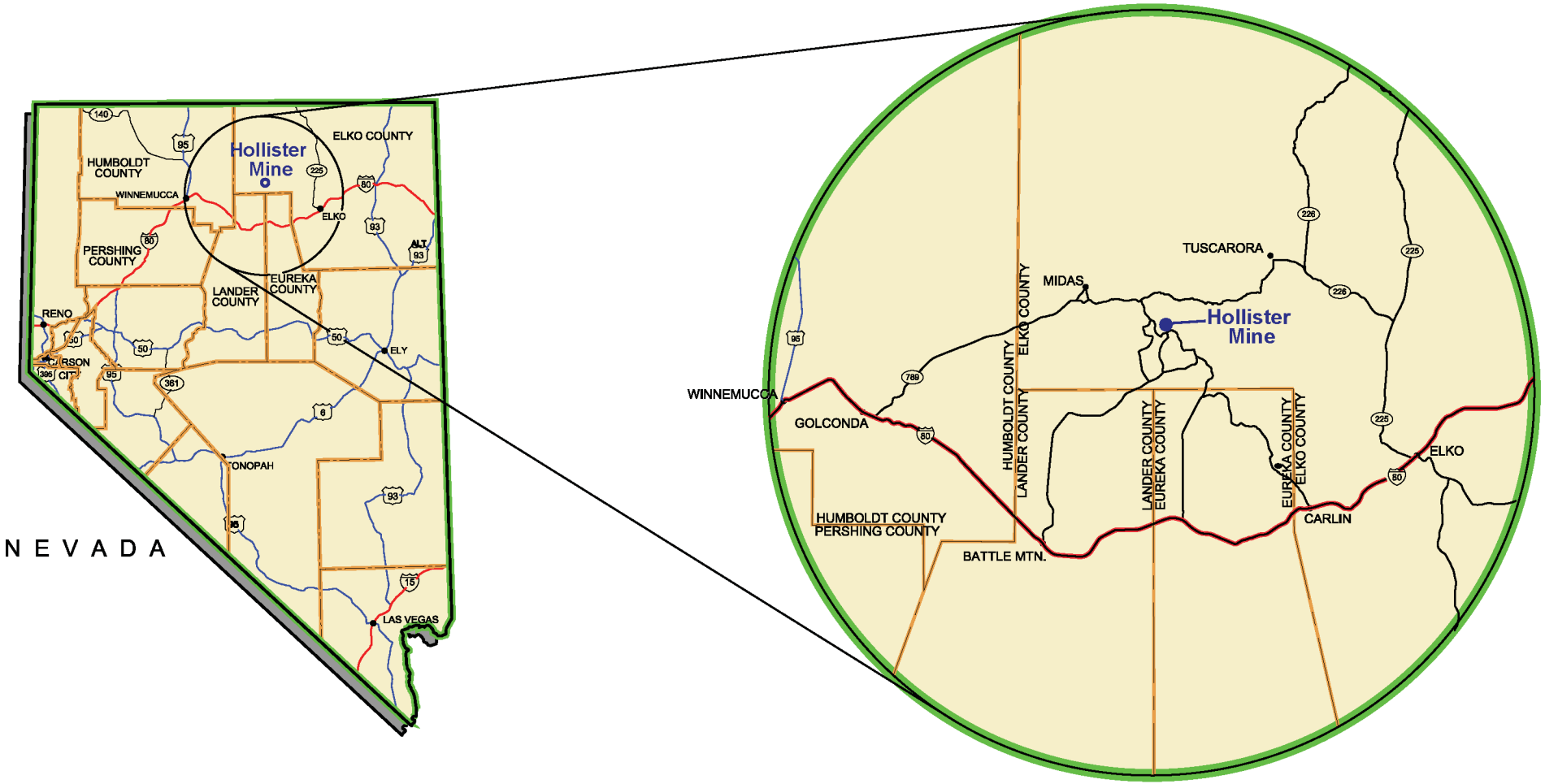
Montgomery, 2010, Hydrogeologic Monitoring Summary 2006-2009, Hollister Mine Area, Elko County, Nevada, Prepared for Rodeo Creek Gold Inc., prepared by Montgomery & Associates, September 17, 2010.

MWH, 2007, Hydrologic Study of the Hollister Reclamation Project, prepared for Newmont Mining Corporation, prepared by MWH Americas, Inc., June 2007.



Source: AECOM

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 1
	DATE 7-7-10	TITLE Hollister Mine Location	

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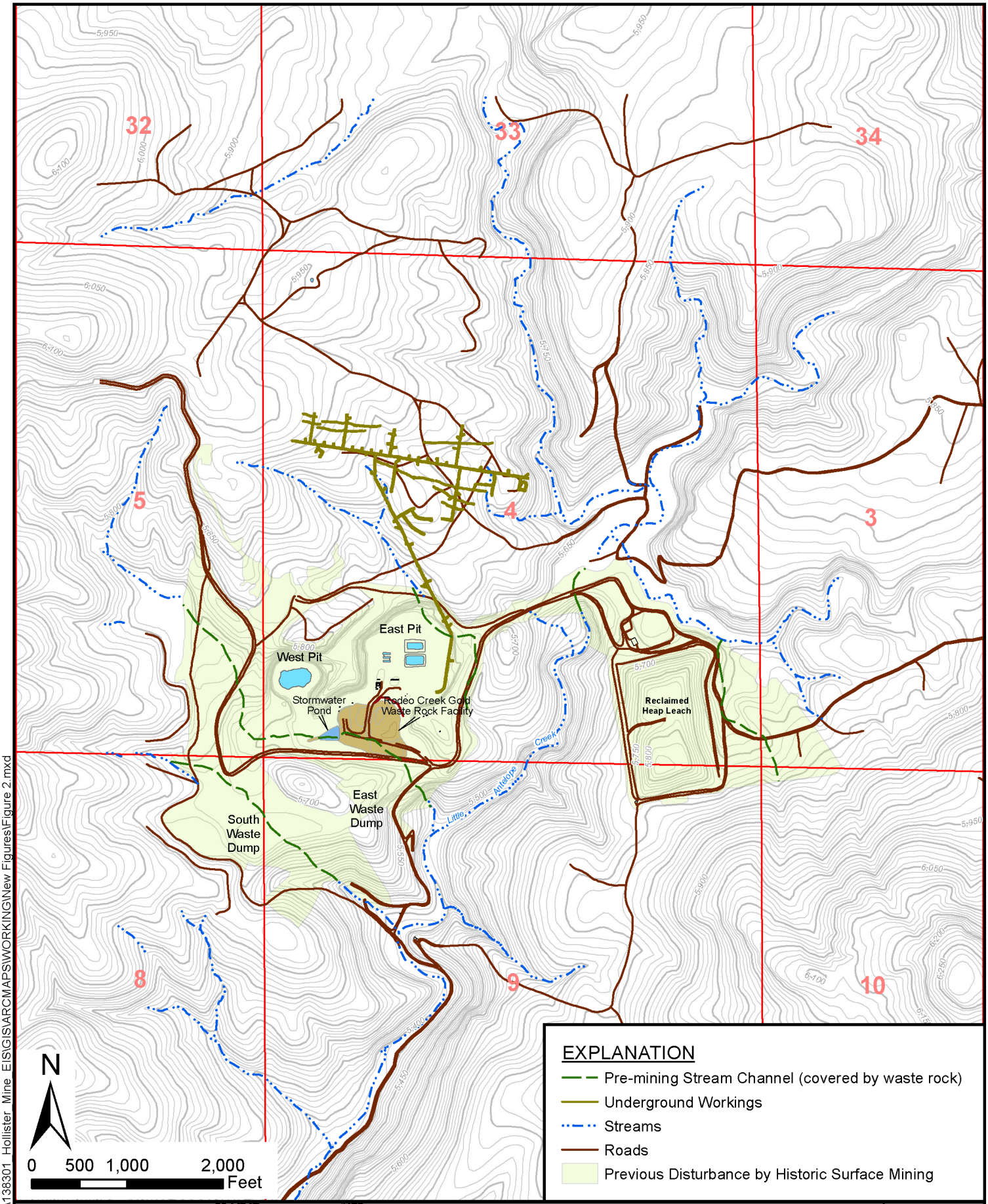

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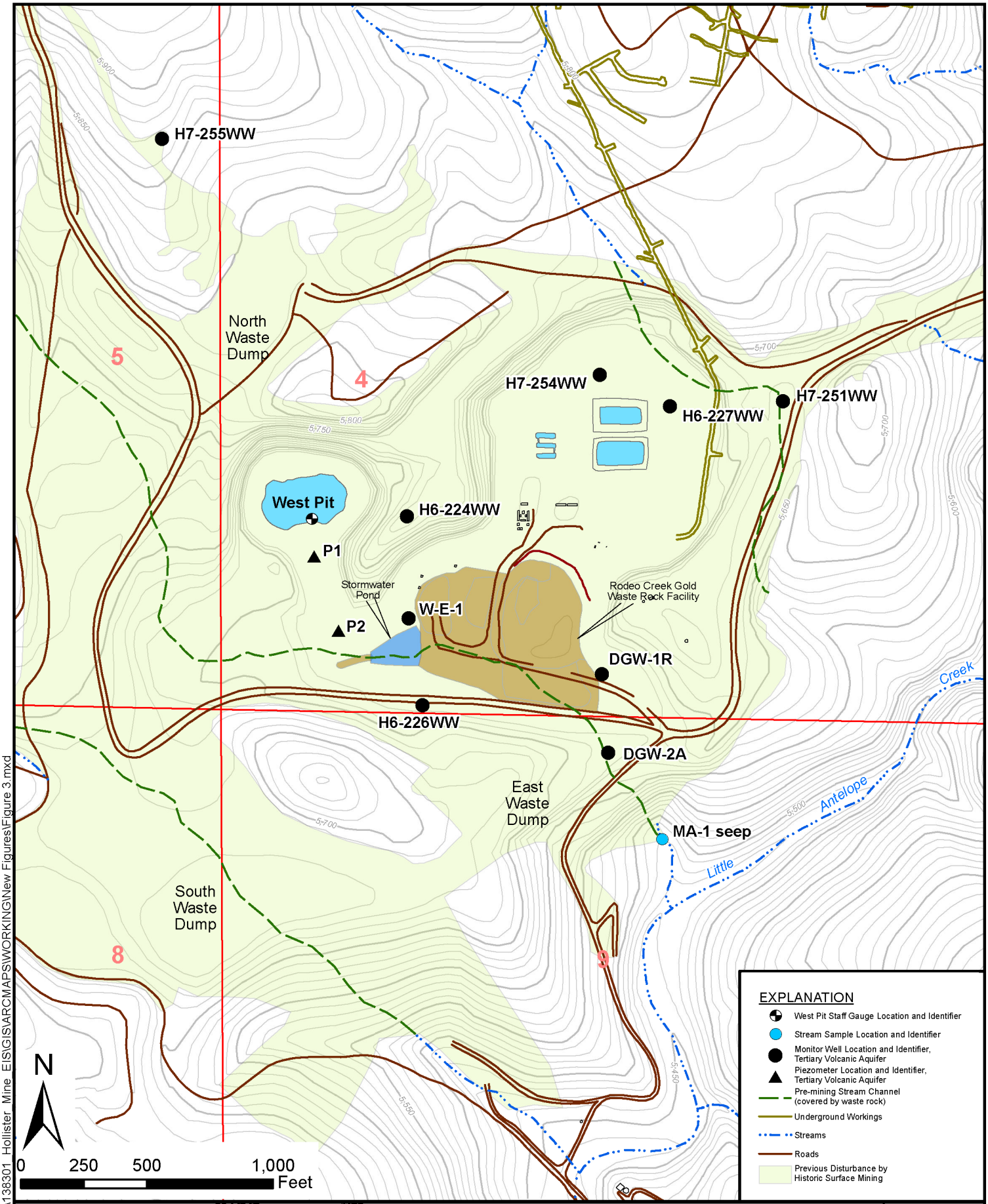
BROWN AND CALDWELL

PROJECT	SITE	
138301	Rodeo Creek Gold - Hollister Mine	Figure
DATE	TITLE	2
9/24/10	Hollister Mine Site Map	



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BROWN AND CALDWELL

PROJECT	SITE	
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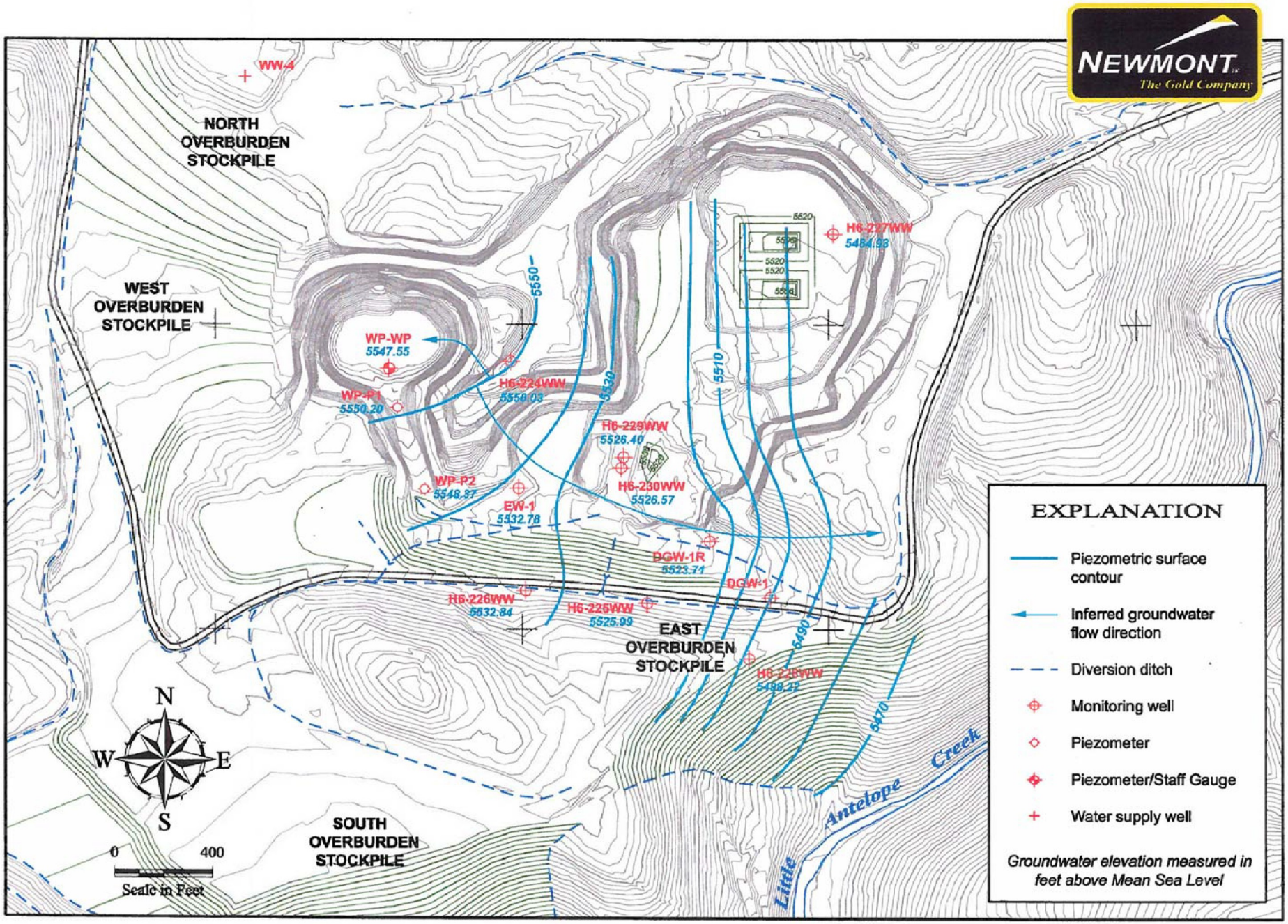
DATE	TITLE	
9/24/10	Tertiary Volcanics Monitoring Locations and the MA-1 Seep	3

BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 4
	DATE 9/27/10	TITLE Tertiary Volcanics Aquifer Water Level Contours, 1997	



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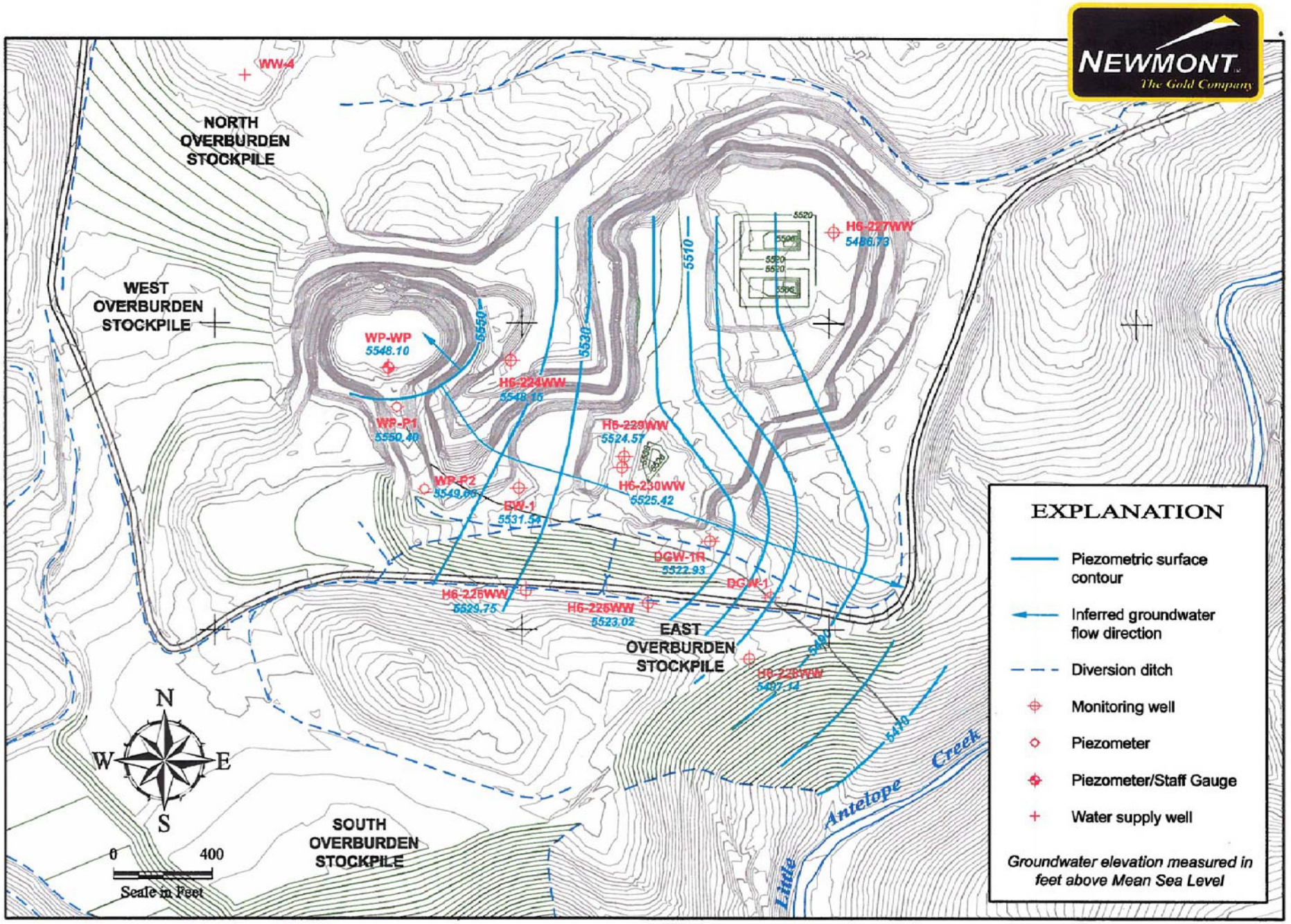

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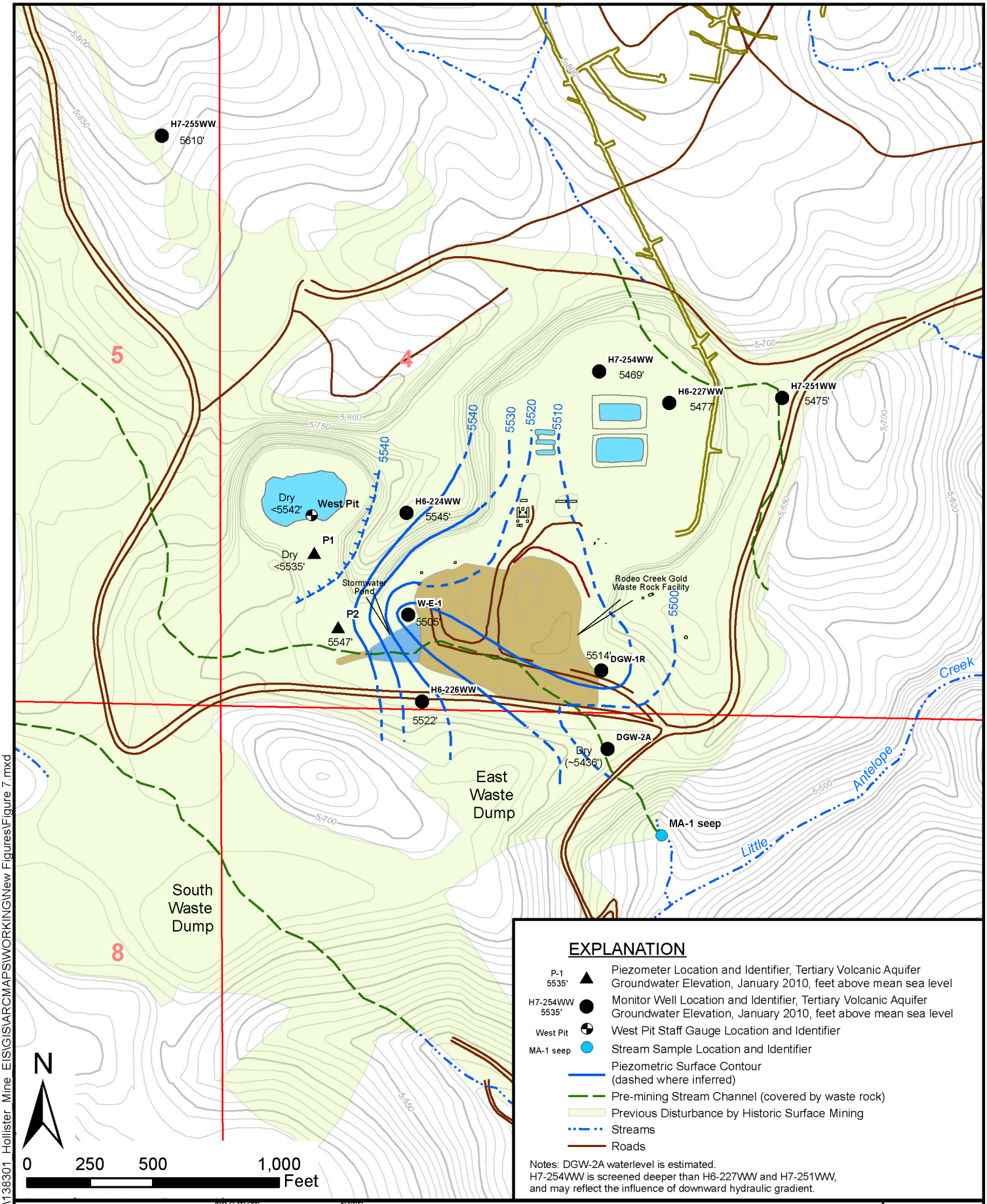

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BROWN AND CALDWELL

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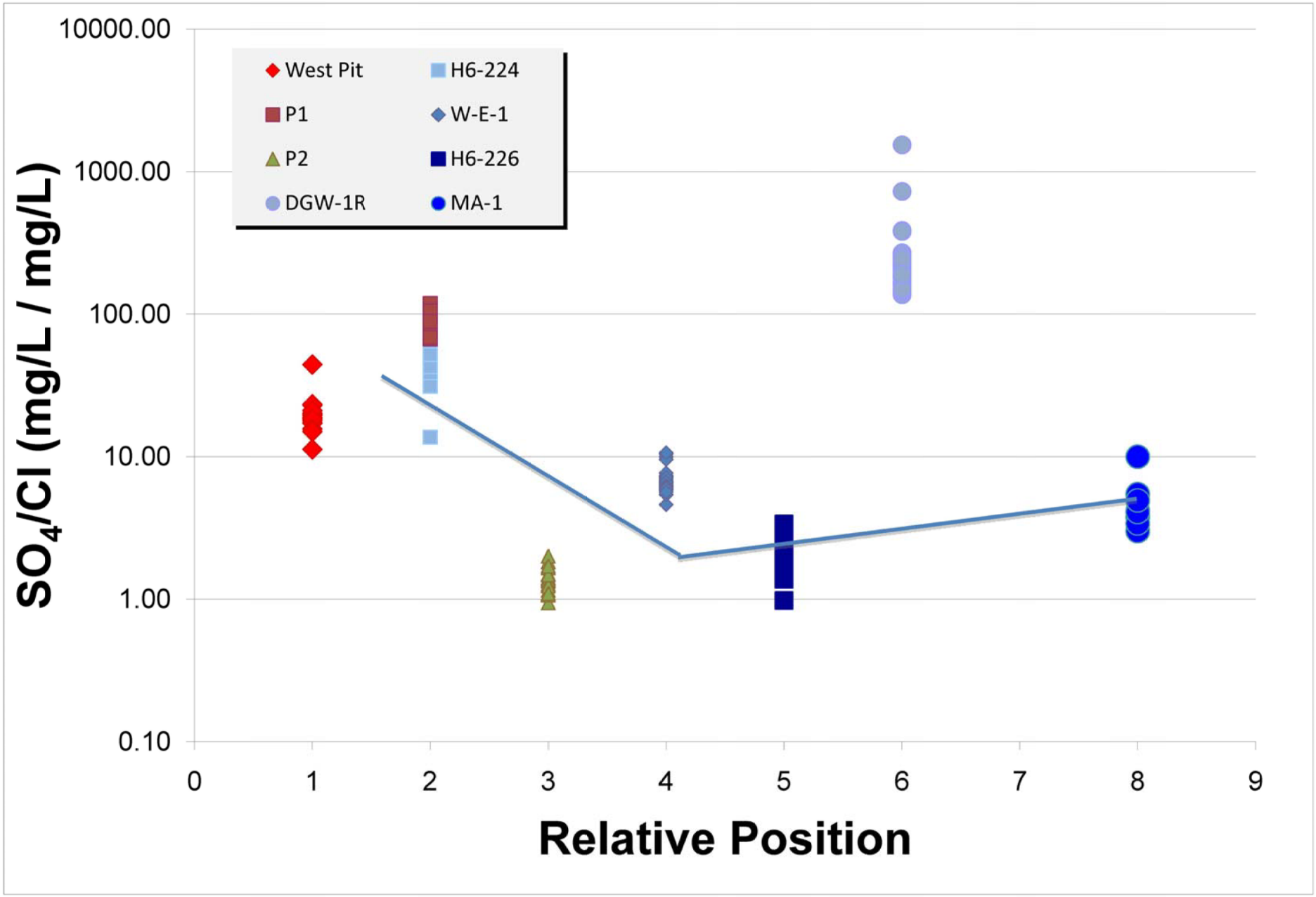
DATE	TITLE	
9/24/10	Tertiary Volcanics Aquifer Water Level Contours, January 2010	7



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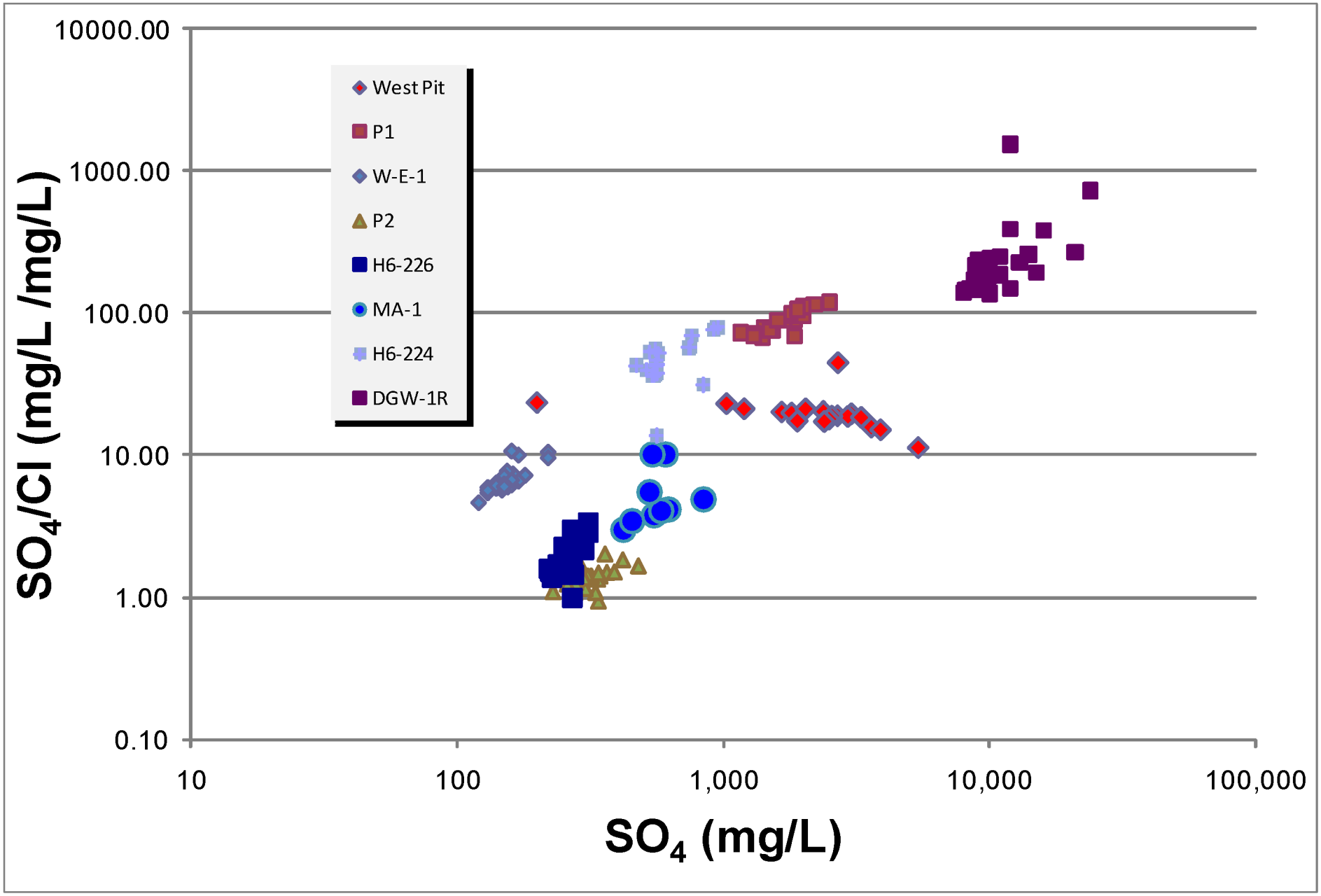

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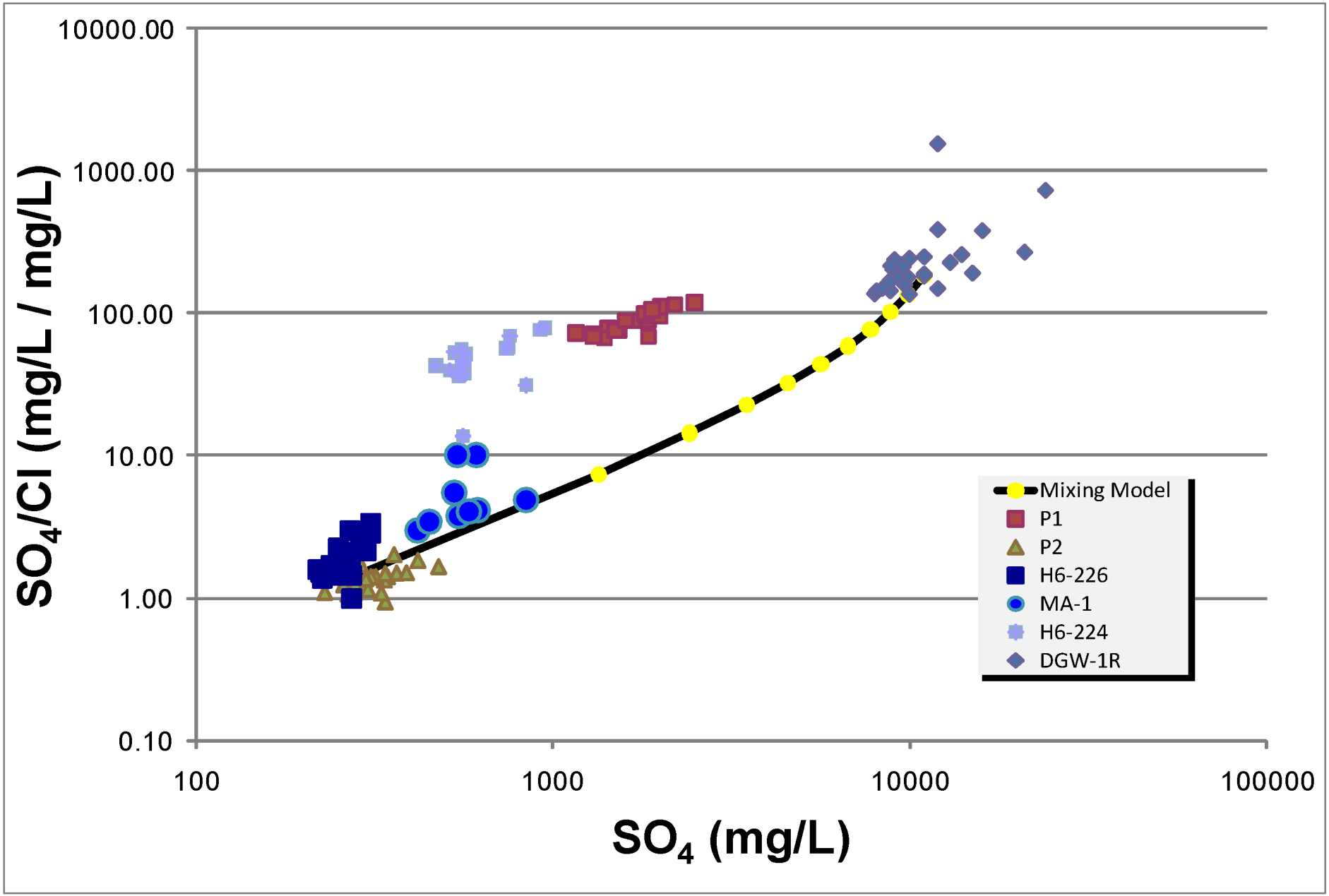

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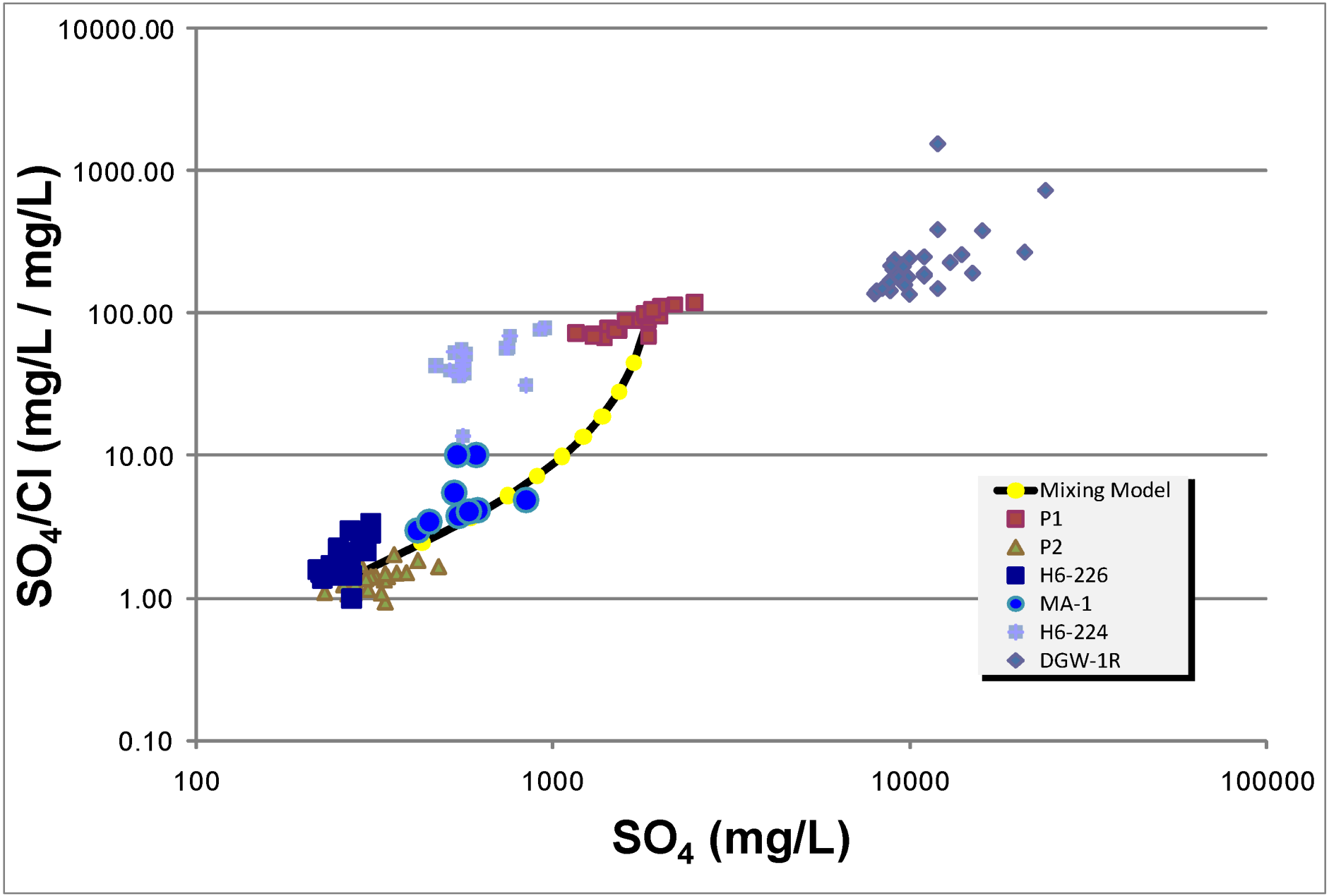
	DATE 9/27/10	TITLE Simple Mixing Model for the Combination of P2 Water and DGW-1R Water	



BROWN AND CALDWELL	PROJECT 138301	SITE Rodeo Creek Gold - Hollister Mine	Figure 11
	DATE 9/27/10	TITLE Simple Mixing Model for the Combination of P2 Water and P1 Water	

Attachment A

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MEMORANDUM

TO:	Brad Hart	**FROM:**	Mark A. Williamson, PhD
ORGANIZATION:	Brown & Caldwell	**DATE:**	September 27, 2010
CC:	File	**PROJECT:**	1004.10
SUBJECT:	Hollister EIS Evaluation of Connectivity Between West Pit and Seep MA-1		

Summary

Seep MA-1 does not appear to be influenced by groundwater in the vicinity of the West Pit. Although seep MA-1 bears a chemical signature that is consistent with influence by groundwater in the West Pit area (P1, H6-224, West Pit sump), groundwater between the West Pit and MA-1 (P2, H6-226, W-E-1, see Figure 1) does not carry a geochemical fingerprint showing influence from the West Pit. Therefore, it is difficult to link West Pit and MA-1. Alternatively, the groundwater in the vicinity of the waste rock pile in the East Pit (DGW-1R) has a geochemical fingerprint that is consistent with a link to MA-1 while having little or no evidence of intermediate groundwater (groundwater between potential source and MA-1 that appears chemically unaffected). Mixing calculations indicate that about 30% West Pit water mixing with unaffected water is required to reproduce water quality at MA-1. Only 5% groundwater from the DGW-1R area is required to produce the same result.

Approach

The approach used for evaluating a possible hydrologic link between West Pit and MA-1 was to compare the SO_4/Cl (sulfate/chloride) fingerprint for each, as well as for wells that lie between West Pit and MA-1 (intermediate wells). Sulfate is a chemical constituent that is associated with the weathering of sulfide minerals, and chloride is a largely natural, chemically conservative constituent that was used to normalize the sulfate concentration. From late 2005 through early 2009 (Montgomery, 2010) this parameter remained fairly steady and distinct among the various groundwater (and surface water) sampling locations (see Figure 2), which makes it a useful fingerprint for surface and groundwater from various locations at the project site. In the same way that water chemistries are plotted on a standard Piper diagram to illustrate the proportions of three constituents (SO_4, Cl and HCO_3) and illustrate distinct water types, the SO_4/Cl is used to simply distinguish between water types.

The key wells (P1, P2, W-E-1, H6-226WW, H6-224WW, DGQ-1R, and DGW-2B) have samples taken from roughly the same depth below the water table, thus comparison of their chemical compositions is appropriate. Figure 3 shows the depths from which samples are collected. It is noteworthy that DGW-1R and DGW-2b are relatively deep compared with other key wells.

The SO_4/Cl ratio for each key well was plotted as a function of relative distance from the West Pit area (Figure 4). Figure 1 illustrates the positions of the wells. As shown in Figure 4, the SO_4/Cl fingerprint varies as a function of relative distance[1] from the West Pit area, going toward MA-1. The decrease in this parameter to a value that is lower than MA-1 at a point between West Pit and MA-1, highlighted by the line passing through the center of intermediate wells, suggests they are not hydrologically connected. Well W-E-1, which is an intermediate well, appears to have a signature very similar to MA-1. However its SO_4/Cl fingerprint is unique among site wells (see Figure 5) and is not explained by mixing of any observed groundwater compositions.

[1] The relative distance simply corresponds to the order in which wells occur along a path from the West Pit to MA-1, without specific regard to absolute distance (in, say, feet).

Figure 1. Site map showing well locations. The figure is oriented with north to the top.

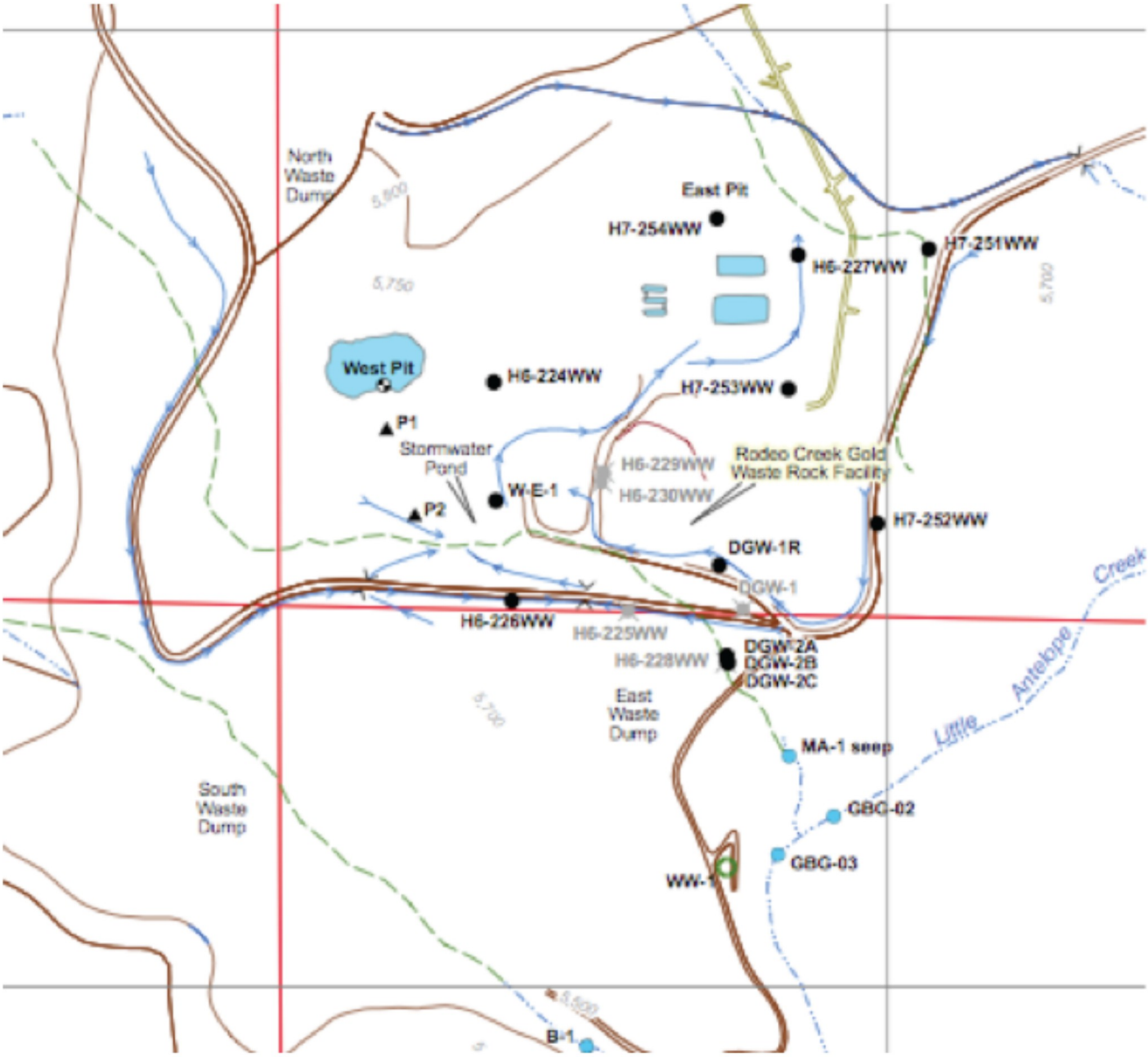


Figure 2. Sulfate/Chloride ratio in key wells over time.

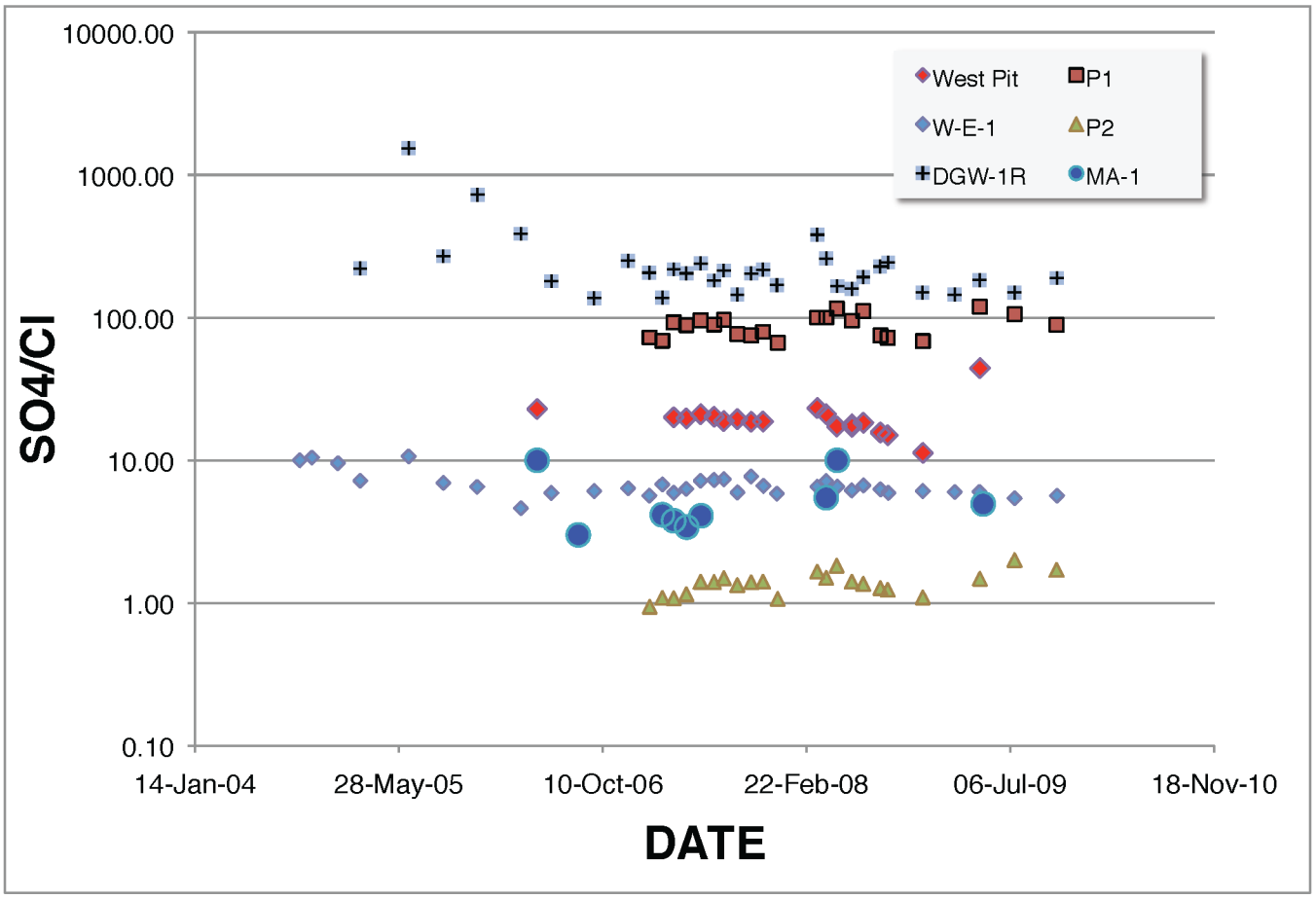
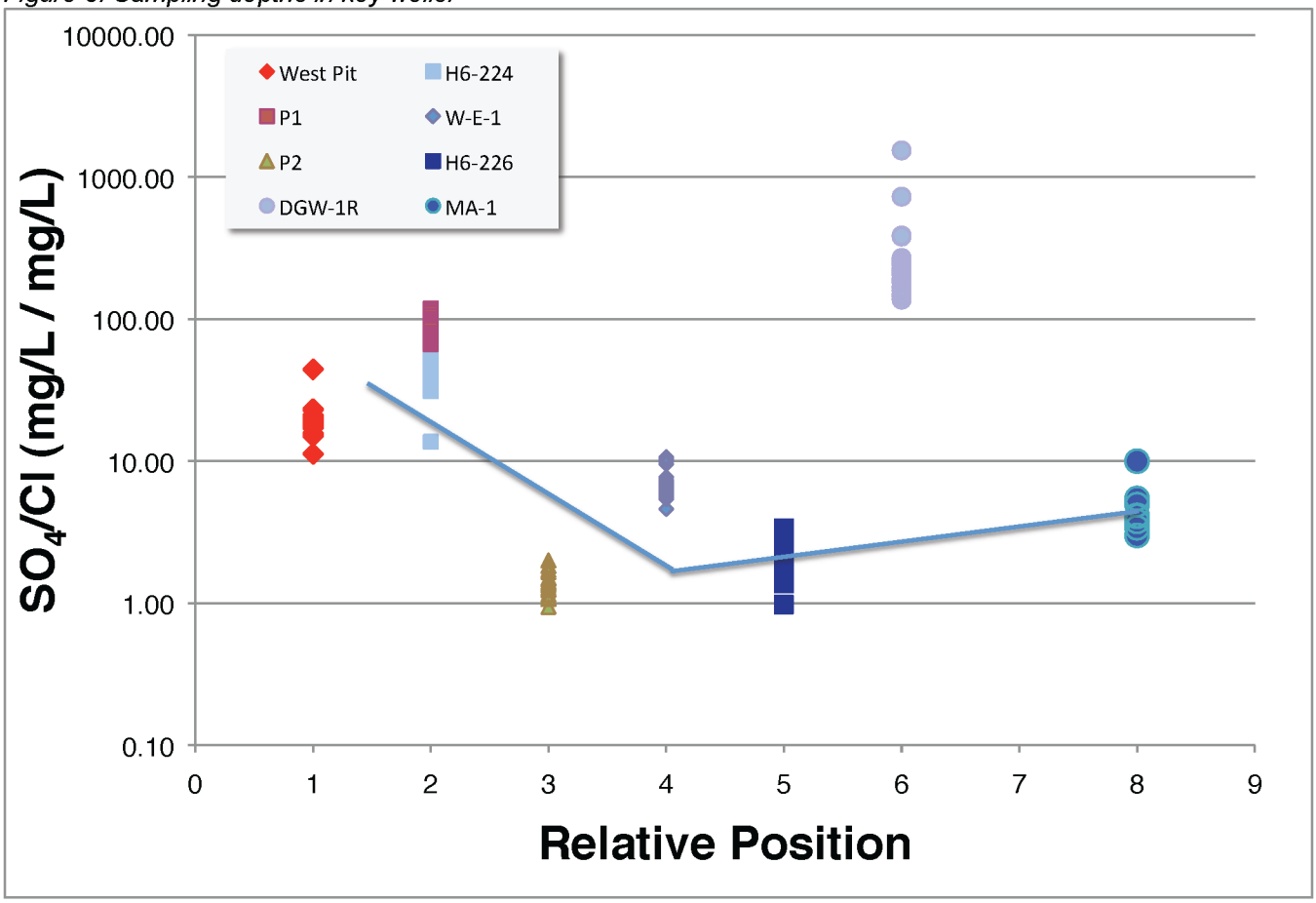
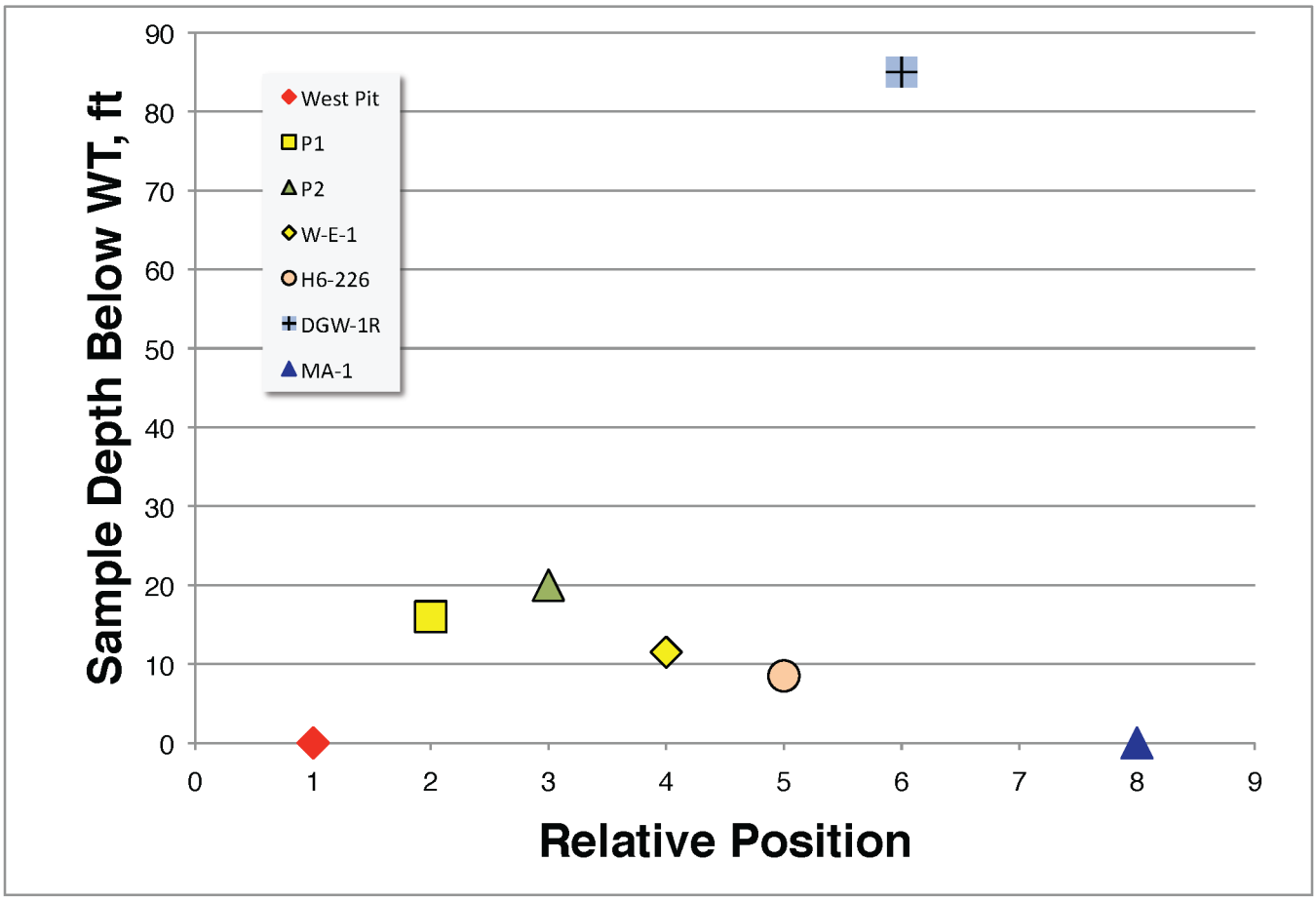


Figure 3. Sampling depths in key wells.



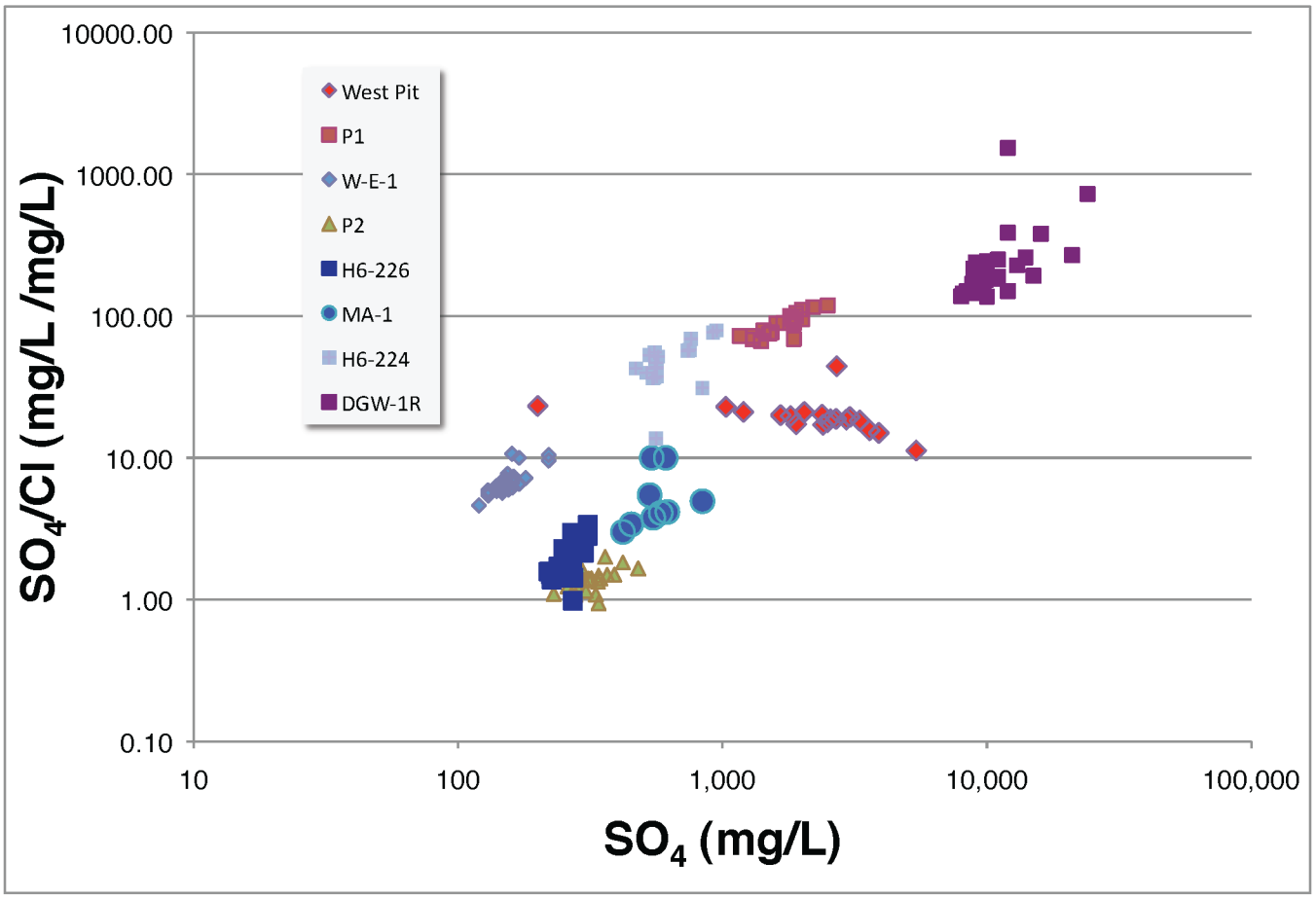
NOTE: WT = Water Table

Figure 4. Sulfate/Chloride ratio with relative distance from West Pit to MA-1.



To compliment and refine the potential relationship(s) among the sampling locations with distance (Figure 4), the SO_4/Cl fingerprint is plotted as a function of the associated SO_4 concentration, which is shown in Figure 5. Such a plot directly comparing the fingerprint parameter with total concentration enables interpretation of dilution effects. For any sampling location, the position of its plotted points may only be produced by mixing two (or more) other sampling locations that bound it. In other words, the cluster of points corresponding to MA-1 may be produced by mixing of the (water chemistry) clusters that are on either side of it. MA-1 chemistry can be produced by mixing P2/H6-226 and west pit water (either P1, H6-224, or the West Pit) or DGW-1R. While similar to MA-1 in SO_4/Cl fingerprint, W-E-1 has lower sulfate. This suggests that there is no flow path from the West Pit to MA-1 that travels north of P2 and H6-226. Note that West Pit points plot in Figure 5 as a basically horizontal line, illustrating changes in total composition with a constant fingerprint. This is consistent with evaporation that does not involve significant, if any, mineral precipitation. This flattening effect is not observed at MA-1, suggesting a lack of connectivity between MA-1 and the West Pit.

Figure 5. Sulfate/Chloride as a function of sulfate concentration.



Evaporation does not appear to account for observations at MA-1. Although the MA-1 point cluster can be reproduced using either West Pit water or DGW-1R water to mix with intermediate water (like P2), Figure 4 illustrates that the SO_4/Cl ratio at points between West Pit and MA-1 drops below that of MA-1, and from Figure 5 it can be seen that the sulfate concentration does as well. Thus, another input of water (e.g. DGW-1R) would be required to boost these parameters at mid-point locations to values associated with MA-1. The higher SO_4/Cl ratio at seep MA-1 relative to P2 cannot be reproduced by evaporation alone. If a water is evaporated (for example the West Pit sump), the resulting water chemistry would shift horizontally with SO_4/Cl ratio, not increase, as both sulfate and chloride would concentrate proportionally and the ratio would not be expected to increase.

The relative proportions of P2 type water and DGW-1R water required to produce something that looks like MA-1 can be estimated using a mixing model. The mixing model simply calculates the concentrations of sulfate and chloride for a range of mixing proportions between two waters. The SO_4/Cl ratio is then calculated and plotted versus sulfate. Figure 6 illustrates the result of calculations of mixing DGW-1R water with P2 water. The black line in Figure 6 is the binary mixing of P2 type water and DGW-1R water, and the points along the line are in 10% mixing increments. MA-1 data points lie at a position along this line that correspond to a mixing proportion of about 95% P2 water and 5% DGW-1R water. A similar calculation (Figure 7) indicates that water from P1 must be mixed 30% to 70% P2 to achieve the same effect as 5% DGW-1R. However, given the above analysis (see dip in SO_4/Cl ratio in Figure 4) this magnitude of mixing seems improbable.

Figure 6. Simple mining model for combination of P2 water and DGW-1R water.

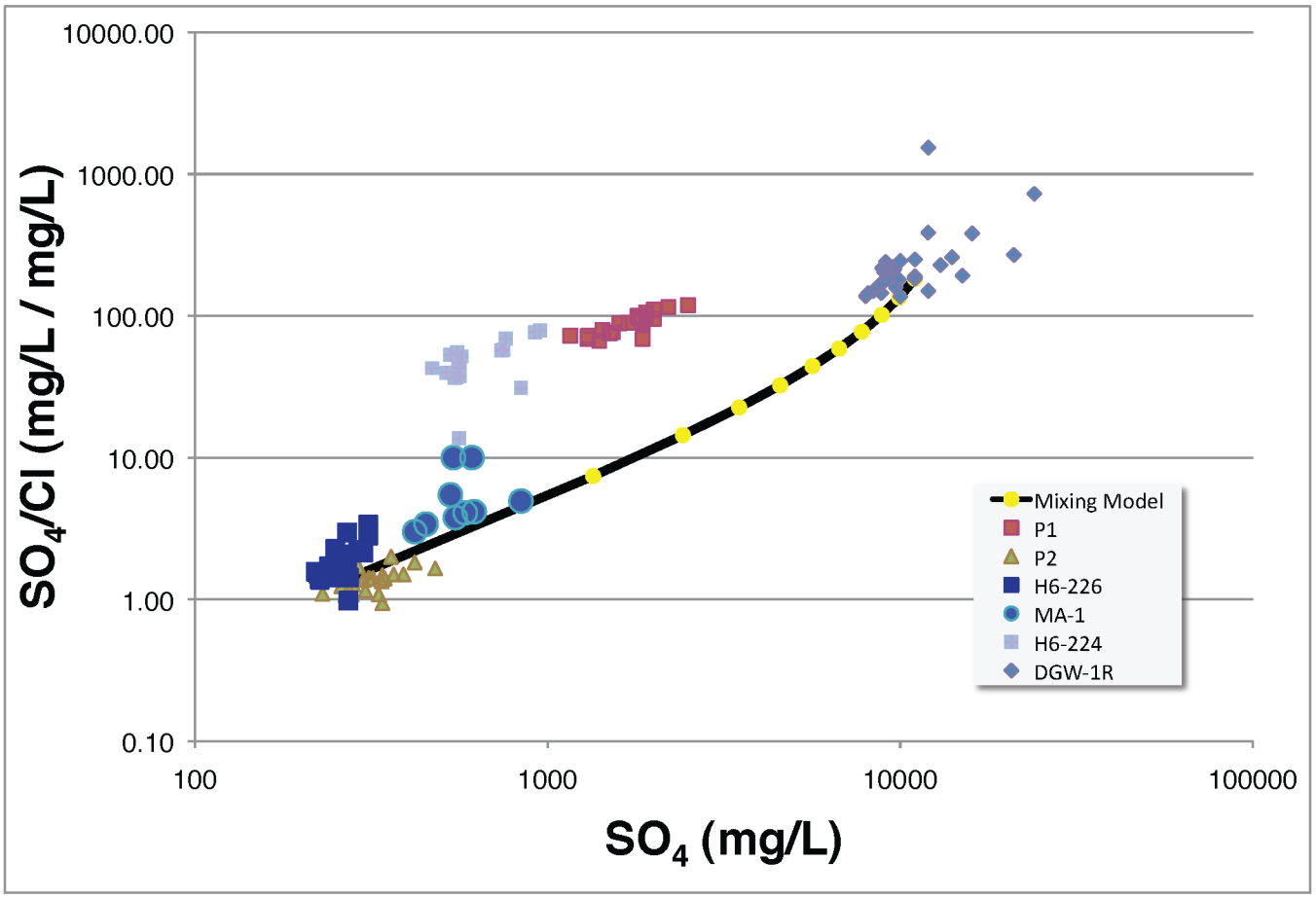
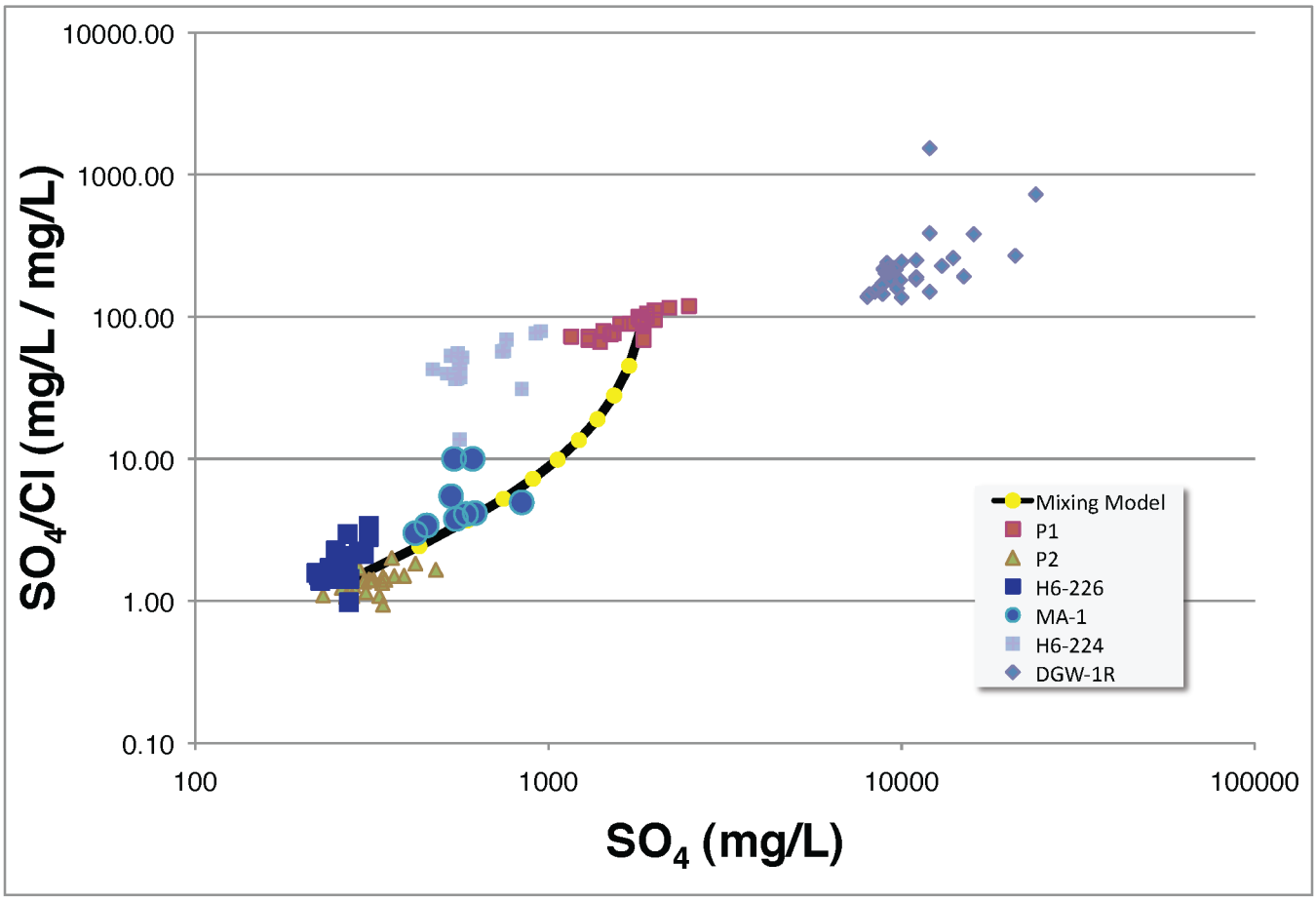


Figure 7. Simple mining model for combination of P2 water and west pit (P1) water.



References

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Appendix C

Surface Water

Table C-1 All Spring Points and Wetland Polygons within the Hollister Maximum 10-foot Drawdown Contour

Spring ID	Source	Distance to Vinini	Topo Elevation (feet)	Bedrock GW Elevation (feet)	GW Elev-Topo Elev (feet)	Geologic Unit	Surface Geology Comment	Potentially Affected by Vinini Formation Drawdown	Within 10-ft Drawdown Contour
559	BLM 2006	> 500	5,586	5,610	24	Tc	Hill slope and drainage near Carlin Formation outcrop	Yes	Y
564	BLM 2006	0	5,944	5,485	-459	Ov	Associated with Vinini outcrop	No	Y
566	BLM 2006	0-500	5,590	5,575	-15	Tcu	Carlin Spring	No	Y
567	BLM 2006	> 500	5,842	5,400	-442	Tc	Drainage along hill slope in Carlin Formation	No	Y
568	BLM 2006	> 500	5,861	5,400	-461	Tc	Drainage along hill slope in Carlin Formation	No	Y
576	BLM 2006	0-500	5,500	5,476	-24	Tcu	Carlin spring	No	Y
623	BLM 2006	> 500	5,899	5,400	-499	Tc	Drainage along hill slope in Carlin Formation	No	Y
625	BLM 2006	> 500	5,760	5,310	-450	Tc	Hill slope in Carlin Formation	No	Y
626	BLM 2006	> 500	5,775	5,310	-465	Tc	Hill slope in Carlin Formation	No	Y
639	BLM 2006	0	5,947	5,485	-462	Ov	Associated with Vinini outcrop	No	Y
643	BLM 2006	> 500	5,602	5,610	8	Tc	Hill slope and drainage near Carlin Formation outcrop	Yes	Y
644	BLM 2006	0-500	5,600	5,615	15	Tcu	Carlin Spring	Yes	Y
741	BLM 2006	>500	5,762	5,660	-102	Qtg	Along Boulder Creek in Quaternary Alluv.	No	N
895	BLM 2006	> 500	5,692	5,410	-282	Tc	Base of hill near drainage in Carlin Formation	No	Y
896	BLM 2006	> 500	5,687	5,410	-277	Tc	Base of hill near drainage in Carlin Formation	No	Y
27455	Brown and Caldwell 2010b	0-500	5,595	5,615	20	Tcu	Carlin Spring	No	Y
69732	Brown and Caldwell 2010b	0	5,720	5,370	-350	Ov/Ta	Springs associated with Tertiary andesite or Vinini	No	Y
71734	Brown and Caldwell 2010b	0	5,720	5,370	-350	Ov/Ta	Springs associated with Tertiary andesite or Vinini	No	Y
71735	Brown and Caldwell 2010b	0	5,720	5,370	-350	Ov/Ta	Springs associated with Tertiary andesite or Vinini	No	Y
74011	Brown and Caldwell 2010b	0	5,720	5,370	-350	Ov/Ta	Springs associated with Tertiary andesite or Vinini	No	Y
129521	BLM 2000b	> 500	5,840	5,400	-440	Tc	Drainage along hill slope in Carlin Formation	No	Y
129522	BLM 2000b	> 500	5,840	5,400	-440	Tc	Drainage along hill slope in Carlin Formation	No	Y
129526	BLM 2000b	> 500	5,393	5,340	-53	Tc	Along Little Antelope Creek	No	Y
129600	BLM 2000b	> 500	5,725	5,600	-125	Qtg	Along Boulder Creek in Quaternary Alluv.	No	N
129601	BLM 2000b	> 500	5,673	5,620	-53	Qtg	Along Boulder Creek in Quaternary Alluv.	No	N
129602	BLM 2000b	> 500	5,726	5,630	-96	Qtg	Along Boulder Creek in Quaternary Alluv.	No	N
129605	BLM 2000b	> 500	5,890	5,660	-230	Qtg	Along Boulder Creek in Quaternary Alluv.	No	N
12952A	BLM 2000b	> 500	5,256	5,270	14	Tc	Along Little Antelope Creek	No	Y
12952B	BLM 2000b	> 500	5,239	5,260	21	Tc	Along Little Antelope Creek	No	Y
12952C	BLM 2000b	> 500	5,569	5,250	-319	Tc	Base of hill near drainage in Carlin Formation	No	Y
12952D	BLM 2000b	> 500	5,289	5,200	-89	Tc	Base of hill near drainage in Carlin Formation	No	Y

Table C-1 All Spring Points and Wetland Polygons within the Hollister Maximum 10-foot Drawdown Contour

Spring ID	Source	Distance to Vinini	Topo Elevation (feet)	Bedrock GW Elevation (feet)	GW Elev-Topo Elev (feet)	Geologic Unit	Surface Geology Comment	Potentially Affected by Vinini Formation Drawdown	Within 10-ft Drawdown Contour
12959A	BLM 2000b	> 500	5,384	5,200	-184	Tc	Base of hill near drainage in Carlin Formation	No	Y
12959D	BLM 2000b	> 500	5,340	5,330	-10	Ta	Along Hill Slope in Tert. Andesite	No	Y
12959E	BLM 2000b	> 500	5,432	5,340	-92	Ta	Along Hill Slope in Tert. Andesite	No	Y
12959F	BLM 2000b	> 500	5,565	5,340	-225	Ta	Along Hill Slope in Tert. Andesite	No	Y
1295A3	BLM 2000b	> 500	5,907	5,400	-507	Tc	Drainage along hill slope in Carlin Formation	No	Y
1295C4	BLM 2000b	0-500	5,620	5,600	-20	Alluv/Tcu	Alluvial/Carlin spring along Alkali Creek near base of cliff	No	Y
1295C9	BLM 2000b	0-500	5,412	5,467	55	Alluv/Tcu	Alluvial or Carlin spring at base of hill	No	Y
1295C9	BLM 2000b	0-500	5,412	5,472	60	Alluv/Tcm	Alluvial spring	No	Y
1295CO	BLM 2000b	> 500	5,693	5,410	-283	Tc	Base of hill near drainage in Carlin Formation	No	Y
1295D3	BLM 2000b	> 500	5,542	5,600	58	Tc	Drainage in Carlin Formation	No	Y
1295D8	BLM 2000b	> 500	5,588	5,610	22	Tc	Hill slope and drainage near Carlin Formation outcrop	Yes	Y
1295D9	BLM 2000b	> 500	5,601	5,610	9	Tc	Hill slope and drainage near Carlin Formation outcrop	Yes	Y
1295DA	BLM 2000b	0-500	5,600	5,615	15	Tcu	Carlin Spring	Yes	Y
1295DC	BLM 2000b	0-500	5,614	5,610	-4	Tcu	Carlin Spring	Yes	Y
SADA1	Sada 2007	0-500	5,412	5,472	60	Alluv/Tcm	Alluvial spring	No	Y
V06262	Brown and Caldwell 2010b	0-500	5,585	5,575	-10	Tcu	Carlin Spring	No	Y
W-046	JBR 2010	0	5,940	5,485	-455	Ov	Associated with Vinini outcrop	No	Y
W-084	JBR 2010	0-500	5,602	5,410	-192	Tc	Base of hill near drainage in Carlin Formation	No	Y
W-175	JBR 2010	0-500	5,847	5,600	-247	Ov	Hillslope spring in Vinini	No	Y
W-201	JBR 2010	0	5,918	5,485	-433	Ov	Associated with Vinini outcrop	No	Y
W-202	JBR 2010	0	5,803	5,550	-253	Ov	Drainage associated with Vinini outcrop	No	Y
W-203	JBR 2010	0	5,790	5,550	-240	Ov	Drainage associated with Vinini outcrop	No	Y
565	BLM 2006	> 500	5,601	5,580	-21	Ov	Drainage associated with Vinini	Yes-High Potential	Y
566	BLM 2006	0-500	5,597	5,580	-17	Ov	Drainage associated with Vinini	Yes-High Potential	Y
570	BLM 2006	0	5,477	5,600	123	Ov	Spring associated with Vinini	Yes-High Potential	Y
576	BLM 2006	> 500	5,500	5,472	-28	Ov	Vinini Spring	Yes-High Potential	Y
1295C4	BLM 2000b	0-500	5,620	5,600	-20	Ov	Vinini Spring	Yes-High Potential	Y
1295CF	BLM 2000b	0-500	5,438	5,512	74	Ov	Vinini Spring	Yes-High Potential	Y
1295D2	BLM 2000b	0-500	5,580	5,600	20	Ov	Vinini Spring	Yes-High Potential	Y
1295D6	BLM 2000b	> 500	5,601	5,580	-21	Ov	Drainage associated with Vinini	Yes-High Potential	Y
W-017	JBR 2010	0-500	5,569	5,600	31	Ov	Spring associated with Vinini	Yes-High Potential	Y

Table C-1 All Spring Points and Wetland Polygons within the Hollister Maximum 10-foot Drawdown Contour

Spring ID	Source	Distance to Vinini	Topo Elevation (feet)	Bedrock GW Elevation (feet)	GW Elev-Topo Elev (feet)	Geologic Unit	Surface Geology Comment	Potentially Affected by Vinini Formation Drawdown	Within 10-ft Drawdown Contour
W-111	JBR 2010	0-500	5,594	5,580	-14	Ov	Drainage associated with Vinini	Yes-High Potential	Y
571	BLM 2006	0-500	5,477	5,510	33	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
572	BLM 2006	> 500	5,465	5,510	45	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
573	BLM 2006	> 500	5,460	5,510	50	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
574	BLM 2006	> 500	5,467	5,510	43	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
575	BLM 2006	> 500	5,459	5,495	36	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
571	BLM 2006	> 500	5,450	5,510	60	Penn/Perm &Tcm	Strathearn Formation spring	Yes-Low Potential	Y
1295CA	BLM 2000b	0-500	5,455	5,486	31	Penn/Perm	Strathearn Formation spring	Yes-Low Potential	Y
1295CA	BLM 2000b	0-500	5,455	5,486	31	Penn/Perm	Strathearn Formation spring	Yes-Low Potential	Y
1295CB	BLM 2000b	> 500	5,457	5,500	43	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
1295CC	BLM 2000b	> 500	5,460	5,500	40	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
1295CD	BLM 2000b	> 500	5,456	5,500	44	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
1295CE	BLM 2000b	0-500	5,447	5,510	63	Tcm	Spring in Carlin Formation at base of hill with Strathearn Formation	Yes-Low Potential	Y
1295D5	BLM 2000b	0-500	5,603	5,574	-29	Tcu	Spring along fault in Carlin Formation	Yes-Low Potential	Y
SADA 8,9	Sada 2007	> 500	5,460	5,490	30	Penn/Perm	Strathearn Formation spring	Yes-Low Potential	Y
SADA2	Sada 2007	> 500	5,450	5,510	60	Penn/Perm &Tcm	Strathearn Formation spring	Yes-Low Potential	Y
SADA3-7	Sada 2007	> 500	5,450	5,505	55	Tcm	Spring in Carlin Formation at base of hill with Strathearn Formation	Yes-Low Potential	Y
W-002A	JBR 2010	0-500	5,447	5,500	53	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
W002B	JBR 2010	>500	5,458	5,510	52	Penn/Perm &Tcm	Strathearn Formation spring	Yes-Low Potential	Y
W002C	JBR 2010	>500	5,460	5,490	30	Penn/Perm	Strathearn Formation spring	Yes-Low Potential	Y
W-002C	JBR 2010	>500	5,456	5,505	49	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
W-002D	AECOM 2010a	0-500	5,409	5,500	91	Penn/Perm	Spring along hillslope in Strathearn Formation	Yes-Low Potential	Y
Alkali Springs	JBR 2010	0-500	5,592	5,600	8	Tcu	Carlin Formation Spring Adjacent to Vinini Formation	Yes-High Potential	Y

Alluv = Quaternary Alluvium

Tcm or Tcu = Carlin Formation

Penn/Perm = Strathearn Formation

Ov = Vinini Formation

Qtg = Quaternary gravel

Ta = Tertiary andesite

Table C-2 Water Rights within the Water Resources Study Area

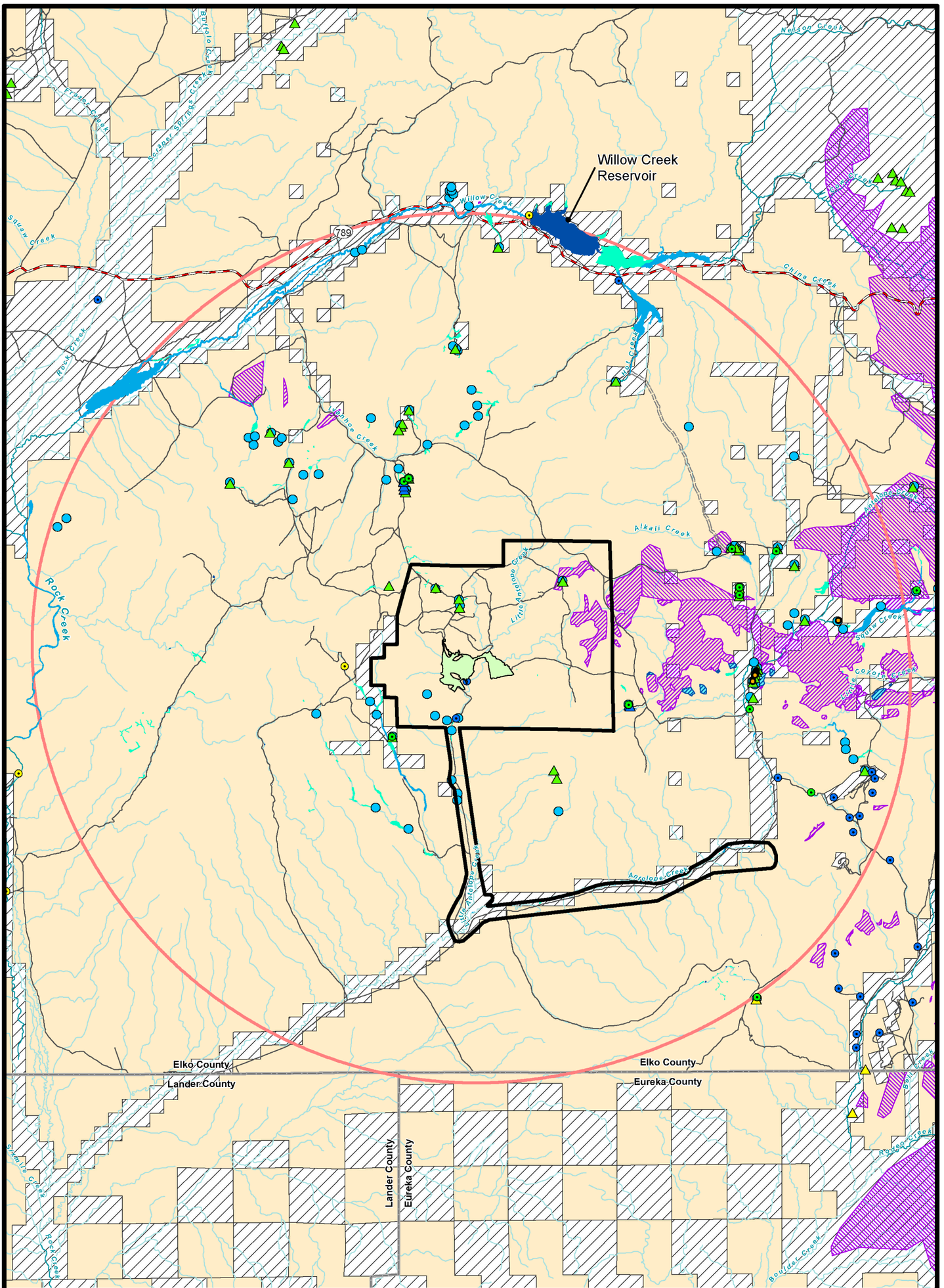
App. No.	Owner of Record	Source	Manner of Use	Status	Annual Duty (afa)	Diversion Rate (cfs)	POINT OF DIVERSION					POD Designation	Duration of Use	Comments
							QQ	QTR	SEC	TWN (N)	RNG (E)			
52751	Rodeo Creek Gold, Inc.	Underground	Mining & Milling	Cert. (14006)	51.14	0.223	NE	NW	9	37	48	WW-1	Jan 1-Dec 31	The TCD of this cert. and any certs. Issued under Permits 52750, 52752 and 52754 shall not exceed 238.71 acre-feet annually.
52754	Rodeo Creek Gold, Inc.	Underground	Mining & Milling	Cert. (14008)	124.376	0.500	SW	SW	9	37	48	WW-5	Jan 1-Dec 31	The TCD of this cert. and any certs. Issued under Permits 52750, 52751 and 52752 shall not exceed 238.71 acre-feet annually.
69732	Rodeo Creek Gold, Inc.	Underground	Mining & Milling	Permit	200.00	1.500	SE	SW	4	37	48	Portal	Jan 1-Dec 31	The total combined diversion rate under this permit and any subsequent changes to this permit shall not exceed 1.5 cfs (673.24 gpm).
71734	Rodeo Creek Gold, Inc.	Underground	Mining, Milling & Dewatering	Permit	30.176	0.212	SE	SW	4	37	48	Portal	Jan 1-Dec 31	
71735	Rodeo Creek Gold, Inc.	Underground	Mining, Milling & Dewatering	Permit	33.015	0.116	SE	SW	4	37	48	Portal	Jan 1-Dec 31	
74011	Rodeo Creek Gold, Inc.	Underground	Mining & Milling	Permit	102.00	2.00	SE	SW	4	37	48	Portal	Jan 1-Dec 31	The TCD of water under permits 52751, 69732, 71734, 71735 and 74011 shall not exceed 416.34 acre-feet annually.
78864	Ruby Pipeline, LLC	Underground	Construction	Permit	5.156	0.05	SE	SE	35	39	48	MP 368.22 Well	Jan1-Dec 31	This permit will expire upon completion of the pipeline project.
3930	Russell Land and Cattle Co.	Spring	Stockwatering	Cert. (1318)	N/A	0.01875	NW	NW	17	38	48	Ivanhoe Spring	Jan 1-Dec 31	Sufficient to water 500 cattle, 100 horses
3931	Russell Land and Cattle Co.	Spring	Stockwatering	Cert. (1319)	N/A	0.01875	SW	NW	20	38	48	Russell Spring	Jan 1-Dec 31	Sufficient to water 500 cattle, 100 horses
V06261	26 Ranch Inc.	Spring	Stockwatering	Vested	N/A	0.0046875	SE	NW	32	38	49	26 Ranch Spring #24	Jan 1-Dec 31	Sufficient to water 150 cattle and sheep
V06262	26 Ranch Inc.	Spring	Stockwatering	Vested	N/A	0.0046875	SE	NW	32	38	49	26 Ranch Spring #25	Jan 1-Dec 31	Sufficient to water 150 cattle and sheep
46744	BLM	Spring	Stockwatering	Cert. (12245)	12.31	0.0167	NE	NE	18	37	48	Willow Spring Creek	Jan 1-Dec 31	Sufficient to water 1,500 head of cattle
V06234	26 Ranch Inc.	Other Surface Water	Stockwatering	Vested	N/A	0.0156	SW	SW	6	37	48	Old Timers Channel	Jan 1-Dec 31	Sufficient to water 500 cattle and sheep
V06235	26 Ranch Inc.	Spring	Stockwatering	Vested	N/A	0.00625	NE	SW	12	37	48	Mud Springs	Jan 1-Dec 31	Sufficient to water 200 cattle and sheep
27455	26 Ranch Inc.	Spring	Stockwatering	Cert. (8343)	4.11	0.0057	NW	SW	29	38	49	Alkali Spring	Jan 1-Dec 31	Sufficient to water 1,500 head of cattle
27456	26 Ranch Inc.	Spring	Stockwatering	Cert. (8343)	6.440	0.008912	NW	SW	28	38	49	Chicken Spring	Jan 1-Dec 31	Sufficient to water 1,500 head of cattle
27658	26 Ranch Inc.	Spring	Stockwatering	Cert. (8346)	16.140	0.0223	NW	SE	8	37	49	Santa Rita Field Spring	Jan 1-Dec 31	Sufficient to water 1,500 head of cattle
42932	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Cert. (15357)	29.36	0.041	NE	NE	22	37	49	Well No. 1	Jan 1-Dec 31	The TCD of this cert. and any certs. Issued under Permits 42931, 42934 and 61410 shall not exceed 196.42 acre-feet annually.
61410	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Cert. (15359)	49.20	0.068	SE	SW	22	37	49	Well No. 3	Jan 1-Dec 31	The TCD of this cert. and any certs. Issued under Permits 42931, 42932 and 42934 shall not exceed 196.42 acre-feet annually.

Table C-2 Water Rights within the Water Resources Study Area

App. No.	Owner of Record	Source	Manner of Use	Status	Annual Duty (afa)	Diversion Rate (cfs)	POINT OF DIVERSION					POD Designation	Duration of Use	Comments
							QQ	QTR	SEC	TWN (N)	RNG (E)			
62577	Meridian Gold Company	Underground	Mining & Milling	Permit	1448.000	2.00	SW	SW	16	37	49	N/A	Jan 1-Dec 31	The TCD of water under permits 62577, 62578 and 62579 shall not exceed 1500.00 acre-feet annually.
62578	Meridian Gold Company	Underground	Mining & Milling	Permit	1448.000	2.00	NE	SW	22	37	49	N/A	Jan 1-Dec 31	The TCD of water under permits 62577, 62578 and 62579 shall not exceed 1500.00 acre-feet annually.
70710	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Permit	24.010	0.03	SE	SE	15	37	49	Well No. 4	Jan 1-Dec 31	The TCD of water under Permits 42931, Cert. 15356; 42932, Cert. 15357; 42934, Cert. 15358; 61410, Cert. 15359; and 70710 shall not exceed 196.42 acre-feet annually.
73322	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Permit	15.78	0.022	SE	SE	15	37	49	Well No. 5	Jan 1-Dec 31	The TCD of water under Permits 42931, Cert. 15356; 42932, Cert. 15357; 61410, Cert. 15359; Permit 70710, Temp. Permit 73107T and Permit 73322 shall not exceed 196.42 acre-feet annually.
76543	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Permit	29.68	0.041	NW	SE	22	37	49	Well No. 5	Jan 1-Dec 31	The TCD of water under Permits 42932, Cert. 15357; 61410, Cert. 15359; Permits 70710, 73322 and 76543 shall not exceed 196.42 acre-feet annually.
78846T	Baroid Drilling Fluids, Inc.	Underground	Mining & Milling	Permit	48.39	0.067	SW	NW	22	37	49	N/A	Jan 1-Dec 31	The TCD of water under Permits 42932, Cert. 15357; 61410, Cert. 15359; Permits 70710, 73322, 76543 and 78846T shall not exceed 196.42 acre-feet annually.
V06237	26 Ranch Inc.	Spring	Stockwatering	Vested	N/A	0.003125	NW	NE	21	37	49	26 Ranch Spring #6	Jan 1-Dec 31	Sufficient to water 100 cattle and sheep
10208	Barrick Goldstrike Mines, Inc.	Stream	Irrigation	Cert. (2673)	21555.48	0.00000	NE	SW	27	39	48	Willow Creek	Mar 15 – Sept 15	

TCD = Total Combined Duty.

Source: Brown and Caldwell 2010b.



Legend

- Project Area Boundary
- Mining Disturbance
- State Highway
- Rural Road
- Vehicular Trail (4WD)
- Maximum Extent of 10-ft Groundwater Drawdown Contour
- Spingsnails (Sada 2007)

Springs (BLM 2006)
- Spring Complex
- Spring
- Spring/Seep

Seeps/Springs (BLM 2000b)
- Seeps/Springs

Points of Diversion (Brown and Caldwell 2010b)
- Active Spring Water Right
- Active Surface Water Right
- Active Underground Water Right

Wetland/Riparian Features (AECOM 2010a; JBR 2010)
- Open Water
- Riparian Area
- Wetland

Surface Ownership
- Bureau of Land Management
- Private

Vinini Formation
- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation
- 1:24k Geologic Maps (NBMG)

N

0 1 2 Miles

Hollister Underground Mine Project EIS

Figure C-1

Springs, Water Rights and Wetland/Riparian Areas in the Projected Maximum 10-foot Groundwater Drawdown Area

3/23/2012

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Geologic Units

- Qu - Alluvium, undivided
- QTgc - Gravel terraces and poorly exposed Carlin Formation
- Tvu - Tertiary volcanics, undivided
- Tcr - Craig Rhyolite (Miocene)
- Trp - Rhyolite Porphyry (Miocene)
- Tri - Rhyolite intrusions (Miocene)
- Trv - Rhyolite Velvet Area (Miocene)
- Tdh - Dacite (Eocene)
- Ttsm - Tuffs and tuffaceoous sedimentary rocks
- Tcu - Carlin Formation, sedimentary and volcanic rocks, undivided
- Dsc - Slaven Chert (Ordovician)
- Du - Devonian rocks, undivided
- Ov - Vinini Formation (Ordovician)
- PIPs - Pensylvanian-Permian Strathearn Formation
- dmr - Mining disturbance
- Water

Inset Map

Area of Detail

Elko County
Lander County
Eureka County

Legend

- Project Area Boundary
- Rural Road
- Maximum Extent of 10-ft Groundwater Drawdown Contour (2070)
- Springsnails (Sada 2007)
- Spring Complex

Springs

- Seep/Spring (BLM 2000b [CIA])
- Spring or Spring Complex (BLM 2006)

Wetland/Riparian Features (AECOM 2010a, JBR 2010)

- Riparian Area (ex. R-000)
- Wetland (ex. W-000)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Sources: AECOM 2010a; BLM 2000b; Brown & Caldwell 2010a,b; Coats 1986; JBR 2010; Sada 2007; Theodore et al. 2006; Wallace 2003a,b;

N

0 0.7 1.4 Miles

Hollister Underground Mine Project EIS

Figure C-2

Springs Associated with Vinini Formation and Adjacent Geologic Units

3/23/2012

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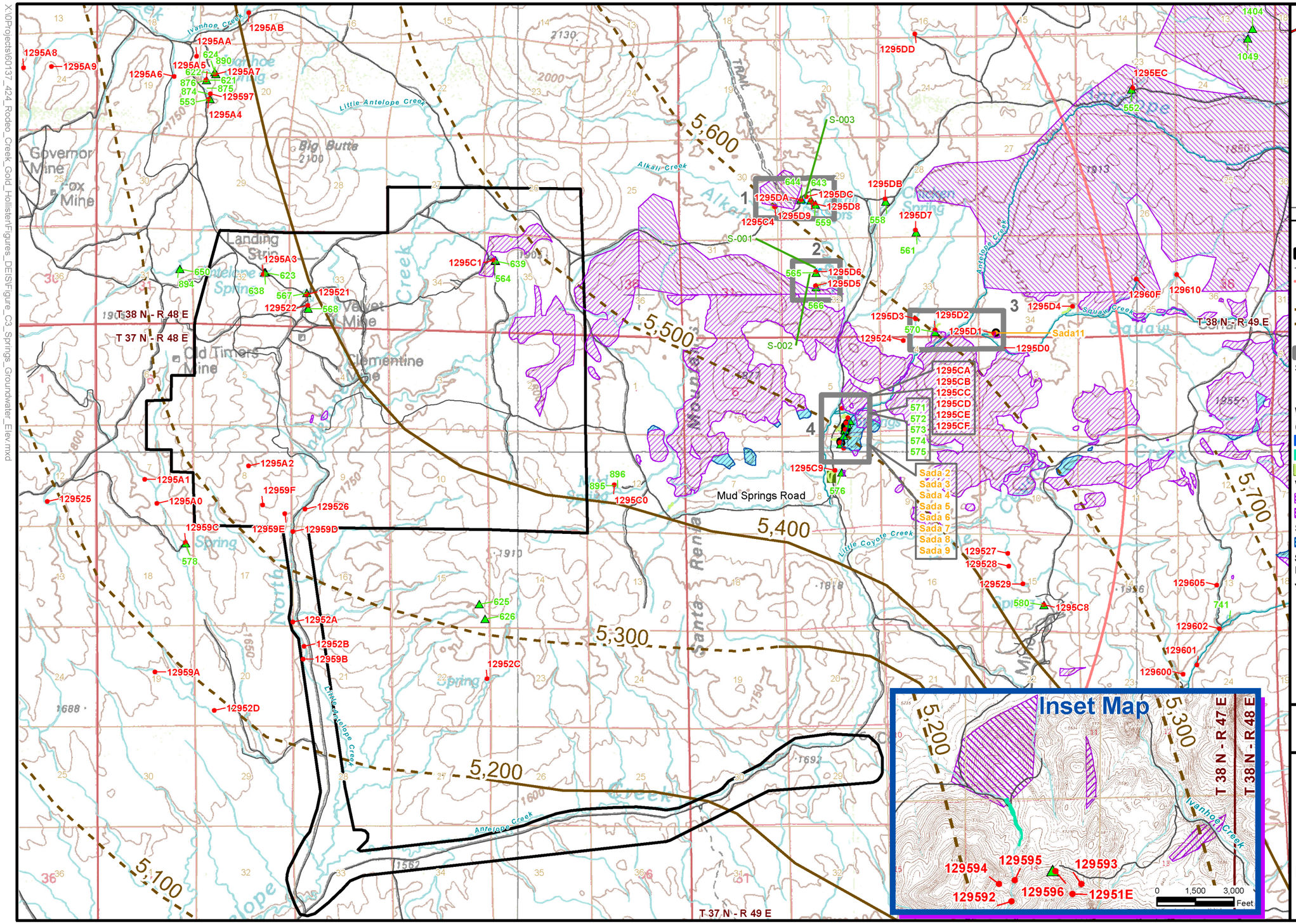

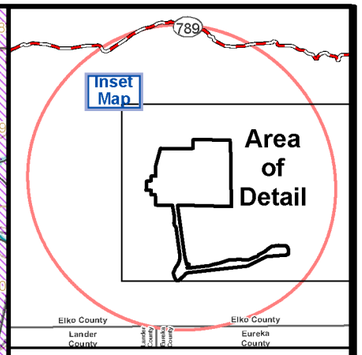

Legend

- Project Area Boundary
- Rural Road
- Maximum Extent of 10-ft Groundwater Drawdown Contour (2070)
- Water-table Contour
- Uncertain Water-table Contour Level
- Spingsnails (Sada 2007)
- Spring Complex

Springs

- Seep/Spring (BLM 2000b [CIA])
- Spring or Spring Complex (BLM 2006)

Wetland/Riparian Features (AECOM 2010a, JBR 2010)

- Open Water (ex. O-000)
- Riparian Area (ex. R-000)
- Wetland (ex. W-000)

Vinini Formation

- 1:24k Geologic Maps (NBMG)
- 1:250k Geologic Maps (USGS)

Strathearn Formation

- 1:24k Geologic Maps (NBMG)

Sources: AECOM 2010a; BLM 2000b; Brown & Caldwell 2010a,b; JBR 2010; Sada 2007.

N

0 0.75 1.5 Miles

Hollister Underground Mine Project EIS

Figure C-3

Springs Associated with Vinini and Strathearn Formations and Groundwater and Surface Elevations

3/23/2012

Appendix D

Soils

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1652	Ninemile, steep-Graley-Ninemile Association	Ninemile	35	400.5	H1	0	4	Very cobbly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	0
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			
1652	Ninemile, steep-Graley-Ninemile Association	Graley	30		H1	0	12	Very cobbly loam	Not Severe	Low	No	Poor	SL, R, BR, D, CC	0
					H2	12	17	Very gravelly clay, very gravelly clay loam	Not Severe		No			
					H3	17	21	Unweathered bedrock			No			
1652	Ninemile, steep-Graley-Ninemile Association	Ninemile	20		H1	0	4	Very cobbly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	0
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			
1652	Ninemile, steep-Graley-Ninemile Association	Welch	5		H1	0	10	Silt loam	Severe	Low	Yes	Fair	WD, CL, R	60
					H2	10	60	Sr to sandy loam to silty clay loam	Not Severe	Low	Yes			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1657	Ninemile-Alyan Association	Ninemile	45	645.2	H1	0	4	Gravelly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	4
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			
1657	Ninemile-Alyan Association	Alyan	40		H1	0	9	Gravelly loam	Not Severe	Low	No	Poor	SL, CL, R, BR, D, OM	9
					H2	9	16	Clay	Not Severe		No			
					H3	16	28	Gravelly clay	Not Severe		No			
					H4	28	32	Very gravelly clay	Not Severe		No			
					H5	32	36	Unweathered bedrock			No			
1657	Ninemile-Alyan Association	Welch	5		H1	0	14	Silt loam	Severe	Moderate	Yes	Fair	WD, CL, R	62
					H2	14	62	Sr to sandy loam to silty clay loam	Not Severe		Yes			
1659	Ninemile-Carstump Association	Ninemile	50	2,470.8	H1	0	4	Gravelly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	4
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1659	Ninemile-Carstump Association	Carstump	35		H1	0	14	Gravelly loam	Not Severe	Moderate	No	Poor	CL, R, SL, BR, OM, D	14
					H2	14	36	Very cobbly clay, very gravelly clay	Not Severe		No			
					H3	36	40	Unweathered bedrock			No			
1720	Quarz-Alyan-Ninemile Association	Quarz	35	1,367.6	H1	0	6	Very gravelly loam	Not Severe	Low	No	Poor	SL, R, CL, BR, D	0
					H2	6	21	Very gravelly clay, very gravelly clay loam	Not Severe		No			
					H3	21	25	Unweathered bedrock			No			
1720	Quarz-Alyan-Ninemile Association	Alyan	35	1,367.6	H1	0	9	Cobbly loam	Not Severe	Low	No	Poor	SL, CL, R, BR, D, OM	0
					H2	9	16	Clay	Not Severe		No			
					H3	16	28	Gravelly clay	Not Severe		No			
					H4	28	32	Very gravelly clay	Not Severe		No			
					H5	32	36	Unweathered bedrock			No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1720	Quarz-Alyan-Ninemile Association	Ninemile	25	1,367.6	H1	0	4	Very cobbly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	0
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			
1802	Bregar-Ninemile-Pequop Association	Bregar	40	1,932.8	H1	0	2	Very gravelly loam	Not Severe	Low	No	Poor	R, BR, SL, D, OM	0
					H2	2	7	Extremely cobbly clay loam, very gravelly clay loam, very gravelly sandy clay loam	Not Severe		No			
					H3	7	11	Unweathered bedrock			No			
1802	Bregar-Ninemile-Pequop Association	Ninemile	30	1,932.8	H1	0	4	Gravelly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	4
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1802	Bregar-Ninemile-Pequop Association	Pequop	15	1,932.8	H1	0	12	Gravelly loam	Not Severe	Moderate	No	Fair	SL, R, D	12
					H2	12	50	Very gravelly clay loam, very gravelly sandy clay loam, extremely gravelly sandy clay loam	Not Severe		No			
					H3	50	60	Very gravelly loam, extremely gravelly loam	Not Severe		No			
1888	Chen-Pie Creek-Alyan Association	Crooked Creek	2	72.4	H1	0	3	Silty clay loam	Severe	Low	Yes	Poor	CL, WD	3
					H2	3	37	Clay, silty clay	Not Severe		Yes			
					H3	37	60	Clay loam, silty clay loam, silt loam	Not Severe		Yes			
1888	Chen-Pie Creek-Alyan Association	Chen	40	72.4	H1	0	7	Cobbly loam	Not Severe	Moderate	No	Poor	SL, CL, R, BR, D, OM	0
					H2	7	15	Very cobbly clay, very gravelly clay, extremely gravelly clay	Not Severe		No			
					H3	15	19	Unweathered bedrock			No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
1888	Chen-Pie Creek-Alyan Association	Pie Creek	25	72.4	H1	0	5	Very cobbly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	0
					H2	5	16	Clay	Not Severe		No			
					H3	16	23	Clay, clay loam	Not Severe		No			
					H4	23	27	Unweathered bedrock			No			
1888	Chen-Pie Creek-Alyan Association	Alyan	20	72.4	H1	0	9	Gravelly loam	Not Severe	Low	No	Poor	SL, CL, R, BR, D, OM	9
					H2	9	16	Clay	Not Severe		No			
					H3	16	28	Gravelly clay	Not Severe		No			
					H4	28	32	Very gravelly clay	Not Severe		No			
					H5	32	36	Unweathered bedrock			No			
2004	Alyan, cobbly loam-Ninemile-Alyan Association	Welch	5	214.1	H1	0	10	Silt loam	Severe	Low	Yes	Fair	WD, CL, R	60
					H2	10	60	Sr to sandy loam to silty clay loam	Not Severe		Yes			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
2004	Alyan, cobbly loam-Ninemile-Alyan Association	Alyan	35	214.1	H1	0	9	Cobbly loam	Not Severe	Low	No	Poor	SL, CL, R, BR, D, OM	0
					H2	9	16	Clay	Not Severe		No			
					H3	16	28	Gravelly clay	Not Severe		No			
					H4	28	32	Very gravelly clay	Not Severe		No			
					H5	32	36	Unweathered bedrock			No			
2004	Alyan, cobbly loam-Ninemile-Alyan Association	Ninemile	30	214.1	H1	0	4	Gravelly loam	Not Severe	Low	No	Poor	CL, BR, SL, R, D	4
					H2	4	19	Clay, gravelly clay	Not Severe		No			
					H3	19	23	Unweathered bedrock			No			
2004	Alyan, cobbly loam-Ninemile-Alyan Association	Alyan	25	214.1	H1	0	9	Gravelly loam	Not Severe	Low	No	Poor	SL, CL, R, BR, D, OM	9
					H2	9	16	Clay	Not Severe		No			
					H3	16	28	Gravelly clay	Not Severe		No			
					H4	28	32	Very gravelly clay	Not Severe		No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
					H5	32	36	Unweathered bedrock			No			
309	Akler-Susie Creek Association	Akler	45	1,037.7	H1	0	4	Loam	Severe	Moderate	No	Poor	CL, BR, SL, R, D, OM, E	4
					H2	4	18	Clay	Not Severe		No			
					H3	18	22	Weathered bedrock			No			
309	Akler-Susie Creek Association	Susie Creek	40	1,037.7	H1	0	10	Loam	Severe	Moderate	No	Poor	CL, SL, OM	10
					H2	10	30	Clay, clay loam	Not Severe		No			
					H3	30	60	Clay loam, loam	Not Severe		No			
458	Donna-Stampede Association	Donna	45	39.7	H1	0	10	Gravelly loam	Severe	Moderate	No	Poor	CL, R, D, E	10
					H2	10	30	Clay	Not Severe		No			
					H3	30	48	Indurated			No			
					H4	48	60	Stratified extremely gravelly sandy loam to gravelly sandy clay loam	Not Severe		No			

Table D-1 Characteristics and Reclamation Suitabilities of Soils in the Project Area

Map Unit Symbol	Map Unit Name	Component Name	Percent of Map Unit	Total Acres	Horizon	Horizon Depth (inches)		Texture	Water Erosion[1]	Wind Erosion[2]	Hydric Rating	Growth Media Potential	Limiting Factors[3]	RSD[4]
						Top	Bottom							
458	Donna-Stampede Association	Stampede	40	39.7	H1	0	16	Gravelly loam	Severe	Moderate	No	Poor	CL, SL, OM, E	16
					H2	16	37	Clay, silty clay	Not Severe		No			
					H3	37	60	Indurated			No			

[1] Water erosion hazard class determined from Soil Erodibility Factor (Kw).

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

[3] Limiting Factors:

BR = Depth to Bedrock
CC = Cobble Content
D = Droughty
E = Erosion
OM = Low Organic Matter
R = Rock Fragments
S = Salinity
SL = Slope
SD = Too Sandy
CL = Too Clayey
WD = Depth to Water table

[4] RSD = Recommended Soil Salvage Depth (in inches).

Source: USDA-NRCS 2010.

Appendix E

Special Status Species

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
MAMMALS					
Pallid bat *Antrozous pallidus*	BLM; NV-SP	Range: Throughout Nevada. Habitat: Found in a variety of habitats from desert scrub to forests. Roosts in a variety of structures including mines, caves, buildings, and trees. Intolerant of roosts in excess of 40°C.	High. This species has been documented southwest of the study area along Rock Creek. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Townsend's big-eared bat *Corynorhinus townsendii*	BLM; NV-SPS	Range: Throughout Nevada. Habitat: Highly associated with caves and mines. Very susceptible to disturbance at roost sites. Periodically moves to alternate roosts and actively forages and drinks throughout the winter. Typically forages in open habitats.	High. This species has been documented southwest of the study area along Rock Creek. Suitable foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Big brown bat *Eptesicus fuscus*	BLM	Range: Throughout Nevada. Habitat: Found in a variety of habitats including forests, shrublands, and agricultural and urban areas. Roosts in a variety of structures including mines, caves, buildings, rock crevices, and trees. More tolerant of human habitation than other bat species. Roosts in groups up to several hundred individuals.	High. This species has been documented southeast of the study area in the Santa Renia Mountains. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Silver-haired bat *Lasionycteris noctivagans*	BLM	Range: Throughout Nevada but occurs primarily in forest and riparian habitats. Habitat: A forest associated species often found at higher elevations in piñon-juniper, subalpine fir, aspen and willow habitats. Roosts almost exclusively in trees in the summer. Frequently alternates roost sites. Maternity roost sites are usually in woodpecker holes.	Low. Marginal foraging habitat occurs within the study area.	No.	Bradley et al. 2006.
Western red bat *Lasiurus blossevilli*	BLM	Range: Known from only a few locations in Nevada in Lincoln and Clark counties. Habitat: Found primarily in wooded habitats. Species is a solitary rooster in trees and under leaf litter. Originally thought to only be a migrant in Nevada but small breeding populations may exist in the Fallon and Muddy River areas.	None.	Yes. This species' known distribution in Nevada is outside the study area.	Bradley et al. 2006.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Hoary bat *Lasiurus cinereus*	BLM	Range: Patchy distribution throughout Nevada. Habitat: Tree-associated species. Found primarily in forested upland habitats, as well as in forest riparian zones, and agriculture habitats. May occur in park and garden settings in urban areas. A solitary rooster that typically roosts in trees.	Low. Marginal roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006.
California myotis *Myotis californicus*	BLM	Range: Throughout Nevada but mainly found in the southern half of the state at lower elevations. Habitat: Found in a variety of habitats from desert scrub to forests. Roosts in a variety of structures including mines, caves, buildings, and trees. Actively forages throughout the winter.	Moderate. Marginal roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Small-footed myotis *Myotis ciliolabrum*	BLM	Range: Throughout Nevada. Habitat: Found in a variety of habitats from desert scrub to pine-fir forests. Roosts in caves, mines and trees. Forages in open areas.	High. This species has been documented southeast of the study area in the Santa Renia Mountains. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Long-eared myotis *Myotis evotis*	BLM	Range: Throughout Nevada, primarily at higher elevations. Habitat: Primarily a forest-associated species but also utilizes sagebrush and desert scrub habitats. Roosts in caves, mines and under bridges. May forage within mine and cave structures, gleaning moths from the rock walls.	High. This species has been documented southeast of the study area in the Santa Renia Mountains. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Little brown myotis *Myotis lucifugus*	BLM	Range: Found primarily in the northern part of Nevada. Habitat: Found at higher elevations in coniferous forest. Requires a nearby water source. Roosts in trees, buildings, caves, and mines. One of the species most commonly found in human structures.	Low. Marginal foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Long-legged myotis *Myotis volans*	BLM	Range: Throughout Nevada but absent from the low desert. Habitat: Piñon-juniper and other higher elevation forest habitats as well as sagebrush shrublands. Night roosts and hibernacula located in caves and mines. Forages in open areas at canopy height.	High. This species has been documented southeast of the study area in the Santa Renia Mountains. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Yuma myotis *Myotis yumanensis*	BLM	Range: Found in the western, southern and north-central part of Nevada. Habitat: Found in a wide variety of habitats from low to mid-elevations, including sagebrush, salt desert scrub, agriculture, playa, and riparian habitats. One of the species that is most tolerant of human habitation and one of the few that thrives in a relatively urbanized environment. Roosts in buildings, trees, mines, caves, bridges and other man-made structures.	High. This species has been documented northeast of the study area in the Tuscarora Mountains. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006; NDOW 2010a.
Western pipistrelle bat *Pipstrellus hesperus*	BLM	Range: Throughout most of Nevada. More common in the western and southern portions. Habitat: Lower and Upper Sonoran desert habitats of blackbrush, creosote, salt desert shrub and sagebrush, with occasional occurrence in ponderosa pine and piñon-juniper, usually in association with rock features such as granite boulders and canyons. Roosts in mainly in rock crevices.	High. This species has been documented south of the study area along Rock Creek. Suitable roosting and foraging habitat occurs within the study area.	No.	Bradley et al. 2006.
Brazilian free-tailed bat *Tadarida braziliensis*	BLM; NV-SP	Range: Throughout Nevada. Habitat: Found in a wide variety of habitats from desert scrub to coniferous forests. Roosts in caves, mines, trees, bridges, and buildings. Colonies often number in the thousands.	Moderate. This species has not been documented in the project region. The nearest record is approximately 35 miles southeast of the study area along the Humboldt River near Elko, Nevada. However, suitable foraging habitat occurs within the study area.	No.	Bradley et al. 2006.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Preble's shrew *Sorex preblei*	BLM	Range: Northern Nevada. Habitat: Found in a variety of habitats including arid grassland and sagebrush shrubland, forest edges, and willow-fringed creeks and marshes.	High. This species has been recorded approximately 35 miles northeast of the study area near Sheep Creek. Suitable habitat occurs within the study area.	No.	Ports and George 1990; Wildlife Action Plan Team 2006.
Fletcher dark kangaroo mouse *Microdipodops megacephalus nasutus*	BLM; NV-SPS	Range: Throughout Nevada. Habitat: Intermountain desert scrub, sagebrush, grasslands and meadows, badlands and dunes, and areas around desert playas and ephemeral pools.	High. This species has been recorded in Elko County near Halleck, Nevada. Suitable habitat occurs within the study area.	No.	O'Farrell and Blaustein 1974; Wildlife Action Plan Team 2006.
Pygmy rabbit *Brachylagus idahoensis*	BLM	Range: Throughout Nevada but typically found in areas dominated by sagebrush. Habitat: Requires dense sagebrush for cover as well as appropriate deep soils for burrowing (i.e., high clay content). Often found in drainages with taller sagebrush present.	High. This species has been recorded along the Mud Springs Road. The study area contains patches of suitable unburned sagebrush habitat.	No.	AECOM 2010b; BLM 2004b; NDOW 2010a.
River otter *Lontra canadensis*	BLM	Range: Northeastern to central-western Nevada. Habitat: Riverine systems and associated marshes, lakes, and ponds. When inactive, occupies hollow logs, spaces under roots, logs, or overhangs, abandoned beaver lodges, dense thickets near water, or burrows of other animal; such sites also are used for rearing young.	None.	Yes. No suitable habitat occurs within the study area. The nearest documented records are south of the study area along the Humboldt River.	Boyle 2006; Wildlife Action Plan Team 2006.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
BIRDS					
Bald eagle *Haliaeetus leucocephalus*	NV-E	Range: Throughout Nevada. Habitat: Generally nests and roosts in close proximity to large water bodies including rivers, lakes, and reservoirs. Requires abundant food sources such as fish and waterfowl. Breeding period is February 15-July-15.	Moderate: Occurrence within the study area would be limited to migrating and foraging individuals.	No.	BLM 2004a; Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990.
Northern goshawk *Accipiter gentilis*	BLM; NV-SPS	Range: Primarily found in the northern two-thirds of Nevada. Habitat: Deep conifer-dominated mixed forests. May exhibit seasonal migrations depending on prey availability. Preferred nesting habitat is aspen stands within coniferous forests along perennial streams. Breeding period is April 15-August 1.	None.	Yes. No suitable habitat occurs within the study area.	Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990.
Swainson's hawk *Buteo swainsoni*	BLM	Range: Found throughout Nevada, typically in agricultural areas. Habitat: Agricultural valleys and associated uplands. Nests in large shrubs and trees such as cottonwood, willows and aspen. Breeding period is April 1-July 15.	High. Known nesting areas occur south of the study area along the Humboldt River. No known nests occur within the study area. Suitable nesting and foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990; NDOW 2010a.
Ferruginous hawk *Buteo regalis*	BLM	Range: Throughout Nevada; mainly in the east-central portion of the state. Habitat: Dry, open country. Nests usually occur in trees at the interface between piñon-juniper and desert scrub/grasslands. Forages over open areas with an adequate prey base. Breeding period is March 15-July 15.	High. One active nest occurs south of Antelope Creek within the study area. Suitable nesting and foraging habitat occurs throughout the study area.	No.	AECOM 2010c; Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990; NDOW 2010a.
Golden eagle *Aquila chrysaetos*	BLM	Range: Throughout Nevada. Habitat: Mountain or hilly terrain. Nests usually occur on cliffs or in trees. Forages over open areas with an adequate prey base. Breeding period is March 15-July 15.	High. No known nests occur within the study area. However, this species has been documented in the study area. Suitable foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990; NDOW 2010a.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Peregrine falcon *Falco peregrines*	BLM; NV-E	Range: Southwest and extreme southeast Nevada Habitat: Open country near cliffs. Typically migrates south of U.S. during winter months. Nests on cliffs and rock ledges. Forages in open areas typically near water. Breeding period is March 15-July 15.	None.	Yes. This species known distribution in Nevada is outside the study area.	Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990.
Prairie falcon *Falco mexicanus*	BLM	Range: Throughout Nevada. Habitat: Dry, open country including desert scrub and sagebrush grasslands. Usually nests on cliffs in proximity to suitable foraging habitat. Breeding period is March 15-July 15.	High. No known nests occur within the study area. However, this species has been documented nesting in the project vicinity approximately 2 miles northeast of the Hollister site. Suitable foraging habitat occurs within the study area.	No.	BLM 2004a; Floyd et al. 2007; Herron et al. 1985; Johnsgard 1990; NDOW 2010a.
Greater sage-grouse *Centrocercus urophasianus*	FC; BLM	Range: Throughout Nevada in areas with sagebrush. Habitat: Sagebrush grasslands. Leks are located in open areas in close proximity to escape cover. Nests are located in sagebrush habitat, typically within 2 miles of the lek. Broods are raised in wet, grassy areas near sagebrush. Winter habitat consists of south and east facing slopes with minimal snow cover. Breeding period (including displaying, nesting, and brooding) is March 1-July 31.	High. Three active leks and one inactive lek occur within the study area. Suitable nesting, brooding, and wintering habitat occurs within the study area.	No.	Connelly et al. 2000; Floyd et al. 2007; NDOW 2010a, 2009a; Neel 1999; Wildlife Action Plan Team 2006.
Sandhill crane *Grus canadensis*	BLM	Range: Breeds in the lower river valleys and interior basins of the northeastern and east-central regions of Nevada. Habitat: Large irrigated hay meadows, flooded pastures, and grasslands. Also found in agricultural grain fields certain times of the year. Approximately 90% of nesting pairs are found in Elko County with additional nesting pairs in White Pine, Eureka, Lander, northern Lincoln and Nye, and eastern Humboldt counties. Breeding period is April 15-July 15.	Low. Marginal habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Long-billed curlew *Numenius americanus*	BLM	Range: A confirmed breeder at Sheldon NWR in northern Washoe County, Ruby Lake NWR in Elko County, Lahontan Valley in Churchill County, and Fish Creek Ranch in Eureka County. Habitat: Prefer closely cropped grasslands, pastures, wet or dry meadows, either on the fringe of a marsh or in a meadow or broad riverine floodplain such as the Humboldt River. Non-breeding feeding areas include irrigated pastures and croplands, shallow wetlands, and newly plowed fields. Breeding period is April 15-July 15.	High. Marginal habitat occurs within the study area; however, a population has become established in the vicinity.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Black tern *Chlidonias niger*	BLM	Range: Nests on shallow lakes and wetlands from Sheldon NWR to Ruby Lakes NWR south to Mason Valley WMA in western Nevada. Habitat: Prefers marshes in very fresh water, typically characterized by cattail and/or spikerush. Breeding period is April 15-July 15.	Low. Marginal habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Western Yellow-billed cuckoo *Coccyzus americanus*	FC; NV-SPS	Range: Found mainly in the western and southern portions of Nevada. Habitat: Found in cottonwood, willow, riparian and other woodland habitats. Prefer dense under-stories. Breeding period is April 15-July 15.	Low. Marginal habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Western burrowing owl *Athene cunicularia hypugea*	BLM	Range: Throughout Nevada. Habitat: Open country from desert scrub to grasslands. Often found in or around prairie dog colonies. Nests in burrows. Breeding period is April 15-August 15.	High. Suitable nesting and foraging habitat occurs within the study area.	No.	BLM 2004a; Floyd et al. 2007; Herron et al. 1985.
Long-eared owl *Asio otus*	BLM	Range: Throughout Nevada. Found primarily at higher elevations. Habitat: Juniper woodlands, riparian forests, and coniferous forests. Will often take over old hawk, crow or magpie nests. Breeding period is February 15-July 15.	Low. Suitable foraging habitat occurs within the study area. However, roosting and nesting habitat is lacking within the study area.	No.	Floyd et al. 2007; Herron et al. 1985.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Short-eared owl *Asio flammues*	BLM	Range: Throughout Nevada. Habitat: Open country from desert-scrub to sagebrush-grasslands. Nests and roosts on the ground. Forages primarily at dawn and dusk. Breeding period is February 15-July 15.	High. An active nest was found along Antelope Creek during field surveys. Suitable nesting and foraging habitat occurs within the study area.	No.	AECOM 2010c; Floyd et al. 2007; Herron et al. 1985.
Lewis's woodpecker *Melanerpes lewis*	BLM	Range: A resident breeder in isolated pockets mainly in the northern half of the state. Habitat: During the breeding season, this species prefers open habitats that facilitate its foraging behavior of hawking for insects. Scattered trees and/or snags are necessary for nesting. Open or park-like ponderosa pine, burned-over stands of Douglas fir, mixed conifer, piñon-juniper, riparian, and oak woodlands are preferred nesting areas. Furthermore, this species prefers areas with a grassy and bushy understory. Breeding period is April 15-July 15.	Moderate. Suitable nesting and foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Pinyon jay *Gymnorthinus cyanocephalus*	BLM	Range: Throughout Nevada, although more common in the central and southern portions of the state. Habitat: Piñon-juniper woodlands. Less frequently found in pine forests and sagebrush grasslands. Distribution is determined by availability of food resources. Nests in loose colonies. Breeding period is April 15-July 15.	Moderate. Suitable nesting and foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Juniper titmouse *Baoolophus griseus*	BLM	Range: Found mainly in piñon-juniper woodlands from Interstate 80 south to the Colorado River. Habitat: Strongly associated with piñon-juniper woodlands and to a lesser extent, sagebrush shrublands. Snags and heart rot are assumed to be important in providing nesting cavities. Dense foliage and closed canopies are preferred, while thin understory and ground cover are preferred for feeding activities. Breeding period is April 15-July 15.	Moderate. Suitable nesting and foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.

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Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
Loggerhead shrike *Lanius ludovicianus*	BLM; NV-SPS	Range: Throughout Nevada. Habitat: Open country including desert scrub and sagebrush grasslands. Nests and forages in brushy areas. Breeding period is April 15-July 15.	High. This species was observed during field surveys. Suitable nesting and foraging habitat occurs within the study area.	No.	AECOM 2010c; Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Yellow-breasted chat *Icteria virens*	BLM	Range: Throughout Nevada although more common in the eastern portion of the state. Habitat: Found in cottonwood, willow, riparian and other woodland habitats. Prefer dense understories. Breeding period is April 15-July 15.	Low. Marginal habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Vesper sparrow *Pooecetes gramineus*	BLM	Range: Nesting has been recorded only in the northern half of Nevada. However, the higher mountain ranges in southern Nevada may provide nesting habitat for the species as well. Habitat: Nests in various open shrub habitats from high elevation valleys to higher mountain slopes and basins. Breeding period is April 15-July 15.	High. Suitable nesting and foraging habitat occurs within the study area.	No.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.
Black rosy-finch *Leucosticte atrata*	BLM	Range: In Nevada, this species breeds on the highest mountains of Elko and White Pine counties. Habitat: Breeds and nests in alpine tundra habitat. Nests on high ridges and peaks (9,000 to 13,000 feet in elevation) near rock cover, usually in crevices and holes in cliff sides. Breeding period is May 1-July 15.	None.	Yes. No suitable habitat occurs within the study area.	Floyd et al. 2007; Neel 1999; Wildlife Action Plan Team 2006.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
AMPHIBIANS					
Columbia spotted frog *Rana luteiventris*	FC; NV-SP	Range: Central (Nye County) and northeast (Elko and Eureka Counties), usually at elevations between 5,600 and 8,700 feet. Habitat: Quiet aquatic habitats including perennial streams, ponds, springs, lakes and marshes. May travel to uplands during wet weather. Females typically lay eggs in late April and May. Tadpoles develop into frogs from mid-summer to late fall.	Low. Known populations exist east of the study area in the Maggie Creek drainage. No known records of this species exist for the study area, although marginal habitat occurs along Little Antelope Creek and Antelope Creek.	No.	AECOM 2010d; BLM 2008b; NDOW 2010a; USFWS 2010.
Northern leopard frog *Rana pipiens*	BLM; NV-SP	Range: Isolated habitats throughout Nevada. Absent from the southwestern portion of the state. Habitat: Springs, slow streams, marshes, bogs, ponds, canals, flood plains, reservoirs, and lakes. Usually found in permanent water with rooted aquatic vegetation. During the summer, commonly inhabits wet meadows and fields. Females typically lay eggs in late April and May. Tadpoles develop into frogs from mid-summer to late fall.	Low. No known records of this species exist for the study area, although marginal habitat occurs along Little Antelope Creek and Antelope Creek.	No.	AECOM 2010d; NatureServe Explorer 2010a.
FISH					
Lahontan cutthroat trout *Oncorhychus clarkii henshawi*	FT	Range: Found in the Lahontan Basin of northern Nevada, and eastern Oregon. Habitat: Occurs in a wide variety of habitats including lakes, rivers, and creeks. Riverine habitat includes cool flowing water with available cover of well-vegetated and stable stream banks.	None.	Yes. No suitable habitat occurs within the study area.	USFWS 2010.
Interior redband trout *Oncorhynchus mykiss gairdneri*	BLM	Range: Washington, Idaho, Oregon, Montana, and Nevada. In Nevada, this species occurs in Elko county in the Long-Ruby Valleys watershed. Habitat: Low-gradient, medium-elevation stream reaches with an abundance of complex pools. Winter habitat includes deep pools with extensive amounts of cover in third-order mountain streams.	None.	Yes. No suitable habitat occurs within the study area.	Behnke 1992; NatureServe Explorer 2010b.

Table E-1 Special Status Species Identified for the Hollister Underground Mine Project

Common Name/ Scientific Name	Status[1]	Range Habitat Requirements	Potential for Occurrence Within or Near the Study area	Eliminated from Detailed Analysis	References
IINVERTEBRATES					
Mattoni's blue *Euphilotes pallescens mattoni*	BLM	Range: Throughout Nevada. Habitat: Arid areas such as desert flats and edges of sand dunes. This species is typically most abundant from early July to September.	None.	Yes. No suitable habitat occurs within the study area.	BLM 2004a; Butterflies and Moths of North America Online 2010.

[1] Status:

FT-Federally Threatened Species

FC-Federal Candidate Species

BLM-BLM Sensitive Species

NV-SP-Nevada State Protected

NV-SPS-Nevada State Protected Sensitive

Note: See Chapter 6.0, References, for references cited in this table.

Appendix F

Previous Cultural Resources Investigations Within the Project Area and CESA

Table F-1 Previous Cultural Resources Investigations Within the Project Area and CESA

Agency Report No.	NSM Report No.	Report Title/Name	Author	Report Date	CESA	Project Area	Class III
1-0059 (N)	4-75	Boulder Field Fence #4736	Peterson, Harry	1976	Yes	No	Yes
1-0102 (P)	4-116	Lucky Spring Canyon Development (Pipeline, Tank and Guzzler)	Waski, Lynda L.	1977	No	Yes	Yes
1-0162 (P)		25 Allotment Fences and Cattleguards	Armentrout, Lynda L.	1978	Yes	Yes	Yes
1-0170 (P)/2-83 (P)	18-9	Report of Archaeological Reconnaissance Along Proposed 230kV Transmission Line Right-of-Way of Sierra Pacific Power Company. Part II: Valmy to Jackpot, Nevada	Rusco, Mary and Evelyn Seelinger	1974	Yes	No	Yes
1-0185 (P)	4-205-1	Willow Springs Development and Pipeline	Armentrout, Lynda L.	1978	Yes	No	Yes
1-0185 (P) addendum	4-205-2	Willow Springs - Pipeline, Access Road for Construction	Armentrout, Lynda L.	1978	Yes	No	Yes
1-0253 (P)		Cultural Resource Survey of the Sierra Pacific Power Company 230/345 kV Transmission Line, Nevada. Part 4: Rossi Reroute	Napton, L. Kyle, and Elizabeth Anne Greathouse	1980	Yes	No	Yes
1-0310 (N)	4-291	O'Brian Resources Corp. Geothermal Temperature Gradient Holes, NOI-N1-02-81	Witter, Donald	1980	Yes	No	Yes
1-0361 (P)	4-171-1	Rossi Mine Plan Of Operations Inventory and Clearance	Murphy, Tim	1981	Yes	No	Yes
1-0484 (P)	4-323-1	Cordex Plan of Operations NV-10-12P-81	Jaynes, Stanley	1981	Yes	No	Yes
1-0489 (P)	4-530	U.S. Steel Notice of Mineral Exploration, NV-010-29N-81	Jaynes, Stanley	1981	No	Yes	Yes
1-0561 (P)	4-617	Willow Springs Pipeline and Troughs	Jaynes, Stanley	1982	Yes	No	Yes
1-0709 (P)		Archaeological Report on the Evaluation of Sites CrNV-12-1986 to 1989 and CrNV-12-2000 to 2004, the Dee Gold Mine, Elko County	Ellis, Robert R.	1983	Yes	No	Yes
1-0761 (P)		Archaeological Investigations at the Rossi Mine Sites, Elko County, Nevada	Rusco, Mary K.	1982			No
1-0764 (P)	4-568	Notice for Phil Davis Claims	Jaynes, Stanley	1982	Yes	No	Yes
1-0800 (P)	4-1098	U.S. Steel Notice of Mineral Exploration, NV-010-21N-84	Foulkes, Gary	1984	Yes	No	Yes
1-1101 (P)	4-665	An Intensive Archaeological Reconnaissance of the Tosawihi Quarries Archaeological District (26EK3032)	Elston, Robert G., Christopher Raven and Elizabeth Budy	1987	No	Yes	Yes
1-1108 (P)		An Intensive Reconnaissance of Historic Resources in the Tosawihi Quarries Archaeological District, Elko County, Nevada	Zeier, Charles	1987	No	Yes	Yes, but same as 1-1101
1-1124 (P)	4-540	An Archaeological Survey of the U.S. Steel Project Area	Budy, Elizabeth E.	1987	No	Yes	Yes
1-1161 (P)		An Intensive Archaeological Survey of the USX-East	Raven, Christopher	1988	No	Yes	Yes
1-1181 (P)	4-663-1	An Intensive Archaeological Reconnaissance of the Proposed Ivanhoe/USX Access Road	Drews, Michael P.	1988	Yes	Yes	Yes
1-1181 (P)	4-664	The Tosawihi Quarries: An Archaeological Testing Program	Elston, Robert G.	1989		Yes	No
1-1181-1 (P)	4-663	Archaeological Reconnaissance of Some Re-ailgnment Alternatives for the Proposed Ivanhoe/USX Access Road	Callaway, Cashion	1988	Yes	Yes	Yes
1-1207 (P)		An Archaeological Data Recovery Plan for the Ivanhoe Project	IMR	1988		Yes	No
1-1240 (P)	18-274	Archaeological Survey of Sierra Pacific Power Company's Proposed Ivanhoe 120 kV Extention	McLane, Alvin R.	1988	Yes	No	Yes
1-1245 (P)	18-275	An Archaeological Survey of Sierra Pacific Power Company's Coyote Creek 120 kV Extention	Price, Barry	1989	Yes	No	Yes
1-1260 (P)		Ivanhoe Borrow Pit	Callaway, Cashion	1989	Yes	Yes	Yes
1-1326 (P)	4-667	Ivanhoe Main Access-Final 1 1/2 Miles (Main Access Road and Office Compound)	Botkin, Steve	1990	No	Yes	Yes
1-1327 (P)	4-668	Ivanhoe Causeway Interlocality Assessment	Botkin, Steve	1990	No	Yes	Yes
1-1328 (P)		A Class III Cultural Resource Inventory of the Little Antelope Creek Access Road, Elko County, Nevada	Stoner, Edward J., and Robert R. Peterson	1990	No	Yes	Yes
1-1328A (N) Addendum		Water Well 6	Elston, Robert G.	1990	No	Yes	Yes
1-1360 (P)		Reevaluation of Various Archaeological Sites in the Ivanhoe Mining District, Elko County, Nevada	Raven, Christopher	1990		Yes	No

Table F-1 Previous Cultural Resources Investigations Within the Project Area and CESA

Agency Report No.	NSM Report No.	Report Title/Name	Author	Report Date	CESA	Project Area	Class III
1-1362 (P)		Archaeological Investigations at Tosawihi, A Great Basin Quarry, Part 3: A Perspective from Locality 36	Elston, Robert G., and Christopher Raven	1992		Yes	No
1-1368 (P)	4-544	Archaeological Reconnaissance for the Coyote Creek Substation Access Road Improvement, Elko County, Nevada	King, Ronald F.	1990	Yes	No	Yes
1-1408 (P)	4-587	A Cultural Resources Inventory of the Waste Dump Expansion Project for Dee Gold Mining Company in Elko County, Nevada	Johnson, Frank	1991	Yes	No	Yes
1-1422 (P)		A Cultural Resource Inventory of the Humboldt Gold Venture Exploration Project, West of the Tuscarora Mountains, Elko County, Nevada	Billat, Scott E.	1991	Yes	No	Yes
1-1428 (P)	4-1411	An Inspection of 22 Proposed Drill Sites and Access Routes in the Tosawihi Vicinity	Carambelas, Kristopher R.	1991	No	Yes	Yes
1-1440 (P)	18-293	A Cultural Resource Inventory for Dee Gold	Johnson, Frank	1991	Yes	No	Yes
1-1447 (P)		An Inspection of 15 Proposed Drill Sites and Access Routes in the Tosawihi Vicinity	IMR	1991	No	Yes	Yes
1-1448 (P)	4-671	Little Antelope Creek Riparrian Fence Enhancement	Carambelas, Kristopher	1991	No	Yes	Yes
1-1449 (P)	4-670	Silver Cloud Road Modifications	Carambelas, Kristopher	1991	Yes	Yes	Yes
1-1461 (P)		A Class III Archaeological Survey of the Ivanhoe Expansion Project	Botkin, Steve	1991	No	Yes	Yes
1-1466 (P)		An Inspection of 16 Proposed Drill Sites and Access Routes in the Tosawihi Quarries (26EK3032)	Raven, Christopher	1991	No	Yes	Yes
1-1467 (P)		Archaeological Investigations at Tosawihi, A Great Basin Quarry, Part 2: A Regional Study	Leach, Melinda, and Steve Botkin	1992	No	Yes	Class II
1-1469 (N)		Ivanhoe Air Quality Monitoring Station, Proposed Fenceline Alignment	Raven, Christopher	1991	No	Yes	Yes
1-1485 (P)		A Reevaluation of Cultural Resources in the Dee Gold Mining Company Waste Dump Expansion Area, Elko County, Nevada	Tipps, Betsy L., and Gary M. Popek	1991	Yes	No	Yes
1-1506 (P)		The Archaeological Reconnaissance of Thirteen Drilling Locations for the Touchstone Resources Company, Inc., The Ivanhoe Project	Carambelas, Kristopher	1991	No	Yes	Yes
1-1520 (P)	18-301	An Archaeological Survey for the Proposed 120kV Transmission Line from Coyote Creek to Bazza, Elko and Eureka Counties, Nevada	Botti, Nancy, and Robert R. Kautz	1992	Yes	Yes	Yes
1-1522 (P)		A Cultural Resources Inventory of Three Proposed Exploratory Drill Sites and Access Routes for the Ivanhoe Project, Elko County, Nevada	Botkin, Steve	1991	No	Yes	Yes
1-1563 (P)		Cultural Resource Inventory of the Dee Gold West Area in Elko County, Nevada	Newsome, Daniel K.	1992	Yes	No	Yes
1-1581 (P)		Archaeological Resources: An Analysis for the Ivanhoe Mine Expansion Project Environmental Impact Statement	Burke, Thomas D., and Mark W. Moore	1992		Yes	No
1-1599 (P)		The Rodeo Creek Project: A Cultural Resources Inventory of Approximately 555 Acres in Elko County, Nevada	Johnson, Frank	1996	Yes	Yes	Yes
1-1620 (P)		A Draft Cultural Resources Management Plan for the Tosawihi Quarries Archaeological Site, Elko County, Nevada	Intermountain Research	1987		Yes	No
1-1630 (P)		A Cultural Resource Inventory of 270 Acres for the Rossi Mine Expansion near the Santa Renia Mountains, Elko County, Nevada	Crosland, Richard I.	1997	Yes	No	Yes
1-1641 (P)		An Archaeological Evaluation of Site 26EK5040	Ataman, Kathryn, Bullock Margaret, Dan Dugas, and Christopher Raven	1992			No
1-1664 (P)	4-657	Cultural Resources Inventory of the Ren Parcel, Elko County, Nevada	Newsome, Daniel K.	1992	Yes	No	Yes
1-1667 (P)		Sites 26EK3032, Localities 26 and 27, and 26EK3516: An Archaeological Testing Program at Tosawihi Quarries	Leach, Melinda, and Steven G. Botkin	1991		Yes	No
1-1668 (P)		Archaeological Investigations at Tosawihi, A Great Basin Quarry, Part 1: The Periphery	Elston, Robert G., and Raven Christopher	1992		Yes	No
1-1678 (P)		Baxter Notice of Intent	Dillingham, Eric	1997	Yes	No	Yes
1-1700 (N)		Background Study for Consultation with Native Americans on Proposed Mining Development within the Traditional Tosawihi ('White Knife') Quarry North of Battle Mountain, Nevada, in the Traditional Land of the Tosawihi People, Western Shoshone Nation	Rusco, Mary K., and Shelly Raven	1992			No

Table F-1 Previous Cultural Resources Investigations Within the Project Area and CESA

Agency Report No.	NSM Report No.	Report Title/Name	Author	Report Date	CESA	Project Area	Class III
1-1701 (N)		Archaeological Monitoring of an Order II Soil Survey in the Tosawihi Vicinity	Intermountain Research	1991		Yes	No
1-1711 (P)		ASAR/Baxter Notice of Intent--Drillhole E	Dillingham, Eric	1997	Yes	No	Yes
1-1720 (P)	4-1496	A Cultural Resources Inventory of Eight Proposed Exploratory Drill Sites, Associated Routes, and a Truck Pull-off Area for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Botkin, Steve	1992	No	Yes	Yes
1-1723 (P)	4-649	Cultural Resource Inventory of the Dee Gold Northern Area in Elko County, Nevada	Newsome, Daniel K.	1992	Yes	No	Yes
1-1724 (P)	4-650	Cultural Resource Inventory of Barrick Goldstrike Mines, Inc.'s Water Well Sites NA-28 and NA-33, Elko County, Nevada	Newsome, Daniel K.	1992	Yes	Yes	Yes
1-1727 (P)		Rossi Mine Waste Dump Expansion	Fowler, Dan, and Janice Stadelman	1992	Yes	No	Yes
1-1747 (P)		A Cultural Resources Review of Six Proposed Exploratory Drill Sites and Associated Access Routes for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1993	No	Yes	Yes
1-1749 (N)		The Tosawihi Quarry: World Heritage Site and Western Shoshone Monument	Clemmer, Richard O.	1990			No
1-1770 (P)	4-1520	A Cultural Resource Inventory for a Mining Notice for White Knight Gold (US) Inc., Squaw Creek Project	Weinberg, M. Cristina	1999	Yes	Yes	Yes
1-1772 (P)/2-2743 (P)		Cultural Resource Inventory Report for the AT&T Coaxial Cable Removal Project Lucin, Utah to Red Bluff, California	Jones and Stokes Associates, Inc.	1998	Yes	No	Yes
1-1794 (P)		Data Recovery in Upper Boulder Valley: Report of Excavations at Site 26EK5512 (CrNV-12-10769), Elko County, Nevada	Crosland, Richard I.	1999			No
1-1843 (N)		Shoshone Range Series and Santa Renia Range Series Guzzlers	Scott, Mike	1994	Yes	Yes	Yes
1-1845 (P)		Archaeological Investigations at Tosawihi, A Great Basin Quarry, Part 7: 26EK5040, A Middle Archaeic Reduction Station and Campsite	Ataman, Kathryn, Bullock Margaret, Dan Dugas, and Robert G. Elston	1995			No
1-1845 (P)		Volume 6: An Archaeological Data Recovery Plan for the Ivanhoe Project: Proposed Data Recovery at 26EK4050, a Tosawihi Quarries Archaeological Site	IMR	1994			No
1-1848 (P)		Treatment Plan for Data Recovery at Four Historic Properties in the East Basin, Upper Boulder Creek, Nevada	Zeanah, David W., Betsy Tipps, Alan R, Schroedl, and Andre D. La Fond	1993			No
1-1878 (P)		Four Additional Loci Defined within the Tosawihi Quarries (26EK3032)	Raven, Christopher, and Steve Botkin	1990	No	Yes	Yes
1-1882 (P)	4-1564	A Cultural Resources Review of Twenty Proposed Exploratory Drill Sites and Associated Access Routes for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	No	Yes	Yes
1-1883 (P)		A Cultural Resources Inventory of Four Proposed Exploratory Drill Sites and Associated Access Routes for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	No	Yes	Yes
1-1886 (P)	18-343	Cultural Resource Inventory of Eight Groundwater Montoring Wells in Elko and Eureka Counties, Nevada	Newsome, Daniel K.	1994	Yes	Yes	Yes
1-1891 (P)		Cultural Resource Inventory of 920 Acres near the Rossi Mine in Elko County, Nevada	Newsome, Daniel K., Jason R. Bright, and Betsy L. Tipps	1999	Yes	No	Yes
1-1907 (P)		A Cultural Resources Inventory of Five Proposed Exploratory Drill Sites and Associated Access Routes in the Jackson NOI Area, for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	Yes	No	Yes
1-1908 (P)		A Cultural Resources Inventory of Four Proposed Exploratory Drill Sites and Associated Access Routes in the Hollister Mine Phase I EA Area, for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	No	Yes	Yes

Table F-1 Previous Cultural Resources Investigations Within the Project Area and CESA

Agency Report No.	NSM Report No.	Report Title/Name	Author	Report Date	CESA	Project Area	Class III
1-1909 (P)		A Cultural Resources Inventory of Six Proposed Exploratory Drill Sites and Associated Access Routes in the Rimrock NOI Area, for the Newmont/Touchstone Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	Yes	No	Yes
1-1927 (P)		A Cultural Resources Inventory of a Proposed Exploratory Drill Site and Associated Access Routes in the Silver Cloud and Governor NOI Areas, for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Ataman, Kathryn	1994	Yes	No	Yes
1-1938 (P)		Great Basin Gold Mining Exploration	Hockett, Bryan	1999			No
1-1956 (P)		Tosawihi Quarries TCP	Hockett, Bryan	1999			No
1-1960 (P)		A Cultural Resources Review of Twenty-Four Proposed Exploratory Drill Sites and Associated Access Routes for the Newmont/Touchstone Ivanhoe Joint Venture, Elko County, Nevada	Dugas, Daniel	1994	No	Yes	Yes
1-1998 (P)		Willow Springs Pipeline Extension	Dillingham, Eric	1999	Yes	No	Yes
1-2010 (P)		Great Basin Gold Company's 2nd Amendment to POO/Notice in Hatter Area	Hockett, Bryan	1999	No	Yes	Yes
1-2013 (P)		Recordation of Hunting Blind Spring Site	Juell, Ken	1991		Yes	No
1-2014 (P)		Redefining the Tosawihi Quarries Archaeological District	Hockett, Bryan	2000		Yes	No
1-2050 (P)		Great Basin Gold's 3rd Amendment and 2nd Notice in Hatter Area, Tosawihi Quarries	Hockett, Bryan	2000	No	Yes	Yes
1-2059 (N)		Flower Project Amendment N16-99-009N	Dillingham, Eric	2000	Yes	No	Yes
1-2148 (P)		Hot Lake EFR Fence	Hockett, Bryan	2001	Yes	No	Yes
1-2199 (P)		Intensive Cultural Resource Inventory of the Hot Lake Fire Dozer-Lines: An Assessment of Damages	K. Russell	2002	Yes	Yes	Yes
1-2213 (P)		Great Basin Gold's 4th Amendment and 3rd Notice in Hatter Area, Tosawihi Quarries	Hockett, Bryan	2002	No	Yes	Yes
1-2263 (P)		Intensive Cultural Resources Invemtory of Barrick Mining Exploration Drill Sites and Access Roads on Upper Boulder and Antelope Creeks near the Rossi Mine, Elko County, Nevada	Fawcett, William B.	2002	Yes	No	Yes
1-2285 (P)		Hollister Block Development Rapid Infiltration Basins	Hockett, Bryan	2003	Yes	Yes	Yes
1-2288 (P)		Hollister Block Development Rapid Infiltration Basins 2	Hockett, Bryan	2003	No	Yes	Yes
1-2290 (N)		Placer Dome Exploration: Silver Cloud Project, Phase II	Russell, K.	2003	Yes	No	Yes
1-2292 (P)		Intensive Cultural Resources Inventory of Placer Dome Deploration's Exploratory Drilling and Access Roads Near the Silver Cloud Mine in Northwestern Elko County, Nevada	Fawcett, William B.	2003	Yes	No	Yes
1-2312 (P)		Cultural Resources Inventory of Hecla Ventures Corporation Hollister Development Block Project, Elko County, Nevada	McCabe, Allen	2003	No	Yes	Yes
1-2330 (P)		Hollister Block Development Rapid Infiltration Basins 3	Hockett, Bryan	2003	Yes	Yes	Yes
1-2366 (P)		Atna/Great Basin Gold Golden Cloud Notice	Hockett, Bryan	2003	Yes	No	Yes
1-2411 (N)		Soil Source Survey for the Hecla Project	Hockett, Bryan	2004	Yes	Yes	Yes
1-2439 (P)		Geologix Mining Notice in the Silver Creek Area	Hockett, Bryan	2004	Yes	No	Yes
1-2440 (P)		Newmont's Gov-Fox Mining Notice	Hockett, Bryan	2004	Yes	No	Yes
1-2481 (P)		Reliance Geological Services Mining Notice along Ivanhoe Creek	Hockett, Bryan	2004	Yes	No	Yes
1-2552 (P)		Contact Era Site along Little Antelope Creek	Hockett, Bryan, and Janice Stadelman	2006	Yes	No	Yes
1-2557 (P)		Hecla's RIB Expansion along Antelope Creek	Hockett, Bryan	2006	Yes	No	Yes
1-2563 (P)		Rossi Mine Cultural Resource Survey, Elko County, Nevada 2007	Native-X, Inc	2007	Yes	No	Yes
1-2565 (P)		Intensive Cultural Resources Inventory of Portions of Drill Seedings within the Sheep Fire in Elko, Lander, and Eureka Counties, Nevada	Fawcett, William B.	2007	Yes	No	Yes
1-2586 (P)		A Cultural Resources Inventory and Monitoring Report for Great Basin Gold RIB Gravel Test Trenches	Hauer, A. Craig, Kathryn Ataman, and Jeff Michel	2007	Yes	Yes	Yes

Table F-1 Previous Cultural Resources Investigations Within the Project Area and CESA

Agency Report No.	NSM Report No.	Report Title/Name	Author	Report Date	CESA	Project Area	Class III
1-2607 (P)		Intensive Cultural Resource Inventory of the Proposed North Antelope Protective Fence	Jensen, Jill	2007	Yes	Yes	Yes
1-2632 (P)		A Cultural Resources Inventory Report for Rodeo Creek Gold Mud Springs Road Project	Michel, Jeff	2008	Yes	Yes	Yes
1-2685 (P)		2007 Willow Creek Fire Protective Fence	Jensen, Jill	2007	Yes	No	Yes
1-2728 (P)		Data Recovery Plan for Site 26EK5285, Elko County, Nevada	Cannon, Michael; Seddon, Matthew and Heather Stettler	2009			No

Source: Summit 2011.

Appendix G

Air Quality Technical Support Document for the Hollister Underground Mine Project EIS - Draft

Air Quality Technical Support Document for the Hollister Underground Mine Project EIS

Revised Draft

List of Acronyms

$\mu g/m^3$	micrograms per cubic meter
µm	Micrometer
AAQS	Ambient Air Quality Standards
ACEPM	Applicant Committed Environmental Protection Agency
AECOM	AECOM Technical Services, Inc.
amsl	above mean sea level
API	American Petroleum Institute
BAPC	Bureau of Air Pollution Control
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CFR	Code of Federal Regulations
CH_3Hg^+	Methylmercury
CO	carbon monoxide
CO_2	carbon dioxide
FLAG	Federal Land Managers Air Quality Related Values Work Group
H_2S	hydrogen sulfide
HAPs	Hazardous Air Pollutants
Hg_0	gaseous elemental mercury
HPS	Hatter Production Shaft, raise, or a ramp
km	kilometers
kV	kilovolt
NAAQS	National Ambient Air Quality Standards
NDEP	Nevada Division of Environmental Protection
NH_3	ammonia
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSPS	New Source Performance Standards
NSSGA	National Sand, Stone and Gravel Association
NvMACT	Nevada Maximum Achievable Control Technology
O_3	ozone
Pb	Lead
PM	particulate matter
PM_{10}	PM with an aerodynamic diameter less than 10 micrometers
$PM_{2.5}$	PM with an aerodynamic diameter less than 2.5 micrometers
ppmw	parts per million weight
PSD	Prevention of Significant Deterioration
RCG	Rodeo Creek Gold Inc.
RGM	reactive gaseous mercury

SIP	State Implementation Plan
SO_2	Sulfur dioxide
tpy	tons per year
USEPA	United States Environmental Protection Agency
VMT	vehicle miles traveled
VOCs	volatile organic compounds
WRSF	Waste Rock Storage Facility

Executive Summary

AECOM Technical Services, Inc. evaluated air quality impacts resulting from expansion of surface and underground exploration to full-scale mining at the Hollister Site located 20 miles southeast of Midas in Elko County, Nevada. This modeling effort assessed air quality impacts from the Proposed Action for the Hollister Underground Mine Project Environmental Impact Statement.

The primary air pollutants of concern for the Hollister Underground Mine Project are nitrogen oxides, carbon monoxide, sulfur dioxide, and particulate matter including particulate matter with an aerodynamic diameter less than 10 micrometers, and particulate matter with an aerodynamic diameter less than 2.5 micrometers. While the total emissions of hazardous air pollutants (HAPs) air toxics from the proposed project do not warrant air toxics modeling, the project's total mercury emissions were assessed.

Screening level or refined dispersion modeling was performed for each criteria pollutant to demonstrate compliance with both the National Ambient Air Quality Standards (NAAQS) and Nevada Ambient Air Quality Standards, collectively referred to as AAQS. Modeling procedures and methods were conducted as described in the approved modeling protocol.

Modeled Emissions Sources at Hollister Site and Esmeralda Mill

Facility sources at Hollister include stationary (point) sources such as a shotcrete batch plant and stationary engines for electrical generation. Portable sources on the mine property include drill rigs used for mineral exploration and a portable generator used for night safety lighting. In addition, fugitive dust sources would be associated with the Proposed Action, and include vehicle travel on unpaved roads, ore stock piles, waste rock facilities, and ore load outs.

The existing Hollister Site power source, the two Cummins diesel generators located in the East Pit, would be taken out of service when electricity becomes available from the proposed 120-kilovolt (kV) and 24.9-kV electric power transmission lines (transmission lines), thereby greatly reducing the emissions associated with the diesel generators, which will remain on-site for emergency backup service.

Total annual project emissions were calculated for the pollutants of concern.

Facility sources at Esmeralda Mill and Midas Mill were not modeled for criteria pollutants or HAPs since these impacts are already evaluated under current operating permits. Visibility impacts from Esmeralda Mill were analyzed at Yosemite National Park due to its proximity. No analysis of visibility impacts was required for Midas Mill or the Hollister Site.

Modeling Results

Screening dispersion modeling was performed to assess impacts of haul truck emissions on dirt roads and portable drill rigs. Results of the conservative screening level dispersion modeling analysis for the Proposed Action demonstrate that the increased traffic associated with hauling ore and proposed use of drill rigs for the Proposed Action would not cause violations of National or State AAQS.

As a result of bringing electric power to the project area, the impacts due to gaseous criteria pollutants emitted by stationary sources, such as the two diesel generators, would be far less than the No Action Alternative, and well within National and State AAQS.

The Class I visibility analysis evaluated the potential changes in visibility from Esmeralda Mill to Yosemite National Park. A screening level assessment of the impacts on visibility from processing

Hollister ore at the Esmeralda Mill was performed using the VISCREEN model version 88341. The plume visual impact screening model VISCREEN is designed to ascertain whether the plume from a facility (i.e., Esmeralda Mill) has the potential to be perceptible to observers under "reasonable worst-case" conditions. The screening level results indicate that the plume formed by emissions from the mill would not be perceptible against either the sky or the terrain when the sun is behind the observer, and it is highly unlikely that the plume would be perceptible when the sun is in front of the observer.

Summary and Conclusions

Gaseous pollutant emissions associated with the Proposed Action would result from construction and mining equipment and vehicle exhaust. Haul truck traffic impacts were well within the National and State AAQS at a distance of 46 feet (14 meters) from the road for a generic road segment that is representative of all dirt roads. The impacts from drill rigs would not cause violations of National or State AAQS. Additionally, the change from diesel generated power to electric power would result in a decrease in the stationary source emissions, and impacts would be far less than the No Action Alternative, and well within National and State AAQS.

No individual HAP (including mercury) would be emitted in a quantity greater than the major source limit of 10 tons per year (tpy) at any of the facilities including the Hollister Site, Esmeralda Mill, and Midas Mill, and the combination of all HAP emissions would be less than the major source limit of 25 tpy; therefore, the proposed project would not constitute a major HAP source. The permitted emissions for mercury at Esmeralda Mill would be about 7 pounds per year. Processing Hollister ore at Midas Mill would result in mercury emissions at the same level as Esmeralda Mill.

The screening level modeling results indicate that visibility impacts from the Esmeralda Mill to Yosemite National Park would be highly unlikely to occur.

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1.0 Introduction and Background

AECOM Technical Services, Inc. (AECOM) evaluated air quality impacts resulting from expansion of surface and underground exploration to full-scale mining at the Hollister Site located 20 miles southeast of Midas in Elko County, Nevada. In accordance with the mine plan, ore would be transported off-site for processing at either the Esmeralda or Midas mills (**Figure 1-1**). The Esmeralda Mill is located approximately 22 miles southwest of Hawthorne in Mineral County, Nevada. The Midas Mill is located 20 miles northwest of the Hollister Site. This modeling effort assessed air quality impacts from the Proposed Action for the Hollister Underground Mine Project Environmental Impact Statement and is not meant to be used for air quality permitting purposes with the State of Nevada Division of Environmental Protection (NDEP).

The Hollister Site and the associated exploration activities are located in all or part of Sections 4, 5, 8, 9, 16, and 17 of Township 37 North (T37N), Range 48 East (R48E), and all or part of Sections 32 and 33 of T38N and R48E (**Figure 1-2**). Lands at the site are administered by the Bureau of Land Management, Tuscarora Field Office.

The Universe Transverse Mercator Zone 11, North American Datum 1983 (NAD83) coordinates of the approximate center of the Hollister facility main operations area are 5,366,631.7 meters east, and 4,550,870.2 meters north. The facility elevation is approximately 5,525 feet above mean sea level (amsl).

Rodeo Creek Gold Inc. (RCG) is proposing an expansion of its existing surface and underground exploration activities at the Hollister Site and the transition to full-scale underground mine production and associated support facilities. The Proposed Action (also called proposed project or the Hollister Underground Mine Project) would contain the following major components (**Figure 1-2**):

- Continued and expanded surface and underground exploration activities;
- Transition from underground exploration and bulk sampling activities to full-scale production of underground gold and silver mining;
- Installation of the Hatter Production Shaft, raise, or a ramp (collectively referred to as the HPS) as the geology of the area dictates;
- Continued maintenance of the existing Ivanhoe access road and Little Antelope Creek road;
- Construction of road(s) within the existing mining disturbance areas and to the HPS;
- Construction of a new 11.6-mile-long transmission line and substation including access routes to replace power provided by two existing diesel generators;
- Mine water management including installation of a National Pollutant Discharge Elimination System (NPDES) permitted outfall for discharge to Little Antelope Creek and surface monitoring and underground dewatering wells, as needed;
- Continued waste rock disposal in the RCG existing permitted and lined Waste Rock Storage Facility (WRSF), in underground mined-out areas as backfill, and a backfill in a new WRSF located on previously disturbed and unreclaimed land in the existing West Pit;
- Construction of ancillary support facilities; and
- Continued and increased transport of ore by truck to off-site existing third-party owned mineral processing facilities at the Esmeralda Mill in Mineral County, Nevada and/or the Midas Mill in Elko County, Nevada, both of which are located on private land.

Based on preliminary estimates of emissions including construction of new facilities, the proposed project could increase emissions of nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2),

particulate matter (PM) including PM with an aerodynamic diameter less than 10 micrometers (PM_{10}), PM with an aerodynamic diameter less than 2.5 micrometers ($PM_{2.5}$), and carbon dioxide (CO_2). The primary air pollutants of concern for the Hollister Underground Mine Project are PM_{10} and $PM_{2.5}$ from mining operations such as surface disturbance, exploration drilling, and ore and waste rock transport and off-site mineral processing, etc., as well as potential mercury emissions from off-site ore processing.

Screening level or refined dispersion modeling was performed for each criteria pollutant to demonstrate compliance with both the National Ambient Air Quality Standards (NAAQS) and Nevada Ambient Air Quality Standards (AAQS), collectively referred to as AAQS. Modeling was conducted for NO_X, SO_2, CO, PM_{10}, and $PM_{2.5}$ for the Hollister Site, proposed ore haulage transportation corridors, and the Esmeralda Mill processing facilities in Mineral County, Nevada.

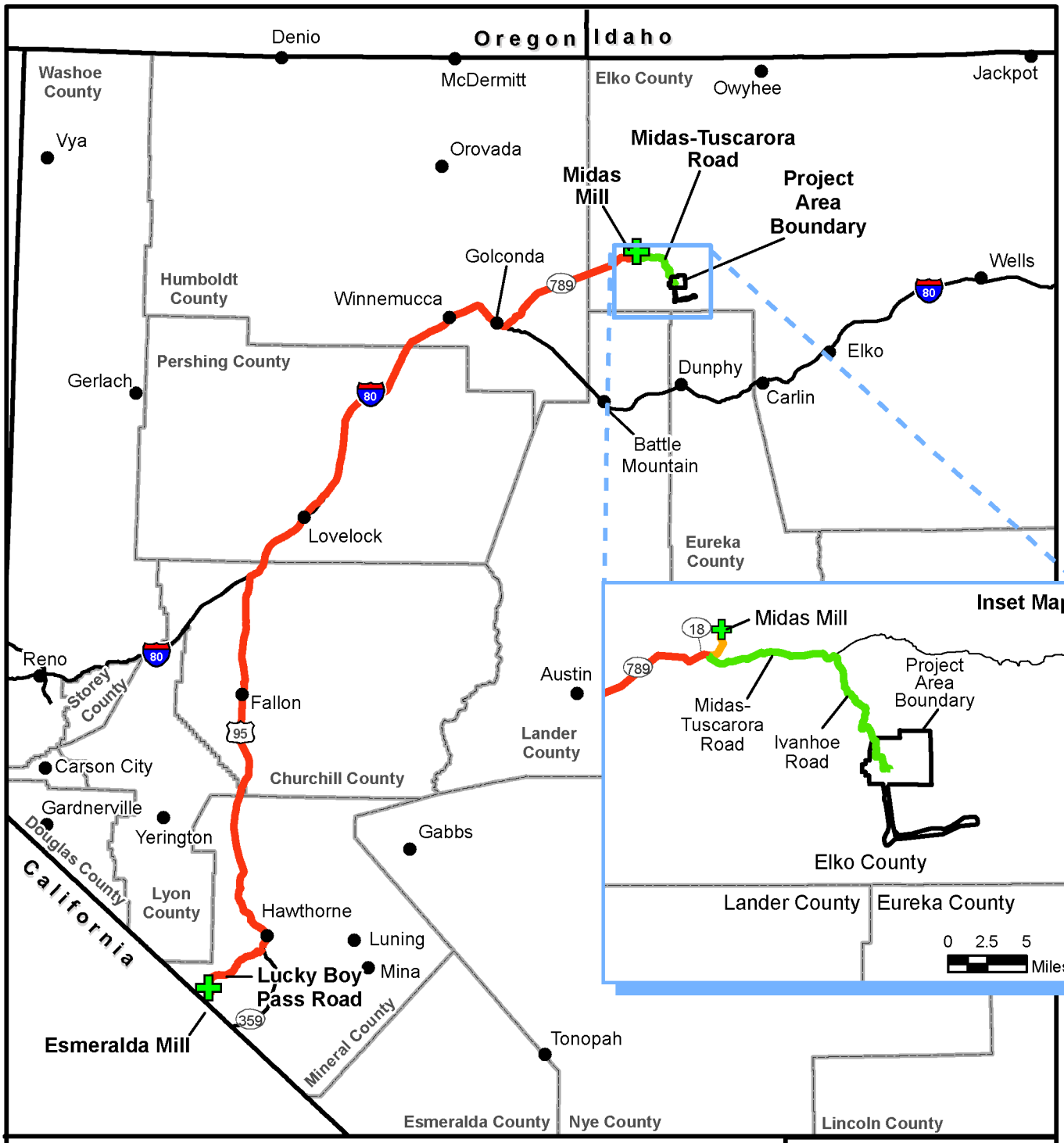
The emissions of air toxics from the proposed project at Hollister are so minimal that they do not warrant air toxics modeling. Mercury emissions from the off-site mill processing the ore from Hollister were estimated based on the existing air permit.

In order to assess the potential visibility impacts at nearby Class I areas, a screening assessment was conducted for two Class I areas. The nearest Class I area to the Hollister Site and Midas Mill is Jarbidge Wilderness, which is approximately 62 miles (100 kilometers [km]) away. The nearest Class I area to the Esmeralda Mill site is Yosemite National Park in California, approximately 28 miles (45 km) away.

The modeling methods used provide conservative estimates of ambient concentrations that potentially may result from the Proposed Action emissions in combination with existing sources in the region. The air quality modeling was conducted in accordance with guidance provided by the United States Environmental Protection Agency (USEPA), the NDEP Bureau of Air Pollution Control (BAPC), and Federal Land Managers' Air Quality Related Work Group (FLAG) as outlined in the following documents:

- Nevada Bureau of Air Pollution Control General Air Dispersion Modeling Guidelines (NDEP-BAPC 2008)
- Guideline on Air Quality Models (published as 40 Code of Federal Regulations [CFR] 58, Appendix W) (USEPA 2005) (hereafter referred to as the Modeling Guideline)
- Modeling Procedures for Demonstrating Compliance with $PM_{2.5}$ NAAQS (USEPA 2010a)
- Guidance Concerning the Implementation of the 1-hour NO_2 NAAQS for the Prevention of Significant Deterioration Program (USEPA 2010b)
- Guidance Concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program (USEPA 2010c)
- FLAG Phase 1 Report – Revised. (FLAG 2010)

AECOM used USEPA approved dispersion models and methods, including screening level and refined modeling described in the above referenced documents, to perform the modeling analyses to determine compliance with AAQS for NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$. The models and methods are described in detail in **Attachment 1**, Air Modeling Protocol. The area surrounding the Hollister Site and each processing facility has been classified as an attainment area for all pollutants. In accord with the approved modeling protocol, AECOM did not model traffic emissions on paved roads between the Hollister Site and mills, but did include unpaved roads in the analysis. RCG's Applicant-committed Environmental Protection Measures (ACEPM), described in Section 2.4.9.6, of the Environmental Impact Statement for the Hollister Underground Mine Project, were accounted for during development of the Proposed Action emissions inventory.



Legend

- Project Area Boundary
- Esmeralda Mill Route
- Midas Mill Route
- Esmeralda Mill and Midas Mill Routes
- Mill Site
- Nevada State Route
- U.S. Federal Highway
- U.S. Interstate Highway

Source: RCG 2010a.

N

0 20 40 Miles

Hollister Underground Air Quality Technical Support Document

Figure 1-1

Ore Transportation Route

10/06/2011

Ivanhoe Road

Antelope Spring

Creek

T38N, R48E

T37N, R48E

Mud Spring

Spring

Transmission Line Analysis Corridor

Little Antelope Creek Road and Buried RIB Pipeline

Proposed 24.9-kV Transmission Line

Mud Springs Road

Coyote Creek Substation

Little

Spring

Antelope Creek Road

Creek

East RIB

West RIBs (2)

Proposed 120-kV Transmission Line

Proposed Rodeo Creek Substation

T37N, R48E

T37N, R49E

INSET MAP

Proposed Mine Office Complex

West Pit

East Pit Facilities

Surface Exploration Storage

Proposed HPS

West

East

South

Proposed NPDES Surface Discharge

0 0.25 0.5 Miles

Humboldt

Elko

Washoe

Pershing

Lander

Eureka

White Pine

Lyon

Churchill

Nye

Mineral

Lincoln

Esmeralda

Clark

Legend

Existing/Authorized Surface Disturbance or Facilities

- Mining Disturbance
- Rapid Infiltration Basin (RIB)
- Water Well
- Escapeway Raise
- Road
- 345-kV Transmission Line
- 120-kV Transmission Line
- Stormwater Diversion Channel
- East Pit Facilities
- Newmont Reclaimed Waste Rock Storage Facilities

Proposed Surface Disturbance or Facilities

- Project Area Boundary
- Transmission Line Analysis Corridor
- Mine Office Complex
- NPDES Surface Discharge
- HPS
- 10,000 Gallon Potable Tank and 35,000 Gallon Fire Water Tank
- Rodeo Creek Substation
- 24.9-kV Transmission Line
- 120-kV Transmission Line
- Buried Pipeline
- Proposed Stormwater Diversion Channel
- East Pit Spur Road
- Surface Exploration Storage

Sources: RCG 2009; BLM 2010b.

N

0 0.6 1.2 Miles

Hollister Underground Air Quality Technical Support Document

Figure 1-2

Overview of Proposed Action Facilities

10/06/2011

2.0 Applicable Air Quality Regulations

Air quality is defined by the concentration of various pollutants and their interactions in the atmosphere. Pollution effects on human health have been used to establish AAQS. Measurement of pollutants in the atmosphere is expressed in units of parts per million or micrograms per cubic meter ($\mu g/m^3$). Both long-term climatic factors and short-term weather fluctuations are considered when assessing air quality concentrations because they control dispersion and transport. Physical effects of air quality depend on many factors, such as the type, amount, and duration of exposure. Air quality standards specify acceptable upper limits of pollutant concentrations and duration of exposure. Air pollutant concentrations below the standards generally are not considered to be detrimental to public health and welfare.

The relative importance of pollutant concentrations can be determined by comparison with appropriate National and/or State AAQS. National and State AAQS are presented in **Table 2-1**. The pollutants of concern for the Hollister Underground Mine Project are nitrogen dioxide (NO_2), CO, SO_2, PM_{10}, and $PM_{2.5}$. Lead (Pb), hydrogen sulfide (H_2S), and ozone (O_3), nor its precursor volatile organic compounds (VOCs), are not emitted or produced in sufficient quantities to be of concern for this project.

Table 2-1 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
O_3[1]	1-hour	235	NA	NA
O_3[1]	8-hour	157	157	157
CO	1-hour	40,000	40,000	40,000
CO less than 5,000 feet amsl	8-hour	10,000	10,000	10,000
CO at or greater than 5,000 feet amsl	8-hour	6,670		
SO_2	1-hour	NA	196	None
SO_2	3-hour	1,300	None	1,300
SO_2	24-hour	365	365	None
SO_2	Annual Average	80	80	None
NO_2	1-hour	188	188	None
NO_2	Annual Average	100	100	100
PM_{10}	24-hour	150	150	150
PM_{10}	Annual Average	50	NA	NA
$PM_{2.5}$	24-hour	35	35	35
$PM_{2.5}$	Annual Average	15	15	15
Pb[1]	Rolling 3-month Average	0.15	0.15	0.15
Pb[1]	Quarterly Arithmetic Mean	1.5	1.5	1.5
H_2S[1]	1-hour	112	--	--

Table 2-1 National and State of Nevada Ambient Air Quality Standards

Pollutant	Nevada Standards		National Standards	
	Averaging Time	Concentration ($\mu g/m^3$)	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
Visibility	Observation	Insufficient amount to reduce the prevailing visibility to less than 30 miles when humidity is less than 70 percent.	--	--

[1] Pollutant not applicable to modeling analysis.

Source: Nevada Administrative Code (NAC) 445B.22097 Standards of Quality for Ambient Air (Nevada Revised Statutes 445B.210, 445B.300); USEPA 2010.

An area is designated by the USEPA as being in attainment for a pollutant if ambient concentrations of that pollutant are below the NAAQS. An area is not in attainment if violations of NAAQS for that pollutant occur. Areas where insufficient data are available to make an attainment status designation are listed as unclassifiable and are treated as being in attainment for regulatory purposes. For the purposes of statewide regulatory planning, this area has been designated as in attainment (not exceeding NAAQS for criteria pollutants) for all pollutants that have an AAQS.

Global Mercury

Mercury is a naturally occurring element in many soils, volcanic rocks, and marine and geothermal water sources. It assumes many forms and can be found naturally in the environment as free metallic mercury, chemically combined with other elements in a number of soil or rock types, and in the form of methylmercury in plants and animals. Mercury is generally present in the atmosphere in one of three chemical forms: gaseous elemental mercury, reactive gaseous mercury (RGM), or particulate mercury. RGM and particulate mercury account for less than 2 percent of the total concentration in air, with elemental mercury accounting for more than 98 percent of the total (Fitzgerald et al. 1991).

Mercury emissions to the atmosphere come from both background and man-made sources. Background sources of mercury include natural sources such as naturally enriched soils and volcanoes. The fate of mercury emissions follows pathways from the emission source to transport, deposition, exposure, and potential human uptake risks. From a single source such as a power plant or mill, or other thermal source, a portion of the emissions are deposited locally near the source while the remaining mercury is dispersed regionally and globally.

Discerning mercury speciation is important in predicting the deposition and bioaccumulation of mercury in the environment. Gaseous elemental mercury (Hg_0) must be transformed to particulate or oxidized mercury in order to contribute substantially to mercury deposition and subsequent entry into water bodies where further transformation to methylmercury (CH_3Hg^+) can make the mercury available in the aquatic food chain (Porcella 1994). The final pathway to humans for mercury exposure is through eating fish with methylmercury stored in their tissues. About 0.3 percent of the total mercury emitted from a point source is deposited in lakes and streams to form a methylmercury compound (Porcella 1994).

Elemental mercury travels the farthest and can be transported on wind currents for months to years if not oxidized, thus providing opportunity for global transport and dispersion. Concentrations of mercury in the air are usually low and of little direct concern. However, RGM and particulates of mercury fall to earth

through rain or snow and enters lakes, rivers, and estuaries. Once there, it can transform to its most toxic form, methylmercury, and accumulate in fish and animal tissues.

RGM has an average atmospheric residence time of days to weeks (less in the presence of precipitation or bromine compounds often present in saline water bodies). It is not easily volatilized, and very water-soluble. It is easily taken up in precipitation or adsorbed on small particles in the atmosphere and falls out as wet or dry deposition. RGM has a higher potential to enter the food chain than elemental mercury and is more easily converted into CH_3Hg^+.

Particulate mercury has an average atmospheric residence time of hours to days (depending on the presence or absence of precipitation and the particle size). This mercury form has low volatility and is easily taken up in precipitation or adsorbed on small particles. The particles fall out of the atmosphere relatively close to the emission source in the presence of precipitation, or as dry deposition that may be transported for longer distances if associated with very small particles. Particle-bound mercury is relatively stable and is not easily converted to CH_3Hg^+ (USEPA 1997).

Mercury accumulates most efficiently in aquatic species as CH_3Hg^+. Predatory species at the top of the aquatic food chain generally have higher mercury concentrations. Nearly all of the mercury that accumulates in fish tissue is methylmercury. Inorganic mercury, which is less efficiently absorbed and more readily eliminated from the body than methylmercury, does not tend to bio-accumulate.

Local Mercury

When bound in mineral forms that typically appear in ore (e.g., cinnabar), mercury is a stable compound that remains in solid form. Ore processing has the potential to liberate mercury from these stable minerals by dissolving it in process solutions. Because it has a boiling point of 675°F, mercury has the potential to volatilize into a gaseous form when subjected to thermal processes in a recovery and refining circuit. This mercury is then released to the atmosphere where it may convert into RGM or particulate mercury.

Mercury is included on the federal list of hazardous air pollutants (HAPs), which has been adopted by reference in the Nevada air quality regulations. Nevada air quality regulations (NAC 445B.349) prohibit the “discharge into the atmosphere from any stationary source any hazardous air pollutant or toxic regulated air pollutant that threatens the health and safety of the general public, as determined by the director.” The USEPA has not established a National Emission Standard for Hazardous Air Pollutants for mercury emissions from gold ore processing facilities, but it has proposed one similar to the Nevada Maximum Achievable Control Technology (NvMACT) rules already in effect, and discussed below.

Under its broad statutory authority to regulate air pollution, BAPC has implemented a mercury control program that applies to all emission units located at precious metals mines that use direct or indirect thermal energy. This program is unique to the state of Nevada and is codified at NAC 445B.3611 to NAC 445B.3689. The program’s goal is to ensure that all non de-minimis thermal units with a potential to emit mercury, are controlled to provide the maximum degree of reduction of mercury emissions in accordance with factors enumerated in the rule. Antler Peak Gold, Inc., a subsidiary of Great Basin Gold Ltd. and operators of the Esmeralda Project and Mill facilities, has a mercury operating permit AP1041-2248 for the ore processing equipment at Esmeralda. Midas mill operates under mercury permit number AP1041-2253.

2.1 Regulatory Framework

Ambient air quality and the emission of air pollutants are regulated under both federal and State of Nevada laws and regulations as discussed below.

2.1.1 Federal Clean Air Act

The Federal Clean Air Act (CAA), and the subsequent Federal Clean Air Act Amendments of 1990 (CAAA), require the USEPA to identify NAAQS to protect public health and welfare. The CAA and the CAAA established NAAQS for seven pollutants, known as "criteria" pollutants. The ambient standards set for these pollutants satisfy "criteria" specified in the CAA. A list of the criteria pollutants regulated under the CAA and their currently applicable NAAQS set by the USEPA are listed in **Table 2-1**.

In addition to the designations relative to conforming with the NAAQS, the CAA requires the USEPA to place selected areas within the U.S. into one of three classes, which are designed to limit the deterioration of air quality when it is "better than" the NAAQS. Class I is the most restrictive air quality category. It was created by Congress to prevent further deterioration of air quality in national parks and wilderness areas of a given size, and in existence prior to 1977, or those additional areas that have since been designated Class I under federal regulations (40 CFR 52.21). All remaining selected areas outside of the designated Class I boundaries were designated Class II areas, which allow a relatively greater deterioration of air quality, although still below NAAQS. No Class III areas have been designated.

Federal Prevention of Significant Deterioration (PSD) regulations limit the maximum allowable increase in ambient particulate matter in a Class I area resulting from a major or minor stationary source to 4 $\mu g/m^3$ (annual geometric mean) and 8 $\mu g/m^3$ (24-hour average). Increases in other criteria pollutants are similarly limited. Specific types of facilities (listed facilities) that emit, or have the potential to emit, 100 tons per year (tpy) or more of PM_{10}, $PM_{2.5}$, or other criteria air pollutants, or any facility that emits, or has the potential to emit, 250 tpy or more of PM_{10}, $PM_{2.5}$, or other criteria air pollutants, are considered major stationary sources. Major stationary sources are required to notify federal land managers of Class I areas, which may be affected by the emissions from the source. Generally, federal land managers tend to be more concerned when the Class I area is within 62 miles (100 km) of the major stationary source. The Hollister Site is not a major stationary source. The nearest Class I planning area to Hollister Site, the Jarbidge Wilderness, is located approximately 71 miles (114 km) northeast of the Hollister Site study area. Esmeralda Mill processing facilities also are not a major stationary source. However, under the Proposed Action, ore would be processed at the mill, which is about 28 miles (45 km) from Yosemite National Park, a Class I area. Ore also may be processed at Newmont's Midas Mill, approximately 71 miles (114 km) from the Jarbidge Wilderness Area, the nearest Class I area to the mill.

The PSD regulation increments are triggered for a planning area when a PSD application for a major source or modification affecting that planning area has been deemed complete by the regulatory authority (40 CFR 52.21[b][14]). The closest triggered planning area (Air Pollution Control Region 61L) is located to the south of the project boundary. The planning area in which the proposed project would be located has not been triggered for any pollutant.

New Source Performance Standards (NSPSs), also required under the CAA, are set by the USEPA for specific types of new or modified stationary sources. NSPSs set fixed emission limits for classes of sources to prevent deterioration of air quality from the construction of new sources and to reduce control costs by building pollution controls into the initial design of sources. Certain project components used to process metallic minerals are subject to the NSPSs found in 40 CFR Part 60, Subpart LL (Standards of Performance for Metallic Mineral Processing Plants).

The CAAA introduced a new facility-wide permitting program known as the Federal Operating Permit, or "Title V," program. The program requires facilities with the potential to emit: 1) more than 100 tpy of any regulated pollutant (excluding PM); 2) 10 tpy of any single HAP; or 3) 25 tpy or more of any combination of HAPs, to submit a Federal Operating Permit application. Emissions from the Midas and the Esmeralda mill facilities are below the Title V thresholds for regulated pollutants and HAPs. Hollister has a Title V permit based on the potential to emit more than 100 tpy of NO_X.

The CAA directs the USEPA to delegate primary responsibility for air pollution control to state governments, which comply with specific minimum requirements. The State Implementation Plan (SIP) was originally the mechanism by which a state set emission limits and allocated pollution control responsibility to meet the NAAQS. The function of a SIP broadened after passage of the CAAA; it now includes the implementation of specific technology-based emission standards, permitting of sources, collection of fees, coordination of air quality planning, and prevention of significant deterioration of air quality within regional planning areas and statewide. Section 176 of the CAA, as amended, requires that federal agencies must not engage in, approve, or support in any way any action that does not conform to a SIP for the purpose of attaining AAQS (USEPA 2008).

2.1.2 Nevada State Air Quality Program

The BAPC is the agency in the State of Nevada that has been delegated the responsibility for implementing a SIP (excluding Washoe and Clark counties, which have their own SIP). Included in the SIP are the State of Nevada air quality permit programs (NAC 445B.001 through 445B.3497, inclusive). The Nevada AAQS also are part of the SIP. The Nevada AAQS as they apply to the types of emissions and sources at the Hollister Site and the Esmeralda and Midas mill facilities generally are identical to the NAAQS. In addition to establishing the Nevada AAQS, the BAPC is responsible for permit and enforcement activities throughout the State of Nevada. The BAPC permitting program implements the Title V Federal Operating Permit program, as well as the minor source permitting program for facilities that emit less than 100 tpy of all criteria pollutants and are not a major source of HAPs. The Hollister Site's current operations are regulated by Nevada Class I air quality operating permit number AP1041-1298. The Esmeralda Mine/Mill currently operates under a Nevada Class II air permit number AP1041-2366. The Midas Mill operates under air permit number AP1041-0766.

2.1.3 Conformity for General Federal Actions

According to Section 176I of the CAA (40 CFR 51.853), a federal agency must make a conformity determination in the approval of a project having air emissions that exceed specified thresholds in nonattainment and/or maintenance areas. The proposed project is not in a non-attainment or maintenance area; therefore, a general conformity analysis is not required for the Proposed Action.

3.0 Air Emissions Sources

Air emissions of gaseous, particulate, and Hazardous Air Pollutants (HAPs) are presented below for both the current operations and the Proposed Action.

3.1 Current No Action Emissions Sources

Facility sources at Hollister include stationary sources such as a shotcrete batch plant, ore stock piles, ore load outs, stationary engines for electrical generation, and a stationary engine for a water pump. Portable sources for Hollister operations include drill rigs used for mineral exploration. Up to two drill rigs may operate at any one time, but do not remain in the same location for more than 3 to 4 weeks. The drill rigs are relatively small sources of gaseous and particulate emissions. The drill rig engines are approximately 220 horsepower (hp) diesel engines. Drilling also is a small source of fugitive dust. The primary fugitive dust sources are unpaved haul roads at the Hollister Site and unpaved county roads used by trucks to transport ore to other locations for processing. No crushing or processing of ore takes place at the Hollister Site.

Stationary sources currently permitted to operate at the Hollister Site are listed in **Table 3-1**. Physical source parameters and the total estimated annual emissions for the No Action Alternative are shown in **Tables 3-2** and **3-3**. The stationary sources for the existing Hollister operations are permitted by BAPC to operate and have demonstrated compliance with applicable AAQS (RCG 2010, 2009, 2007). Therefore, it is not necessary to conduct modeling of the current stationary sources and the impacts of the No Action Alternative would not be evaluated further.

Table 3-1 Current Operation of Hollister Site Existing Stationary Sources for the No Action Alternative

Source Number	Unit or Process Description	Engine Rating (hp)	Hours of Operation/Year
S2.001	Diesel Generator, Cummins Model QSK60-G6	2,647	8,760
S2.002	Diesel Generator, Cummins Model QSK60-G6	2,647	8,760
IA1.002	Generator; Night Safety Lighting	20	2,920
IA1.003	Generator 4	140	1,100
IA1.004	Water Pump Engine	140	1,100
IA1.015	Shotcrete Batch Plant	--	8,760

Source: RCG 2009.

Figure 3-1 shows the general location of the Hollister Site. **Figure 3-2** shows the source locations relative to the facility fenceline.

In addition to the sources that operate at the Hollister Site, there are two off-site ore processing facilities: Esmeralda and Midas mills. The off-site ore processing facilities are possible sources of mercury emissions from thermal processes. Antler Peak Gold, Inc. has obtained mercury operating permit number AP1041-2248 for the ore processing at the Esmeralda Mill under the Nevada Maximum Achievable Control Technology (NvMACT) rules, and Midas Mill operates under permit number AP1041-2253.

Table 3-2 Stationary Source Model Input Physical Source Parameters

Source Number	Unit or Process Description	Height (m)	Temperature (°K)	Velocity (m/s)	Diameter (m)
S2.001	Diesel Generator, Cummins Model QSK60-G6	4.57	733.15	52.73	0.41
S2.002	Diesel Generator, Cummins Model QSK60-G6	4.57	733.15	52.73	0.41
IA1.002	Generator; Night Safety Lighting	1.52	840.37	57.73	0.10
IAl.003	Generator 4	2.74	840.37	77.37	0.08
IA1.004	Water Pump Engine	2.74	840.37	77.37	0.08
IA1.015	Shotcrete Batch Plant	0.00	0.00	0.01	1.00

Source: RCG 2009.

Table 3-3 Annual Emissions of Hollister Site Stationary Source for No Action Alternative

Source Number	Unit or Process Description	tpy					
		NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
S2.001	Diesel Generator, Cummins Model QSK60-G6[1]	135	14	22.6	2.1	2.1	671
S2.002	Diesel Generator, Cummins Model QSK60-G6[1]	155	14	22.6	2.1	2.1	671
IA1.002	Generator; Night Safety Lighting	9.0	0	0.2	0.1	0.1	34
IA1.003	Generator 4	2.4	0	0.5	0.2	0.2	88
IA1.004	Water Pump Engine	2.4	0	0.5	0.2	0.2	88
IA1.015	Shotcrete Batch Plant[2]	0	0	0.0	1.8	1.8	0
Total		**304**	**28**	**46**	**6.4**	**6.4**	**1551**

[1] Assuming 8,760 hours per year for the facility power generation.

[2] Assumes 8,760 hours for the shotcrete plant.

3.2 Criteria Emissions and Model Inputs for Proposed Action

Air emissions of both gaseous and particulate pollutants would result from the Proposed Action. Gaseous pollutant emissions associated with the Proposed Action would result from construction and mining equipment and vehicle exhaust. Because the Hollister operations are underground, fugitive dust (i.e., particulate) emissions would be generated primarily by haul trucks transporting ore to processing facilities. Other sources of PM include access roads, ore stockpiles, and disposal of waste rock. For the purposes of calculating emissions for the Proposed Action, the activities that generate emissions were grouped into one of these three categories: stationary sources at the Hollister Site; portable, non-road engines used for mineral exploration drilling at the Hollister Site; and mobile sources that transport ore from the Hollister Site to processing facilities.

The Proposed Action would differ from the current operations, presented in Section 3.1, due to proposed modification of some stationary sources at the Hollister Site and increased drilling and ore hauling activities. The stationary sources at the Hollister Site would remove Generator 4 and the Water Pump Engine as a result of the Proposed Action. In addition, the existing site power source, the two diesel generators located in the East Pit, would be taken out of service once electricity becomes available from

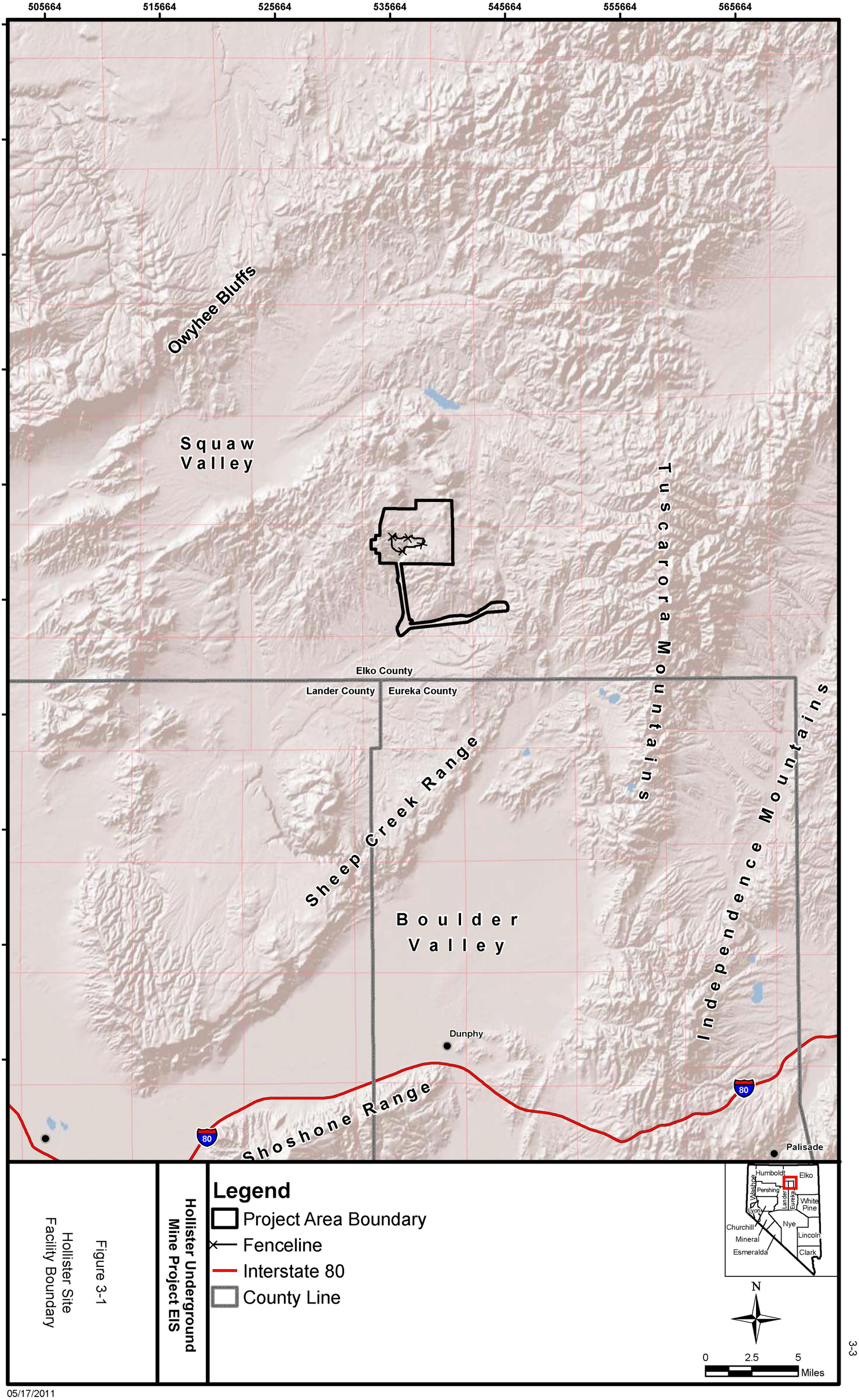
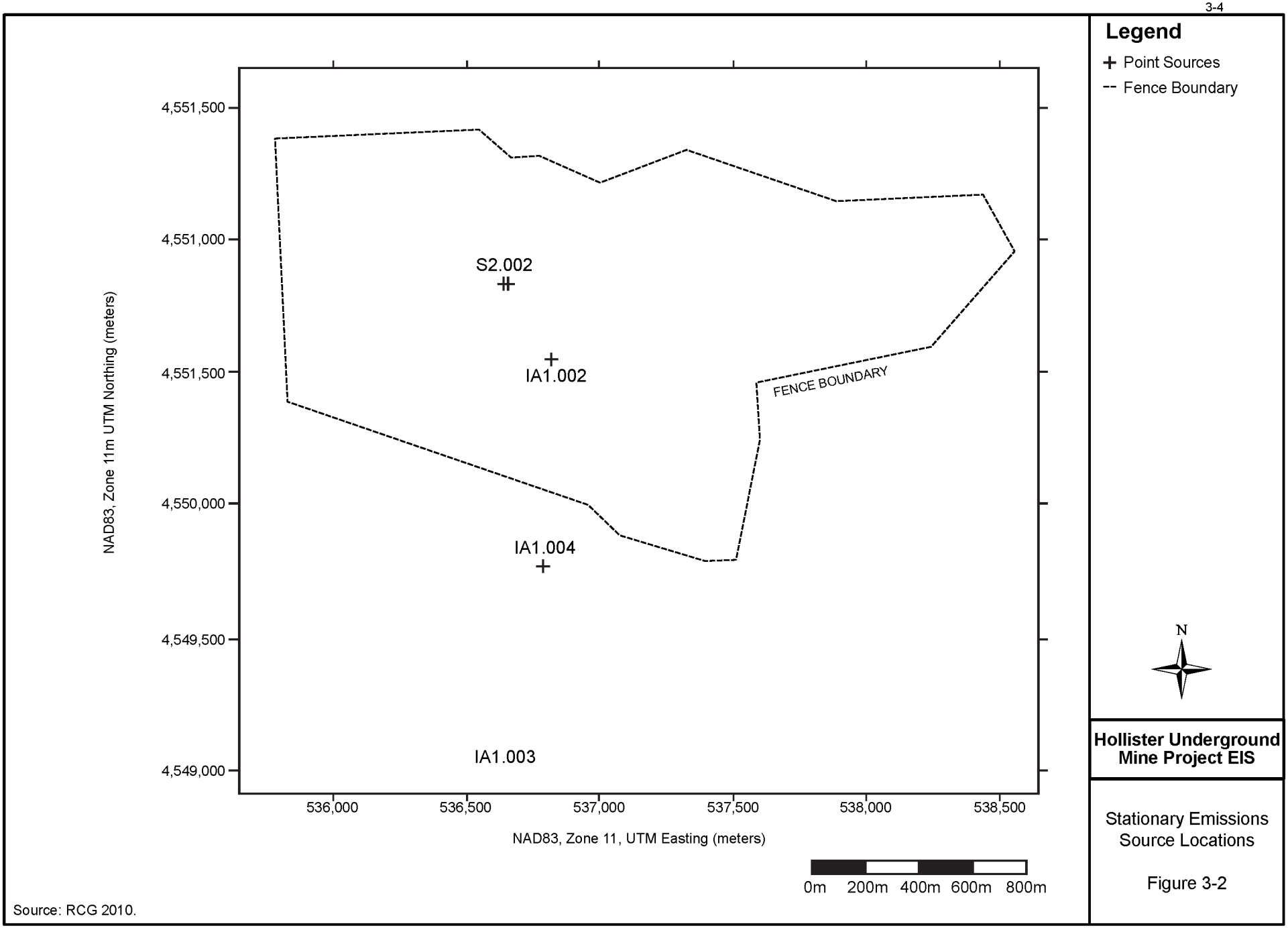


Figure 3-1
Hollister Site
Facility Boundary

Hollister Underground Mine Project EIS

05/17/2011



Source: RCG 2010.

Hollister Underground Mine Project EIS

Stationary Emissions Source Locations

Figure 3-2

05/18/2011

the proposed 120-kV and 24.9-kV transmission lines, thereby greatly reducing the emissions associated with the generators. Emissions associated with milling the ore at Esmeralda Mill and Midas Mill would remain unchanged relative to the currently permitted levels (permit no. AP1041-2248 and AP1041-2253); therefore, emissions from the mills have already demonstrated compliance with applicable AAQS and impacts are not anticipated to change under the Proposed Action.

In addition to reducing the emissions from the generators, RCG has committed to several Applicant Committed Environmental Protection Measures (ACEPM), which are described in Section 2.4.9.6, in the Hollister Underground Mine Project Environmental Impact Statement in order to minimize air emissions associated with the Proposed Action. Gaseous emissions would be minimized by proper equipment maintenance and operation. Particulate emissions would be mitigated by minimization of drop heights during loading, and implementing dust suppression measures. Fugitive dust is specifically addressed as a condition in the Fugitive Dust Control Plan portion of the NDEP Surface Area Disturbance Permit Application. RCG would implement an ongoing program to control fugitive dust from disturbed areas using ACEPM such as application of water and/or chemical dust suppressants (e.g., magnesium chloride), phased construction, and revegetation as appropriate. Access roads, project area roads, and other traffic areas would be maintained on a regular basis to minimize dust and provide for safe travel conditions. These ACEPM are accounted for in the Proposed Action emissions shown throughout this section.

3.2.1 Hollister Mine Stationary Source Emissions

The existing two Cummins diesel generators located in the East Pit would be reduced to 500 hours of operation per year, each, as backup emergency power after electricity becomes available from the proposed 120-kV and 24.9-kV transmission lines. In addition to the modifications to the diesel generators, both the 140 hp generator and 140 hp water pump engine will be removed and the 20 hp generator used for night safety lighting would be used as a portable source. Therefore, the total emissions for the stationary source emissions due to the Proposed Action would be less than the existing Hollister operations under the No Action Alternative. The total annual emissions for the Proposed Action were calculated from emission rates published in the permit applications (RCG 2010, 2009) with adjustments to the annual operating hours for the two generators. In addition, the emissions of CO_2 were estimated for the Proposed Action. CO_2 emissions were estimated using an emission factor of 1.15 lb CO_2/hp •hour of operation (USEPA 1996). The horsepower and annual operating hours of the stationary sources that would operate at Hollister Site are shown in **Table 3-4**. The estimated annual emissions from stationary sources at Hollister Site for the Proposed Action are shown in **Table 3-5**. It is important to note that these annual emissions are at the potential to emit if the generator units were to operate at capacity up to 500 hours per year as emergency generators.

Table 3-4 Hollister Site Stationary Sources for the Proposed Action

Source Number	Unit or Process Description	Engine Rating (hp)	Hours of Operation/Year
S2.001	Diesel Generator, Cummins Model QSK60-G6	2,647	500
S2.002	Diesel Generator, Cummins Model QSK60-G6	2,647	500
IA1.015	Shotcrete Batch Plant	--	8,760

Table 3-5 Annual Emissions of Hollister Site Stationary Sources for the Proposed Action

Source Number	Unit or Process Description	tpy					
		NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
S2.001	Diesel Generator, Cummins Model QSK60-G6[1]	7.7	0.8	1.3	0.1	0.1	671
S2.002	Diesel Generator, Cummins Model QSK60-G6[1]	8.9	0.8	1.3	0.1	0.1	671
IA1.015	Shotcrete Batch Plant[2]	0.0	0.0	0.0	1.8	1.8	0.0
Total		16.6	1.6	2.6	2.0	2.0	1,342

[1] Assuming 500 hours per year for the Cummins generators as backup emergency power.

[2] Assumes 8,760 hours for the shotcrete plant.

Because the Proposed Action emissions of criteria pollutants emitted by stationary sources are less than the No Action Alternative, the impacts due to the Proposed Action would be less than the No Action Alternative. The impacts from the No Action Alternative are well within the National and State AAQS evaluated for current permits (RCG 2010, 2009, 2007). However, several new standards have been promulgated since the submission of the Hollister permit applications. New standards that were not previously evaluated for the Hollister operations include new 1-hour NO_2 and SO_2 standards and new 24-hour and annual standards for $PM_{2.5}$.

As described in more detail in Chapter 5, the impacts from the Proposed Action stationary source emissions were evaluated differently based on USEPA guidance and available data.

- The emissions of SO_2 are below the USEPA's modeling threshold and therefore a modeling analysis is not required for this pollutant (USEPA 2010c).
- A modeling analysis of 1-hour NO_2 was conducted for the stationary sources.
- The impacts of $PM_{2.5}$ were evaluated using a scaling approach.

A modeling analysis was conducted for comparison to the 1-hour NO_2 AAQS. Modeled diesel generator emission rates for NO_X are provided in **Table 3-6**. The physical source parameters, shown in **Table 3-2,** are assumed to remain the same for the Proposed Action.

Table 3-6 Modeled Diesel Generator Emission Rates

Source Number	Unit or Process Description	NO_X (g/s)
S2.001	Diesel Generator, Cummins Model QSK60-G6	3.87
S2.002	Diesel Generator, Cummins Model QSK60-G6	4.47

Source: RCG 2010.

3.2.2 Hollister Site Non-Road Engines

Drill rigs would operate at the Hollister Site within the project area boundary shown in **Figure 3 -**1. Operation of the drill rig engines emits gaseous pollutants (NO_x, CO, SO_2 and CO_2) as well as PM emissions (PM_{10} and $PM_{2.5}$). In addition to the drill rigs, the generator used for night safety lighting is classified as a non-road engine. Once the facility becomes electrified the use of this generator will

diminish significantly as it would only be used as backup. Therefore, the emissions from the drill rigs were used to calculate emissions from non-road engines due to their larger size and more frequent use.

3.2.2.1 Emissions Calculations

Short-term and annual emission rates for NO_x, CO, and PM_{10} were calculated for the drill rig engines based on Tier 2 engine standards from Table 1 of the non-road diesel engine standards (40 CFR 89.112). For conservatism, $PM_{2.5}$ emissions were assumed to be equivalent to those for PM_{10}. For SO_2, the emission factor was derived using **Equation 3-1** assuming the fuel contains 15 parts per million by weight (ppmw) of sulfur based on current federal sulfur standards in 40 CFR 89 for non-road engines. The emission factor for CO_2 was based off standards found in the 2009 American Petroleum Institute's (API) Greenhouse Gas Compendium (API, 2009).

Equation 3-1 Calculation of SO_2 Emission Factor Based on Fuel Sulfur (in g/hp-hr)

$$EF_{SO2} = \frac{15\ lb\ S}{10^6\ lb\ fuel} x \frac{7.05\ lb\ fuel}{gal} x \frac{gal}{137{,}000\ Btu} x \frac{7{,}000\ Btu}{hp-hr} x \frac{64.06\ lb\ SO_2}{32.06\ lb\ S} x \frac{453.6\ g}{lb} = 4.90x10^{-3}\ g/hp-hr$$

Short-term emissions for each pollutant emitted by the drill rigs were calculated as the product of engine size, operating time, and emission factors as shown in **Equation 3-2**.

Equation 3-2 Calculation of Short-term Emissions from Drill Rig Engines

$$E(g/s) = EF(g/hp-hr)\ x \frac{hp}{engine}\ x\ 2\ engines\ x \frac{hour}{3{,}600\ s}$$

In total, the drill rigs would drill 20 holes per year at a rate of 16 days per hole and 20 hours per day. Annual emissions for the drill rigs were calculated as shown in **Equation 3-3** below.

Equation 3-3 Calculation of Annual Emissions from Drill Rig Engines

$$E(tpy) = EF(g/hp-hr)\ x \frac{hp}{engine}\ x\ 2\ engines\ x \frac{20\ hr}{day} x \frac{16\ days}{hole} x \frac{20\ holes}{year} x \frac{lb}{453.59\ g} x \frac{ton}{2{,}000\ lbs}$$

The potential total annual emissions from portable non-road equipment operating at the Hollister Site under the Proposed Action are shown in **Table 3-7**.

Table 3-7 Annual Emissions for Drill Rig Engines at Hollister Site

Annual Total (tpy)					
NO_x	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**
15.21	8.07	0.02	0.47	0.47	1,673

3.2.2.2 Model Inputs

Stack parameters used for modeling the drill rig engines are identified in **Table 3-8** below. The drill rig engines were treated as point sources.

Table 3-8 Drill Rig Engine Stack Parameters

	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (°K)
Drill Rig Engine	6.10	0.38	25.00	700.00

The short-term emissions rates modeled for the drill rig engines are shown in **Table 3-9**.

Table 3-9 Modeled Short-term Emissions for Drill Rig Engines

Short-term Total (g/s)					
NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
5.99E-01	3.18E-01	5.99E-04	1.83E-02	1.83E-02	65.88

3.2.3 Ore Hauling

Ore processing is planned at off-site alternative processing facilities, Esmeralda or Midas mills. The emissions at these facilities are not anticipated to change as a result of this project; however, additional emissions would occur from increases in transporting ore from the mine to the mills. Emissions associated with ore hauling include fugitive PM sources (from unpaved road dust), and gaseous emissions from the mobile source's internal combustion engine (NO_X, SO_2, CO, and PM).

Fugitive dust is specifically addressed as a condition in the Fugitive Dust Control Plan portion of the NDEP Surface Area Disturbance Permit Application. RCG would implement an ongoing program to control fugitive dust from disturbed areas using ACEPM. RCG would control fugitive dust emissions primarily by application of water or magnesium chloride to roads. Access roads, project area roads, parking lots, and other traffic areas would be maintained on a regular basis to minimize dust and provide for safe travel conditions.

All ore hauling emissions were modeled as volume sources. Volume source dimensions are determined by considering the movement of the plume sources during the course of an hour. All fugitive sources including roads are assumed to function at the proposed maximum hourly and annual throughput rates.

3.2.3.1 Emissions Calculations

In order to determine the air impacts associated with hauling ore, two types of emissions sources need to be accounted for: PM emissions from traveling on unpaved roads, and vehicle tailpipe emissions. PM emissions from unpaved roads were calculated using Equation 1a from AP-42 Section 13.2.2, Unpaved Roads (USEPA 2006) as can be seen in **Equation 3-4** below.

Equation 3-4 PM Emission Factors from Unpaved Roads at Industrial Sites

$$E_{PM}\,(lb/VMT) = (k * (s/12)^a\,(W/3)^b$$

Where: k (unitless) = 1.5 for PM_{10} and 0.15 for $PM_{2.5}$
s (%) = surface material silt content = 5
W (tons) = mean vehicle weight = 97.5 tons for haul truck, 5 tons for pick-up truck
a (unitless) = empirical constant = 0.9 for PM_{10} and $PM_{2.5}$
b (unitless) = empirical constant = 0.45 for PM_{10} and $PM_{2.5}$
VMT = Vehicle Miles Traveled

The PM emission factor in **Equation 3-4** provides a rate of PM generated in units of pounds per vehicle mile traveled. For emission calculation purposes, total vehicle miles traveled (VMT) for the Proposed Action were based on the mass of mined ore, the average mass of ore the haul trucks can transport, and the length of road traveled. Calculated VMT on a daily and annual basis are shown in **Tables 3-10** and **3-11** below, assuming all the mined ore is transported to either Esmeralda Mill or Midas Mill, respectively.

Table 3-10 Total Vehicle Miles Traveled on Unpaved Roads to Esmeralda Mill

Averaging Period	Mass of Ore Mined (tons)	Ore Mass Hauled/Truck (tons)	Round Trips	Length of Unpaved Road/ Round Trip (miles)	VMT (miles)
Daily	1,000	38	26	92	2,392
Annual	275,000	38	7,237	92	665,804

Table 3-11 Total Vehicle Miles Traveled on Unpaved Roads to Midas Mill

Averaging Period	Mass of Ore Mined (tons)	Ore Mass Hauled/Truck (tons)	Round Trips	Length of Unpaved Road/ Round Trip (miles)	VMT (miles)
Daily	1,000	38	26	40	1,040
Annual	275,000	38	7,237	40	289,480

Short-term and annual emission rates were then calculated from VMT and **Equation 3-4** to obtain an uncontrolled PM_{10} and $PM_{2.5}$ emissions rate for both the hauler and pickup trucks expected to be used in the project area. Controlled emissions were then obtained by multiplying the uncontrolled emission rate by (1 - Xc), where Xc is the control efficiency of the measure used (i.e., Water or Chemical Suppressant). A control efficiency of 0.75 was used for emission calculations based on information from AP-42 Section 13.2.2 Unpaved Roads (USEPA 2006) with the application of magnesium chloride as a dust suppressant.

Tailpipe emissions were obtained from MOBILE6 model runs previously completed by Enviroscientists, Inc. (Dickerson 2010). Emission factors from MOBILE6 were based on the respective weight of the truck and were given in grams per mile. These emission factors were then multiplied by VMT as described above.

The annual emissions for haul trucks and pick-ups are shown in **Tables 3-12** and **3-13**, assuming all the mined ore is transported to either Esmeralda Mill or Midas Mill, respectively.

Table 3-12 Annual Emissions (tpy) for Ore Hauling on Unpaved Roads to Esmeralda Mill

Emissions Unit	Annual Total (tpy)					
	NO_X[1]	CO[1]	SO_2[1]	PM_{10}[1]	$PM_{2.5}$[1]	CO_2[2]
Hauler Road Dust	-	-	-	543.92	54.39	-
Hauler Tailpipe (Unpaved Roads)	4.69	2.11	0.23	0.14	0.14	1,182
Hauler Tailpipe (Paved Roads)	25.57	11.49	1.27	0.75	0.75	6,452
Pickup Road Dust	-	-	-	142.90	14.29	-
Pickup Tailpipe	1.64	0.73	0.12	0.06	0.06	2,880
Total Hauling Emissions	31.90	14.33	1.62	687.77	69.63	10,515

[1] Based on VMT per year.

[2] Based on continuous operation (12 hours per day).

Table 3-13 Annual Emissions (tpy) for Ore Hauling on Unpaved Roads to Midas Mill

Emissions Unit	Annual Total (tpy)					
	NO_X[1]	CO[1]	SO_2[1]	PM_{10}[1]	$PM_{2.5}$[1]	CO_2[2]
Hauler Road Dust	-	-	-	236.49	23.65	-
Hauler Tailpipe (Unpaved Roads)	2.04	0.92	0.10	0.06	0.06	514
Hauler Tailpipe (Paved Roads)	0.00	0.00	0.00	0.00	0.00	0
Pickup Road Dust	-	-	-	62.13	6.21	-
Pickup Tailpipe	0.71	0.32	0.05	0.03	0.03	230
Total Hauling Emissions	2.75	1.23	0.15	298.70	29.95	744

[1] Based on VMT per year.

[2] Based on continuous operation (12 hours per day).

3.2.3.2 Model Inputs

Stack parameters used for modeling the haul road emissions are identified in **Table 3-14**. All sources were treated as volume sources. In addition to emission rate, the model requires the initial lateral and vertical dimensions of the volume source referred to as σ_{yo} and σ_{zo}, respectively. These initial dimensions were calculated using National Sand, Stone and Gravel Association (NSSGA) guidance Section 5.1.12, Modeling Fugitive Dust Sources (NSSGA 2007). NSSGA guidance is consistent with USEPA modeling guidance for modeling road traffic (2005), but has information specific to calculating haul truck release parameters. The equations to calculate the initial lateral dimension, σ_{yo}, and the initial vertical dimension, σ_{zo}, are shown in **Equations 3-5** and **3-6**. In accord with NSSGA guidance, the haul road width was estimated to be approximately three times the width of the widest vehicle.

Table 3-14 Volume Source Stack Parameters for Ore Hauling

	Haul Road Width (m)	Release Height (m)	σ_y (m)	σ_z (m)
Haul Truck	14.26	3.200	5.5848	1.4886
Pickup Truck	14.26	1.524	5.5848	0.7088
Haul Truck Tailpipe	14.26	2.500	5.5848	2.3300
Pickup Tailpipe	14.26	0.6096	5.5848	0.5671

Equation 3-5 Determination of Initial Lateral Dimension

$$\sigma_{yo} = \frac{Haul\ road\ width\ (m) + 9.75\ (m)}{4.3}$$

Equation 3-6 Determination of Initial Vertical Dimension

$$\sigma_{zo} = \frac{2\ x\ Height\ of\ haul\ truck\ (m)}{4.3}$$

The emission rate for each volume is a function of the volume size. The horizontal volume size is equal to σ_y shown in **Table 3-14**. The total number of volume sources is equal to the road length divided by the length of a volume source. In this case the number of volume sources is 998. The modeled emissions rates are calculated by dividing the total emissions by the number of volume sources and converting the units to grams per second (g/s). The modeled emission rates for hauling traffic are shown in **Tables 3-15** and **3-16**. The total emission rates shown in **Tables 3-15** and **3-16** were used for the modeling analysis in Chapter 5, which demonstrates compliance with the AAQS.

Table 3-15 Modeled Short-term Emissions for Haul Road Trucks

Emissions Unit	Short-term (g/s)				
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$
Hauler Road Dust	0.00E+00	0.00E+00	0.00E+00	7.73E-03	7.73E-04
Hauler Tailpipe	6.66E-05	2.99E-05	3.30E-06	1.96E-06	1.96E-06
Pickup Road Dust	0.00E+00	0.00E+00	0.00E+00	2.03E-03	2.03E-04
Pickup Tailpipe	2.33E-05	1.04E-05	1.68E-06	8.62E-07	8.62E-07
Total	9.00E-05	4.04E-05	4.99E-06	9.76E-03	9.79E-04

Table 3-16 Modeled Annual Emissions for Haul Road Trucks (g/s)

Emissions Unit	Annual (g/s)				
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$
Hauler Road Dust	0.00E+00	0.00E+00	0.00E+00	3.07E-03	3.07E-04
Hauler Tailpipe	2.64E-05	1.19E-05	1.31E-06	7.77E-07	7.77E-07
Pickup Road Dust	0.00E+00	0.00E+00	0.00E+00	8.05E-04	8.05E-05
Pickup Tailpipe	9.26E-06	4.13E-06	6.67E-07	3.42E-07	3.42E-07
Total	3.57E-05	1.60E-05	1.98E-06	3.87E-03	3.87E-04

3.2.4 Total Emissions for the Proposed Action

The total annual emissions for the Proposed Action include: stationary sources at Hollister Site; portable, non-road engines used for mineral exploration drilling at Hollister Site; and mobile sources that transport ore from Hollister Site to processing facilities. Annual emissions calculations for the Proposed Action include application of controls based on ACEPM. The total maximum annual emissions from the Proposed Action are shown in **Table 3-17**. It is important to note that the emissions associated with hauling all the ore to either Esmeralda or Midas mills are both shown in **Table 3-17**; however the maximum Proposed Action emissions are calculated assuming that all the ore is transported to Esmeralda since this provides a conservatively high estimate of emissions.

Table 3-17 Total Annual Emissions (tpy) for the Proposed Action

Emissions Source	Annual Total (tpy)					
	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$	CO_2
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Non-Road Engines	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic – All Ore to Midas Mill	2.75	1.23	0.15	298.70	29.95	744
Ore Hauling Traffic – All Ore to Esmeralda Mill	31.90	14.33	1.62	687.77	69.63	10,515
Maximum Annual Emissions[1]	63.71	24.00	4.24	690.24	72.10	13,530

[1] For a conservatively high estimate of maximum Annual Emissions, the total emissions are calculated assuming all ore is transported to Esmeralda Mill and none of the ore is transported to Midas. Therefore the values presented in the table for emissions related to ore hauling to Midas Mill are not included in the total "Maximum Annual Emissions" values.

3.3 Mercury and Hazardous Air Pollutants

The only HAP that would be emitted due to this project is mercury. Mined ore containing mercury would be processed at either the Esmeralda Mill or the Midas Mill. Antler Peak Gold, Inc. has obtained mercury operating permit number AP1041-2248 for the ore processing at the Esmeralda Mill under the Nevada Maximum Achievable Control Technology rules. The permitted emissions for mercury at Esmeralda Mill would be approximately 7 pounds per year. The thermal units that are permitted by NDEP under the Phase 2 Mercury Operating Permit to Construct at the Esmeralda Mill include: two mercury retorts, a carbon kiln, and two tanks (pregnant and barren solution tanks).

Newmont Midas Operations, Inc. has obtained mercury operating permit number AP1041-2253 for ore processed at Midas Mill. Processing Hollister ore at Midas Mill would result in mercury emissions at the same level as Esmeralda Mill, and is anticipated to be less than 7 pounds per year. Thermal units permitted at the Midas Mill include: two refinery furnaces; two mercury retorts; and associated ancillary equipment (hot plates, drying ovens, and atomic adsorption spectrometer). As part of the permit process, HAPs (including mercury) were modeled. Given that the amount of ore processing would not increase relative to currently permitted levels at either Esmeralda or Midas mills as a result of this project, and current permits demonstrate compliance with all applicable AAQS, an additional modeling demonstration is not required.

3.4 Building Wake Effects

There is a significant distance from the stack locations and the closest structures/buildings to the property boundary. Building-induced downwash from these distant structures/buildings is not expected to contribute to increased ambient air impacts. Therefore, direction-specific building downwash was not incorporated.

4.0 Meteorology

4.1 Wind Rose

Five years of meteorological data (2002-2006) from the National Weather Service's Elko Regional Airport, surface (WBAN 24121) and upper air (WBAN 04105) meteorological data were used in modeling conducted to support current permits (RCG 2010, 2009). The surface data were obtained from the National Climatic Data Center and the upper air data were obtained from the National Oceanic and Atmospheric Administration Radiosonde database.

A regionally representative wind rose diagram for the period January 1, 2001 to December 31, 2006, from the Elko airport is shown in **Figure 4-1**. The wind rose depicts wind speeds and directions. The predominant winds in the region are from the southwest with a secondary maximum from the east.

Wind speed has an important effect on area ventilation and the dilution of pollutant concentrations from individual sources. Light winds, in conjunction with large source emissions, may lead to an accumulation of pollutants that can stagnate or move slowly to downwind areas.

During stable conditions, downwind usually means down valley or toward lower elevations. Climate data from Elko indicate that the potential for air pollution episodes to last 5 or more days is nearly zero (Holzworth 1972). A potential air pollution episode is defined as a period of time with wind speeds less than 2 meters per second and mixing heights less than 1,000 meters.

Visibility impacts of the Esmeralda Mill were assessed with the VISCREEN model, which, as a screening tool, doesn't incorporate actual meteorological data. In order to qualitatively analyze the visibility impacts from the Esmeralda Mill, the wind patterns at Brawley Peaks meteorological monitoring station are shown in **Figure 4-2**. Brawley Peaks monitoring station is located 4 miles southeast of the Esmeralda Mill. A wind rose diagram for Brawley Peak, Nevada for the period January 1, 2006 to December 31, 2010 is presented in **Figure 4-2**.

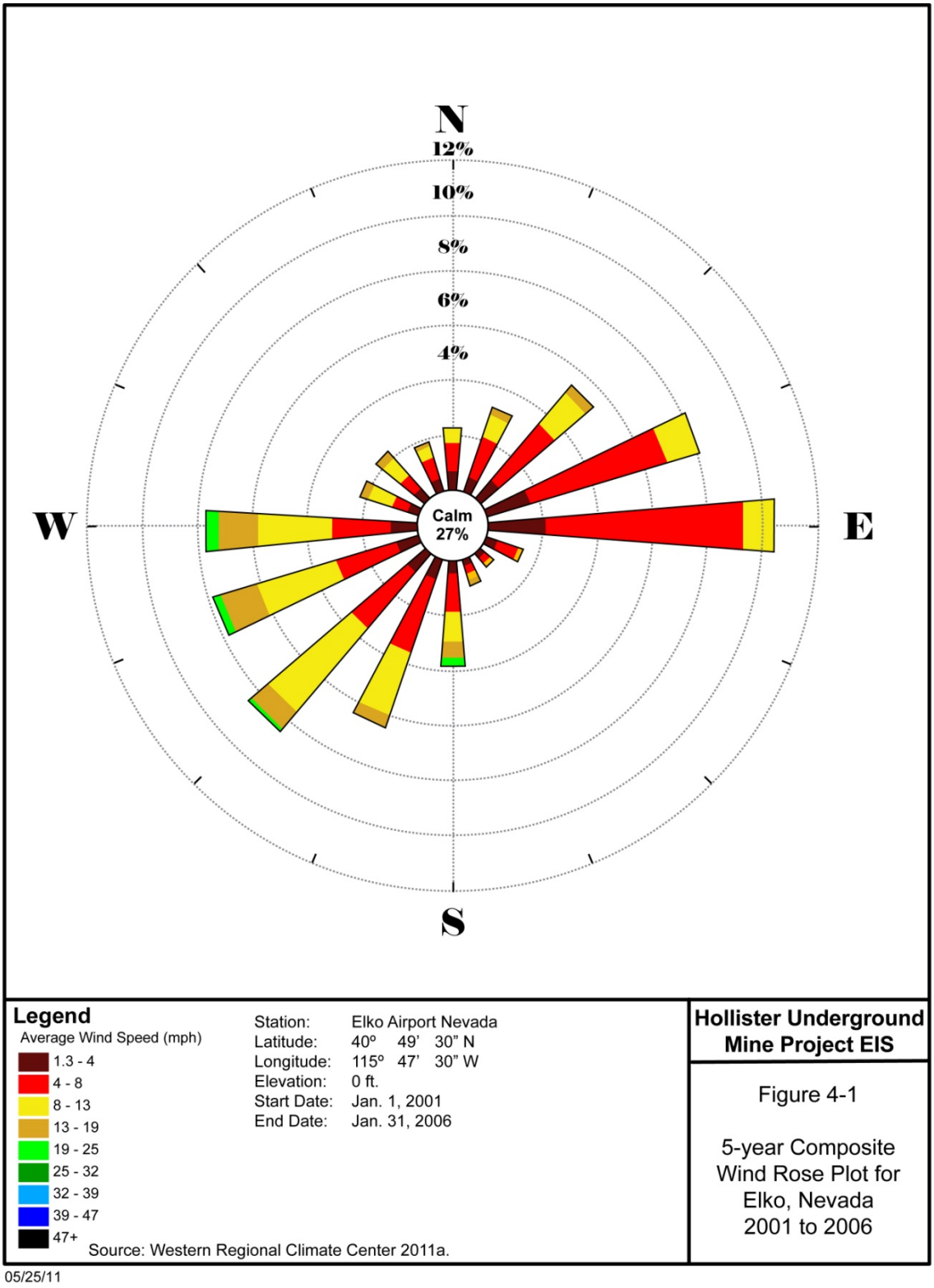


Figure 4-1 5-year Composite Wind Rose Plot for Elko, Nevada – 2001 to 2006

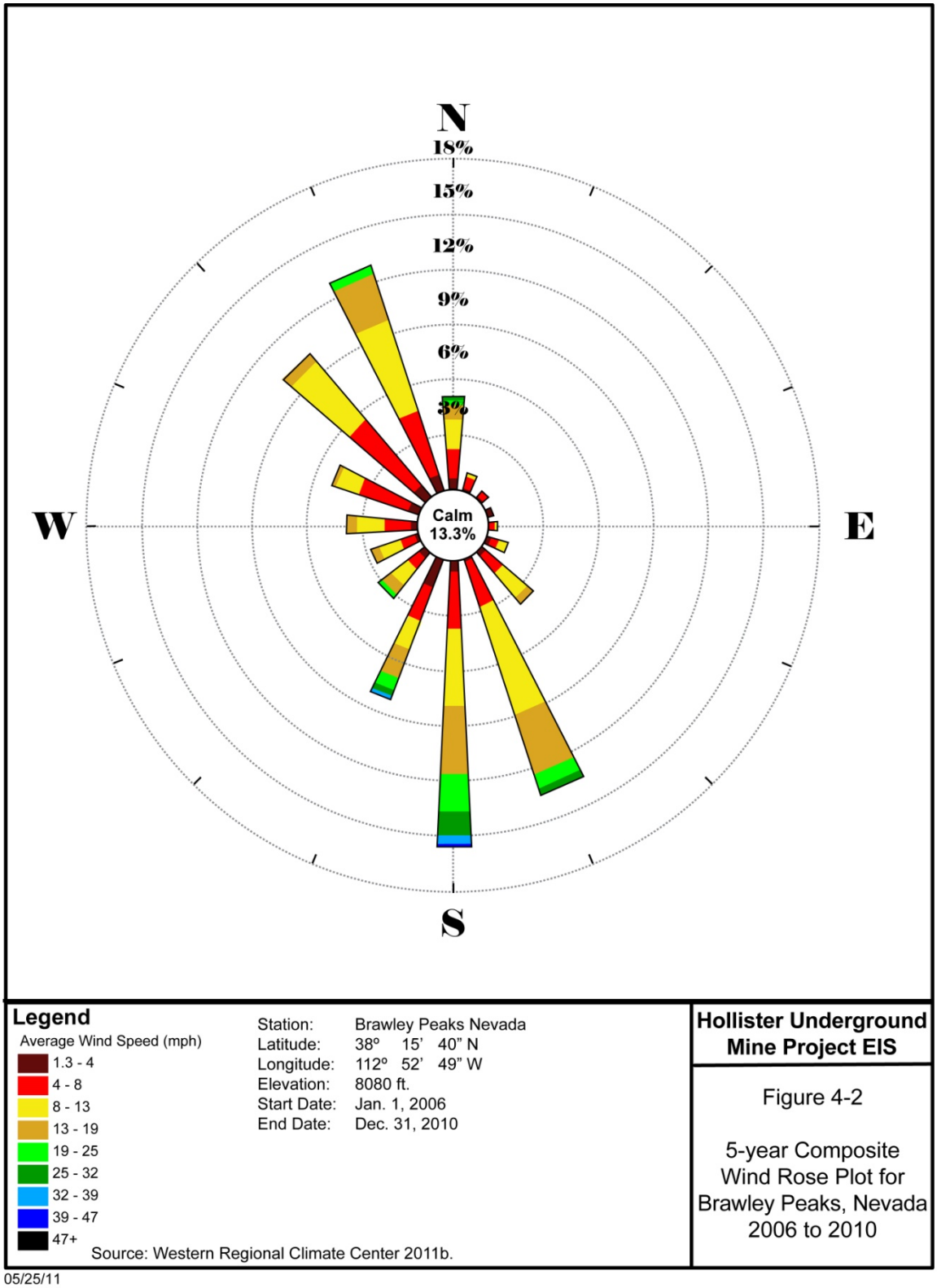


Figure 4-2 5-year Composite Wind Rose Plot for Brawley Peaks, Nevada – 2006 to 2010

5.0 Air Quality Modeling Results

Modeling was conducted for analysis of the Proposed Action's impacts to ambient air quality and visibility.

5.1 Ambient Air Quality Modeling Results

As described in Chapter 3.0, an attainment demonstration has been completed for all pollutants and averaging periods except for a new 1-hour NO_2 and SO_2 standard and new 24-hour and annual standard for $PM_{2.5}$ (RCG 2010, 2009). To determine which of these pollutants required a modeling analysis to demonstrate compliance with AAQS, the annual Proposed Action emissions (shown in **Table 3-17**) were first compared to USEPA modeling thresholds.

- The emissions of SO_2 are below the USEPA modeling threshold and therefore a modeling analysis is not required for this pollutant (USEPA 2010c).
- The emissions of NO_x are not below the USEPA modeling thresholds (USEPA 2010b) and therefore a modeling analysis is required.
- The emissions of $PM_{2.5}$ are not below the USEPA modeling thresholds (USEPA 2010d) and therefore a modeling analysis is required.

Demonstration of compliance for NO_x and $PM_{2.5}$ with the AAQS was determined in a 2-step process using one of the modeling tools SCREEN3 or AERMOD. Initial estimates were performed with SCREEN3. Pollutants determined to have impacts less than AAQS using SCREEN3 were deemed to not cause or contribute to a violation of the AAQS, and as such no refined analyses were performed. Modeling procedures and methods are described in detail in **Attachment 1**, Air Modeling Protocol.

Screening dispersion modeling was performed to assess impacts from the Proposed Action, which includes a decrease in the use of some stationary sources at the Hollister Site and increased ore hauling activities. Air modeling was performed using the USEPA approved SCREEN3 model, as described in **Attachment 1**, Air Modeling Protocol. SCREEN3 is a single source Gaussian plume model which provides maximum ground-level concentrations for point, area, flare, and volume sources. For this study, SCREEN3 model version 96043 was used to evaluate impacts from the emergency generators, portable drill rig engines, and trucks on haul roads. The emergency generators and drill rig engines were modeled as point sources and the trucks were modeled as volume sources.

The SCREEN3 results required post-processing to calculate the maximum impact for each pollutant and averaging period. In order to do this, the modeled 1-hour maximum impacts for each source had to first be multiplied by USEPA scaling factors (USEPA 1992) to estimate the impacts for longer averaging periods. These scaling factors are shown in **Table 5-1**.

Table 5-1 USEPA Scaling Factors from 1-Hour Modeled Impacts

Averaging Period	Scaling Factor (fraction of 1-hour value)
3-hour	1.0
8-hour	0.7
24-hour	0.4
Annual	0.1

5.1.1 Hollister Site Stationary Sources

The modeling analysis previously performed for PM_{10} (RCG 2009) was used as the basis for the comparison to the $PM_{2.5}$ standard. This approach conservatively overestimates the direct $PM_{2.5}$ impacts since emissions of $PM_{2.5}$ are equal to or less than PM_{10} by definition. The USEPA recently has confirmed that while "air quality modeling of direct $PM_{2.5}$ emissions can be accomplished using a USEPA-approved model to predict ambient $PM_{2.5}$ impacts caused by new and modeled sources of $PM_{2.5}$ emissions," it "has not approved any models that can reliably predict the localized ambient $PM_{2.5}$ impacts of precursors (e.g., SO_2 and NO_X) emitted from individual stationary sources." Accordingly, USEPA instructs that an evaluation of $PM_{2.5}$ ambient impacts associated with a single source focus on direct $PM_{2.5}$ emissions (Federal Register 2010). In addition to direct $PM_{2.5}$ emissions, the USEPA has recognized that $PM_{2.5}$ also may include a secondary component that is formed as a result of complex atmospheric reactions involving precursor pollutant emissions. There are four potential pollutant precursors: sulfur dioxide (SO_2), nitrogen oxide (NO_X), volatile organic compounds (VOCs), and ammonia (NH_3). The USEPA presumes that emissions of SO_2 and NO_X would have some secondary contribution to $PM_{2.5}$ ambient concentrations and that emissions of VOCs and NH_3 would not contribute to $PM_{2.5}$ impacts based on its current level of understanding (Federal Register 2008).

As described in the modeling protocol (**Attachment 1**), annual and 24-hour $PM_{2.5}$ background values were calculated for the Hollister Site based on 3 years of measurements of $PM_{2.5}$ collected at Jarbidge Wilderness Area and Great Basin National Park.

Table 5-2 below displays the highest-eighth-high (H8H) PM_{10} result from the previous modeling (RCG 2009) in accordance with the form of the USEPA 24-hour $PM_{2.5}$ AAQS, which classifies an exceedence of the standard if the 98th percentile value over three years exceeds 35 µg/m^3. The results indicate that the conservative evaluation of H8H No Action Alternative plus background are well within the annual and 24-hour standards for $PM_{2.5}$. The $PM_{2.5}$ impacts shown in **Table 5-2** are for the No Action Alternative and the impacts for the Proposed Action would be lower due to the reduction of diesel generators emissions and other sources.

Table 5-2 $PM_{2.5}$ Impacts from Stationary Sources at the Hollister Site

Pollutant	Averaging Time	Impact (µg/m^3)[1]	Background (µg/m^3)	Total Impact (µg/m^3)	NAAQS (µg/m^3)	Percent of NAAQS
$PM_{2.5}$	24-hour	16.86	6.92	23.78	35	68
	Annual	3.45	2.58	6.03	15	40

[1] AERMOD modeled PM_{10} impacts for No Action Alternative (RCG 2009). Impacts for the Proposed Action would be lower due to reduction of the diesel generator emissions.

A modeling analysis was conducted for comparison to the 1-hour NO_2 AAQS. For the Proposed Action, the only stationary sources that would emit NO_x are the diesel generators used for backup power. The emergency generator impacts were assessed at a distance ranging from 0.37 mile (0.59 km) (589 meters), the closest part of the ambient air boundary, to 3.1 miles (5 km). The modeled maximum hourly NO_X emission rates for the emergency generators are shown in **Table 3-4**. The NO_2 impacts from NO_X emissions were estimated using the Ambient Ratio Method, whereby the amount of emissions that are in the form of NO_2 is assumed to be 75 percent of the total NO_X. The SCREEN3 predicted maximum impacts from the emergency generators are shown in **Table 5-3**.

Table 5-3 Hollister Mine SCREEN3 Model Results for Emergency Generators

Pollutant	Averaging Time	Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS
NO_2	1-hour	154.8	n/a	154.8	188	82.3

[1] NDEP BAPC has approved the use of a background value of zero for NO_2 at Hollister Site in past modeling demonstrations (RCG 2010).

5.1.2 Hollister Mine Non-Road Engines

The modeled emission rates associated with drill rig engines are shown in **Table 3-9**. Impacts for the drill rig engines were assessed out to a distance of 1.24 miles (2.0 km) with the max impact distance occurring 417 feet (127 meters) from the drill rig engines. The impacts at 417 feet (127 meters) were calculated for each pollutant and averaging period based on the scaling factors shown in **Table 5-1**. The impacts were then added to the appropriate background concentrations and these results are shown in **Table 5-4** and indicate that impacts from operation of these drill rigs are well below the National and State AAQS.

Table 5-4 Hollister Mine SCREEN3 Model Results for Drill Rigs

Pollutant	Averaging Time	Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS (%)
NO_2	1-hour	47.1	NA	47.1	188	25.0
	Annual	3.4	NA	3.4	100	3.4
CO	1-hour	25.0	NA	25.0	40,000	0.1
	8-hour	17.5	NA	17.5	10,000	0.2
SO_2	1-hour	0.05	NA	0.0	196	0.0
	3-hour	0.05	NA	0.0	1,300	0.0
	24-hour	0.02	NA	0.0	365	0.0
	Annual	0.00	NA	0.0	80	0.0
PM_{10}	24-hour	0.58	10.2	10.8	150	7.2
	Annual	0.11	9.0	9.1	50	18.2
$PM_{2.5}$	24-hour	0.58	6.92	7.5	35	21.4
	Annual	0.11	2.58	2.7	15	17.9

[1] The background values for NO_2 , SO_2, CO, and PM_{10} are from previous modeling demonstrations for the Hollister Site (RCG 2010, 2009). The background concentration for $PM_{2.5}$ is calculated as described in the text above based on the approved modeling protocol (**Attachment 1**).

5.1.3 Ore Hauling

The modeled emission rates associated with ore hauling activities are shown in **Tables 3-15** and **3-16**. Impacts for truck traffic were assessed at a distance of 46 feet (14 meters) from the road for a generic road segment that is representative of all dirt roads in the direct impacts assessment area. A distance of

46 feet (14 meters) was selected for evaluating impacts of ore hauling because this was the distance to the maximum impact predicted by the SCREEN3 model. The SCREEN3 impacts at 46 feet (14 meters) were calculated for each pollutant and averaging period based on the scaling factors shown in **Table 5-1**. The impacts from tailpipe and unpaved road dust emissions from both haul trucks and light-duty trucks were summed and added to the appropriate background concentrations. Results of the conservative screening level dispersion modeling analysis for the Proposed Action are shown in **Table 5-5** and indicate that the impacts from haul road traffic are well below the National and State AAQS.

Table 5-5 Hollister Mine SCREEN3 Model Results for Haul Roads

Pollutant	Averaging Time	Impact ($\mu g/m^3$)	Background ($\mu g/m^3$)[1]	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of NAAQS (%)
NO_2	1-hour	1.9	NA	1.9	188	1.0
	Annual	0.1	NA	0.1	100	0.1
CO	1-hour	0.9	NA	0.9	40,000	0.0
	8-hour	0.6	NA	0.6	10,000	0.0
SO_2	1-hour	0.1	NA	0.1	196	0.1
	3-hour	0.1	NA	0.1	1,300	0.0
	24-hour	0.0	NA	0.0	365	0.0
	Annual	0.0	NA	0.0	80	0.0
PM_{10}	24-hour	20.0	10.2	30.2	150	20.1
	Annual	2.0	9.0	11.0	50	22.0
$PM_{2.5}$	24-hour	2.0	6.92	8.9	35	25.5
	Annual	0.2	2.58	2.8	15	18.5

[1] The background values for NO_2 , SO_2, CO, and PM_{10} are from previous modeling demonstrations for the Hollister Site (RCG 2010, 2009). The background concentration for $PM_{2.5}$ is calculated as described in the text above based on the approved modeling protocol (**Attachment 1**).

5.2 Visibility Analysis

Visibility impairment is caused by particles and gases in the atmosphere. Some particles and gases scatter light while others absorb light. The net effect is called “light extinction.” The result of the scattering and absorption processes is a reduction of the amount of light from a scene that is returned to the observer, and scattering of other light into the sight path, creating a hazy condition. The Hollister Site, Esmeralda Mill and Midas Mill were assessed to determine the requirements for a visibility analysis The Class I visibility analyses for Yosemite National Park were performed using VISCREEN to evaluate impacts from Esmeralda Mill. Federal Land Managers' Air Quality Related Values Work Group (FLAG) recommends that visibility analyses for sources located within 31 miles (50 km) of the Class I area use the VISCREEN model, as described on page 30 of the FLAG report (FLAG 2010).

5.2.1 Visibility at Class I Areas

The Hollister Site is located approximately 62 miles (100 kilometers) from the nearest Class I area, which is the Jarbidge Wilderness Area. According to the Federal Land Managers’ Air Quality Related Values Work Group (FLAG) 2010 Phase I Report (FLAG, 2010), any sources greater than 31 miles

(50 kilometers) from a Class I area would have negligible visibility impacts if the ratio of emissions to distance (Q/D) is 10 or less. The Q/D ratio is the combined emissions (Q, in units of tpy) of SO_2, NO_x, PM_{10}, and H_2SO_4, divided by the distance (in kilometers) from the nearest Class I area. Total emissions for the Proposed Action consist of emissions from stationary sources (**Table 3-5**), ore hauling road traffic (**Table 3-13**), and drill rig engines (**Table 3-7**). The total combined annual emissions (in units of tpy) from these three different source types are shown in **Table 5-6** below. Ore hauling traffic emissions were conservatively assumed for all ore transport to Midas Mill due to its proximity to the Jarbidge Wilderness Area as opposed to the Esmeralda Mill which is closer to Yosemite National Park.

Table 5-6 Total Annual Emissions for Proposed Action when Ore is Transported to the Midas Mill

	tpy					
Emissions Source	**NO_x**	**CO**	**SO_2**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**
Stationary Sources	16.60	1.60	2.60	2.00	2.00	1,342
Drill Rig Engines	15.21	8.07	0.02	0.47	0.47	1,673
Ore Hauling Traffic (Midas Mill)	2.75	1.23	0.15	298.70	29.95	744
Total	34.56	10.91	2.77	301.17	32.42	3,759

Based on the total emissions of NO_X, SO_2, and PM_{10} presented in **Table 5-6**, Q would be equal to 338.5 tons. The Jarbidge Wilderness Area is 62 miles (100 kilometers) away which gives a total Q/D of approximately 3.39 tons/km, well below the upper limit of 10. Based on this screening method, the Q/D value of 3.39 tons/km shows that the emissions from the Hollister Site would have negligible visibility impacts at the Jarbidge Wilderness Area.

The Esmeralda Mill is one of the proposed processing sites for the Hollister ore, and is located about 22 miles southwest of Hawthorne, Nevada, near the California border, and is about 28 miles east of Yosemite National Park, California. Yosemite National Park is considered a federal Class I area. Areas designated as mandatory Class I areas are those national parks exceeding 6,000 acres, wilderness areas and national memorial parks exceeding 5,000 acres, and all international parks, which were in existence on August 7, 1977 (40 CFR part 81, subpart D).

A screening level assessment of the impacts on visibility from processing Hollister Site ore at the Esmeralda Mill was performed using the VISCREEN model version 88341. The plume visual impact screening model VISCREEN is designed to ascertain whether the plume from a facility (i.e., Esmeralda Mill) has the potential to be perceptible to untrained observers under “reasonable worst-case” conditions.

The perceptibility of a plume depends on the plume contrast at all visible wavelengths. At a single wavelength, the contrast between the plume and its surroundings is determined by the difference in the intensity of the light reaching the observer from each. Therefore a single measure, intensity, could be used to quantify contrast if visible light were composed of a single wavelength. With a range of wavelengths, a measure of contrast must recognize both “overall” intensity, and perceived color, and so perceptibility is a function of changes in both brightness and color. To address the added dimension of color as well as brightness, the color contrast parameter, Delta E, was used as the primary basis for determining the perceptibility of plume visual impacts in screening analyses. Delta E provides a single measure of the difference between two arbitrary colors as perceived by humans. This parameter allows us to make quantitative comparisons of the perceptibility of two plumes, even though one may be a reddish discoloration viewed against a blue sky while the other may be a white plume viewed against a dark green forest canopy.

In the plume visual impact screening model VISCREEN, contrasts at three wavelengths (0.45, 0.55, and 0.65 micrometer [µm]) were used to characterize blue, green, and red regions of the visible spectrum. VISCREEN modeling was performed to ascertain whether the plume would be brighter or darker or discolored compared to its viewing background by evaluating its contrasts in the blue, green, and red portions of the visible spectrum. If plume contrast is positive, the plume is brighter than its viewing background; if negative, the plume is darker. If contrasts are different at different wavelengths, the plume is discolored. If contrasts are all zero, the plume is indistinguishable from its background (i.e., imperceptible).

No analysis of visibility impacts was required for Midas Mill since the amount of ore that the facility would process under the Proposed Action would not change relative to currently permitted levels. Since the mill has demonstrated compliance with all applicable AAQS and regional haze requirements, an additional analysis is not required.

5.2.2 VISCREEN Results

Emission rates used in the screening level analysis were the maximum short-term rates expected during the course of a year, and are based on the maximum emission rates in the air quality permit. For screening level analysis, the first criterion is a Delta E value of 2.0; the second is a green (0.55 µm) contrast value of 0.05. Results of the VISCREEN modeling are shown in **Table 5-7**.

Table 5-7 Maximum Visual Impacts Inside Yosemite National Park

Background	Theta (degrees)	Azimuth (degrees)	Distance (km)	Delta E		Contrast	
				Criteria	Plume	Criteria	Plume
Sky – forward scatter	10	157	86	2.00	4.227*	0.05	0.082*
Sky – backward scatter	140	157	86	2.00	0.644	0.05	-0.020
Terrain – forward scatter	10	84	45	2.00	7.887*	0.05	0.060*
Terrain – backward scatter	140	84	45	2.00	0.326	0.05	0.004

* Exceeds screening criteria.

Results are provided for two assumed worst-case sun angles. The “forward scatter” case refers to a situation in which the sun is in front of the observer such that the scattering angle theta is 10 degrees. Such a sun angle would tend to maximize the light scattered by plume particulates and maximize the brightness of the plume. In reality, such a sun angle may or may not occur during worst-case meteorology conditions for the given line of sight as discussed more in the next paragraph. The “backward scatter” case refers to a situation in which the sun is behind the observer such that the scattering angle is 140 degrees. A plume is likely to appear the darkest with such a sun angle. **Table 5-7** shows that contrast and change in light extinction values (Delta E) exceed the screening criteria level. These results indicate that there could be visibility impacts to Yosemite National Park due to ore processing at the mill.

The visibility screening modeling results indicate that under certain worst-case conditions, when the sun is in front of the observer, the Delta E value exceeds the criterion by a factor greater than 2 and the contrast by a smaller margin. The low sun angles would occur only during the early morning hours. An observer looking north and east from the National Park might be able to see a visible plume against the sky or terrain. A visible plume would only be present if the meteorology during the night before and during the early part of that day is conducive to the emissions plume remaining intact and not dispersed. The complex terrain at the mill site and between the mill site and the National Park would favor mixing and dispersion of the plume due to differential heating and cooling of the mountain slopes. During periods of stable atmospheric conditions that would favor a coherent plume, the emissions plume would likely flow with the valley airflow down valley. At Esmeralda, this is generally towards the east; therefore, during the early hours of the day, a plume would not be visible to an observer 28 miles to the south and west. The screening level results for theta values of 140 degrees indicate that the plume formed by emissions from the mill would not be perceptible against either the sky or the terrain during the evening hours when the sun is behind the observer.

6.0 Summary and Conclusions

Gaseous pollutant emissions associated with the Proposed Action would result from construction and mining equipment and vehicle exhaust. RCG has obtained required air quality construction and operating permits from the Nevada BAPC for the Hollister operations. Fugitive dust emissions for the Hollister Underground Mine Project would be generated primarily by haul trucks transporting ore over gravel roads to gold processing facilities. Other sources include surface exploration, access roads, construction of facilities, ore stockpiles, and disposal of waste rock. Particulate emissions would be mitigated by minimization of drop heights during loading, and applying dust suppression procedures. The existing Hollister Site power source, the two Cummins diesel generators located in the East Pit, would be taken out of service once electricity becomes available from the proposed 120-kV and 24.9-kV transmission lines, thereby greatly reducing the gaseous emissions associated with the generators. As a result, the impacts due to gaseous criteria pollutants emitted by stationary sources would be far less than the No Action Alternative, and well within National and State AAQS.

Haul truck traffic impacts were well within the National and State AAQS at a distance of 46 feet (14 meters) from the road for a generic road segment that is representative of all dirt roads. Emissions from exploration drill rigs were well below the National and State AAQS.

Mercury Emissions

Ore from the proposed project would be processed at either the Midas Mill or the Esmeralda Mill. The permitted emissions for mercury at Esmeralda Mill would be about 7 pounds per year. Processing Hollister ore at Midas Mill would result in mercury emissions at the same level as Esmeralda Mill.

HAPs

No individual HAP (including mercury) would be emitted in a quantity greater than the major source limit of 10 tpy, at any of the facilities including the Hollister Site, Esmeralda Mill, and Midas Mill, and the combination of HAP emissions would be less than the major source limit of 25 tpy; therefore, the proposed project would not constitute a major HAP source.

Visibility at Class I Areas

The visibility modeling results indicate that the plume formed by emissions from the Esmeralda Mill would not be perceptible at Yosemite National Park during the afternoon when the sun is behind the observer. Under certain worst-case conditions in the morning, Yosemite National Park could experience visibility impacts from Esmeralda Mill; however, these worst-case conditions are highly unlikely to occur in the project area. Therefore, it is highly unlikely that the Esmeralda Mill would cause visibility impacts at Yosemite National Park.

Negligible visibility impacts would occur to the Jarbidge Wilderness Area as a result of the Proposed Action based on the ratio of emissions to distance (Q/D) calculation.

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Attachment 1

Air Modeling Protocol

Air Modeling Protocol
Final

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1.0 Introduction

AECOM Technical Services, Inc. (AECOM) is submitting this modeling protocol to the Bureau of Land Management (BLM) for evaluating air quality impacts resulting from expansion of surface and underground exploration to full-scale mining at the Hollister Mine located 20 miles southeast of Midas in Elko County, Nevada. Ore would be transported off-site to the Esmeralda Mill located approximately 20 miles southwest of Hawthorne in Mineral County, Nevada, for processing. An alternative ore processing site is located at Newmont's Midas Mill approximately 20 miles northeast of the Hollister Mine. This modeling protocol and subsequent modeling effort are to assess air quality impacts from the Proposed Action and alternatives for the Hollister Underground Mine Project Environmental Impact Statement (EIS) and are not meant to be used for air quality permitting purposes with the State of Nevada Department of Environmental Protection (NDEP). Comparisons to Prevention of Significant Deterioration (PSD) increments are for informational purposes only and the analysis does not constitute a Regulatory Increment Consumption Analysis.

The Hollister Mine and the associated exploration activities will be located in all or part of Sections 4, 5, 8, 9, 16, and 17 of Township 37 North (T37N), Range 48 East (R48E), and all or part of Sections 32 and 33 of T38N, R48E. Lands at the site are administered by the BLM Tuscarora Field Office.

The Universe Transverse Mercator (UTM) Zone 11, North American Datum 1983 (NAD83) coordinates of the approximate center of the facility main production area are 5,366,631.7 meters (m) east, and 4,550,870.2 m north. The mine facility elevation is approximately 5,525 feet above mean sea level.

Based on preliminary estimates of emissions including construction of new facilities, widening of some roads, and other production and exploration activities, the proposed project could increase emissions of nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (PM) including PM with an aerodynamic diameter less than 10 micrometers (PM_{10}), and PM with an aerodynamic diameter less than 2.5 micrometers ($PM_{2.5}$). Screening level and refined dispersion modeling will be performed for each criteria pollutant if screening modeling shows potentially significant impact, to demonstrate compliance with both the National Ambient Air Quality Standards (NAAQS) and Nevada Ambient Air Quality Standards, collectively referred to as AAQS. The emissions of air toxics from the proposed modification generally would not warrant air toxics modeling; nevertheless, mercury emissions from the off-site mill processing the ore from Hollister will be analyzed.

AECOM understands that the primary air pollutants of concern to model for the Hollister Underground Mine Project are PM (PM_{10} and $PM_{2.5}$) from mining operations such as surface disturbance, limited exploration drilling, ore and waste rock transport, mineral processing, and potential mercury emissions from ore processing. Nevertheless, the proposed analysis and dispersion modeling will be conducted for all of the important criteria pollutants emitted, including nitrogen dioxide (NO_2), SO_2, CO, PM_{10}, and $PM_{2.5}$ for the Hollister Mine site area and proposed ore haulage transportation corridors, and for mercury emissions at the Esmeralda Mill processing facilities in Mineral County, Nevada.

This document outlines the proposed approach for the air quality dispersion modeling impact assessment for Class II receptors near the Hollister Mine. The nearest Class I areas to the Hollister mine is Jarbidge Wilderness, which is over 100 kilometers (km) from the facility. An air quality dispersion modeling impact assessment was not performed for the Jarbidge Wilderness Area because the wilderness would not be affected by Hollister operations due to the great distance from the mine site and the low emissions generated. The nearest Class I area to the Esmeralda Mill site is Yosemite National Park in California, approximately 28 miles away. Esmeralda Mill is located in Mineral County approximately 20 miles southwest of Hawthorne, Nevada. Class I impacts will be analyzed for each location, including the Hollister Mine, Midas Mill, and Esmeralda Mill.

The modeling methods are intended to provide conservative estimates of ambient concentrations that potentially may result from the proposed facility emissions in combination with existing sources in the region. The air quality modeling will be conducted in accordance with guidance provided by the United States Environmental Protection Agency (USEPA); Guideline on Air Quality Models (published as 40 Code of Federal Regulations [CFR] 51, Appendix W) (USEPA 2005) (hereafter referred to as the Modeling Guideline). In addition, AECOM also will closely follow the modeling recommendations from the NDEP Bureau of Air Pollution Control (BAPC) as outlined in the following documents; Nevada Bureau of Air Pollution Control General Air Dispersion Modeling Guidelines (NDEP-BAPC 2008). The NDEP guidance will be used to inform the approach to the modeling, but will not be the sole guidance since the purpose of the modeling is not intended for use in obtaining a state air permit.

AECOM will use USEPA-approved dispersion models and methods, including screening level and refined modeling described in the above reference documents to perform the modeling analyses to determine compliance with AAQS for NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$. The area surrounding the Hollister Mine and each processing facility has been classified as attainment for all pollutants. AECOM will not model traffic emissions on paved roads between Hollister and Esmeralda Mill, but will include unpaved roads in the analysis. It is assumed that proposed control measures such as chemical treatment of roadways that would be agreed to by Rodeo Creek Gold would be incorporated in the emissions inventory.

2.0 Modeling Methods

Selection of the appropriate screening and refined dispersion models for use in the analysis is based on the available meteorological input data, the physical characteristics of the sources that are to be simulated, the land use designation in the vicinity of the facility, and the complexity of the nearby terrain.

2.1 Model Selection

2.1.1 SCREEN3

AECOM proposes to use the current version of the USEPA-approved SCREEN3 for screening level analysis. The SCREEN3 analysis is intended to produce estimates of regulatory design concentrations without the need for meteorological data and is designed to produce concentrations that are equal to or greater than (e.g., conservative) the estimates produced by AERMOD with a fully developed set of meteorological and terrain data.

2.1.2 VISCREEN

The Class I visibility analysis for Yosemite National Park (NP) to evaluate impacts from Esmeralda, will be performed using VISCREEN. Federal Land Managers' Air Quality Related Values Work Group (FLAG) recommends that visibility analyses for sources located within 50 km of the Class I area use the VISCREEN model, as described on page 30 of the FLAG document.

The screening analysis is meant to provide a worst-case maximum impact estimate. If the results of the screening analysis show compliance with existing regulatory requirements, then no further modeling for compliance with standards is required.

USEPA has recommended a methodology to assess impacts due to coherent plumes. A guideline for when these steady state conditions apply is the distance from the source to the view of concern. This technique is usually applied for sources locating within 50 km of a Class I area. Applicants should first model their potential plume impacts using the screening model, VISCREEN. This model uses steady-state, gaussian-based plume dispersion techniques to calculate 1-hour concentrations within an elevated plume. The model calculates the change in the color difference index (ΔE) and contrast

between the plume and the viewing background. Values of ΔE and plume contrast are based on the concentrations of fine primary particulates (including sulfates), NO_2, and the geometry of the observer, target, plume, and the position of the sun.

2.1.3 AERMOD

AERMOD is the model of choice for refined model and is recommended for use in modeling multi-source emissions, and can account for plume downwash, stack tip downwash, and point, area, and volume sources (USEPA 2005, 2004). AERMOD also has the ability to model impacts at both simple (below stack height) and complex (terrain heights above the height of the stack) terrain receptors.

AECOM proposes to follow recent March 23, 2010, USEPA guidance for $PM_{2.5}$ modeling. In order to demonstrate that it is appropriate to use PM_{10} as a surrogate for $PM_{2.5}$ ambient air quality impact assessment, it is assumed that as an initial step the applicant will have conducted and appropriate dispersion modeling analysis, which demonstrates compliance with the PM_{10} NAAQS, including an analysis of annual PM_{10} impacts. A simple example illustrating when a PM_{10} modeling analysis might serve as a surrogate for $PM_{2.5}$ modeling would be if a clearly conservative assumption is made that all PM_{10} emissions are $PM_{2.5}$ and the modeled PM_{10} impacts are taken as a direct surrogate for $PM_{2.5}$ impacts and compared to the $PM_{2.5}$ NAAQS (USEPA 2010).

The guidance indicates that adequate accounting for contributions from background $PM_{2.5}$ concentrations to the cumulative impact assessment can be made, and a reasonable demonstration that the modeled PM_{10} emission inventory adequately accounted for potential nearby sources of $PM_{2.5}$, then the appropriateness of surrogacy could be reasonably found in this example. The guidance goes on to say that a source-specific $PM_{2.5}/PM_{10}$ emission factor ratios also may support the assumption of a more realistic, yet conservative approach for taking a ratio of modeled PM_{10} ambient impacts to provide conservative estimates of $PM_{2.5}$ impacts (USEPA 2010). Modeling of $PM_{2.5}$ in accordance with present USEPA guidance would result in conservative estimates of $PM_{2.5}$ impacts. Since modeling of PM_{10} was previously conducted for the Hollister Mine, the $PM_{2.5}$ analysis for the EIS will utilize these results to assess $PM_{2.5}$ impacts from sources at the mine.

2.1.4 Comparison to NAAQS

Combining the modeled and monitored concentrations of $PM_{2.5}$ for comparison to the $PM_{2.5}$ NAAQS also entails considerations that differ from those for other criteria pollutants, due to the issues identified above. Given the importance of secondary contributions for $PM_{2.5}$ and the typically high background levels relative to the NAAQS for $PM_{2.5}$, greater emphasis is placed on the monitored background contribution relative to the modeled inventory. Also, given the probabilistic form of the $PM_{2.5}$ NAAQS, careful consideration must be given to how the monitored and modeled concentrations are combined to estimate the cumulative impact levels.

The representative monitored $PM_{2.5}$ design value, rather than the overall maximum monitored background concentration, should be used as a component of the cumulative analysis. The $PM_{2.5}$ design value for the annual averaging period is based on the 3-year average of the annual average $PM_{2.5}$ concentrations; for the 24-hour averaging period, the design value is based on the 3-year average of the 98th percentile 24-hour average $PM_{2.5}$ concentrations for the daily standard. Details regarding the determination of the 98th percentile monitored 24-hour value based on the number of days sampled during the year are provided in the ambient monitoring regulations, Appendix N to 40 CFR Part 50.

AECOM will follow the regular formula for computing annual 98th percentile values. Calculation of annual 98th percentile values using the regular formula will be based on the creditable number of samples (as described below), rather than on the actual number of samples. Credit will not be granted for extra (non-creditable) samples. Extra samples, however, are candidates for selection as the annual 98th percentile. (The creditable number of samples will determine how deep to go into the data distribution,

but all samples [creditable and extra] will be considered when making the percentile assignment.) The annual creditable number of samples is the sum of the four quarterly creditable number of samples. The procedure is as follows:

Daily Values:

- Sort all the daily values from a particular site and year by ascending value. (For example: (x[1], x[2], x[3], * * *, x[n]). In this case, x[1] is the smallest number and x[n] is the largest value.)
- The 98th percentile is determined from this sorted series of daily values which is ordered from the lowest to the highest number.

Annual Values:

- Compute (0.98) x (cn) as the number "i.d," where "cn" is the annual creditable number of samples, "I" is the integer part of the result, and "d" is the decimal part of the result.
- The 98th percentile value for year y, $P_{0.98,ly}$, is calculated using equation 5 of Appendix N.

The modeled annual concentrations of (primary) $PM_{2.5}$ to be added to the monitored annual design value should be based on the highest average of the modeled annual averages across 5 years for National Weather Service (NWS) meteorological data or the highest modeled annual average for 1 year of site-specific meteorological data. The resulting cumulative annual concentration would then be compared to the annual $PM_{2.5}$ NAAQS of 15 micrograms per cubic meter ($\mu g/m^3$).

For the 24-hour NAAQS analysis, the modeled concentrations to be added to the monitored 24-hour design value should be computed using the same procedure used for the preliminary analysis based on the highest average of the maximum modeled 24-hour averages across 5 years for NWS meteorological data or the maximum modeled 24-hour average for 1 year of site-specific meteorological data. As noted above, use of the average modeled concentration across the appropriate time period more accurately characterizes the modeled contribution from the facility in relation to the NAAQS than use of the highest modeled impact from individual years, while using the average of the first highest 24-hour averages rather than the 98th percentile (8th highest) values is consistent with the screening nature of $PM_{2.5}$ dispersion modeling. Furthermore, combining the 98th percentile monitored with the 98th percentile modeled concentrations for a cumulative impact assessment could result in a value that is below the 98th percentile of the combined cumulative distribution and would, therefore, not be protective of the NAAQS. (USEPA 2010)

2.2 Refined Model Options

In the event refined modeling is required, model input options for AERMOD will be set to their regulatory default values. Regulatory default values include:

- Stack-tip Downwash;
- Model Accounts for Elevated Terrain Effects;
- Use Calms Processing Routine;
- Allow Missing Data; and
- No Exponential Decay.

Given the location of the mine, rural dispersion coefficients are proposed for the AERMOD model.

2.2.1 Meteorological Data Processing

Hourly meteorological data used for refined air quality modeling must be spatially and climatologically representative of the area of interest. The Modeling Guideline recommends a minimum of 1 year of site-specific meteorological data or 5 consecutive years from the most recent, readily available data collected at the nearest NWS station. Required surface meteorological data inputs to the AERMOD meteorological processor (AERMET) include, at minimum, hourly observations of wind speed, wind direction, temperature, and cloud cover (or solar radiation and low-level vertical temperature difference data in lieu of cloud cover). The meteorological processor also requires morning upper air sounding data from a representative NWS station.

2.2.2 On-site Data

At this time, AECOM is unaware of adequate on-site surface meteorological data collected at the Hollister Mine and Esmeralda Mill. In order to accept historical data, a monitoring plan, quarterly data reports, and copies of raw data collected at the site would need to be provided to AECOM for review.

Assuming that on-site data are available, raw monitoring data would be entered into an Excel spreadsheet and processed as follows:

- Data would be validated using information provided in the quarterly reports, including printouts of monthly data summaries provided in Appendix D of each report.
- Nighttime total solar radiation values would be set to zero. An hour is considered a nighttime hour if the sun is below the horizon for the entire hour. Solar elevation angles are computed using an Excel macro and using the longitude and latitude of the monitoring tower.
- Assuming hourly barometric pressure data are not available, hourly values of barometric pressure would be calculated for each hour using the following equation:

$$P_z = P_0 e^{\frac{-gz}{RT}}$$

  where P_z is the calculated station pressure in mb, P_0=1013.3 mb, g=9.81 ms^{-1}, z is the station elevation in meters, R is the ideal gas constant for dry air (287 $JK^{-1}kg^{-1}$), and T is the hourly average ambient temperature measured at the station in Kelvin.

Data recovery statistics for the processed meteorological dataset would be provided in the modeling report. Annual wind roses would be developed from the available data, and the location of the monitoring site with respect to the mine facility would be documented.

2.2.3 Surface Data

The algorithm used by AERMET for estimating the surface heat flux under stable conditions requires either a cloud cover measurement or low-level vertical temperature difference data. Cloud cover data or solar radiation data also are required to determine whether a given hour is convective or stable. If on-site data includes 10-2 m temperature difference and total solar radiation data, NWS surface meteorological data will not be used.

2.2.4 National Weather Service Upper Air Data

The temperature structure of the atmosphere prior to sunrise is required by AERMET to estimate the growth of the convective boundary layer for the day. AERMET uses the 1200 Greenwich Mean Time upper air sounding from the nearest NWS upper air observing station for this purpose. The nearest NWS station to the project site is located in Elko, Nevada, approximately 45 miles southeast of the project site.

Concurrent upper air data would be obtained from the Forecast Systems Laboratory/NCDC Radiosonde Data Archive located at http://rucsoundings.noaa.gov/ and provided as input to AERMET.

2.2.5 Surface Characteristics

Final processing of the meteorological data requires assigning appropriate surface characteristics including surface roughness length (z_0), Bowen Ratio (B_0), and albedo (r). Surface characteristics should be assigned following guidance provided in the current version of the AERMOD Implementation Guide (AIG) (USEPA 2009).

The AIG recommends that the surface characteristics be determined based on digitized land cover data. USEPA has developed the AERSURFACE processor (USEPA 2008) that would be used to determine the site characteristics based on digitized land cover data in accordance with the recommendations from the AIG discussed above. AERSURFACE incorporates look-up tables of representative surface characteristic values by land cover category and seasonal category.

The current version of AERSURFACE supports the use of land cover data from the U.S. Geological Survey (USGS) National Land Cover Data 1992 archives (NLCD92)[1]. The NLCD92 archive provides data at a spatial resolution of 30 m based on a 21-category classification scheme applied over the continental U.S.

AERSURFACE would be used to calculate surface characteristics for twelve 30-degree sectors beginning from the North and ending North (0 to 360 degrees).

2.2.6 Seasonal Classification and Soil Moisture Determination

In AERSURFACE, the various land cover categories are linked to a set of seasonal surface characteristics. As such, AERSURFACE requires specification of the seasonal category for each month of the year. The following five seasonal categories are offered by AERSURFACE:

- Mid-summer with lush vegetation;
- Autumn with un-harvested cropland;
- Late autumn after frost and harvest, or winter with no snow;
- Winter with continuous snow on ground; and
- Transitional spring with partial green coverage or short annuals.

To assign the seasonal classification for each month of each year, the default seasonal classifications found in the AERSURFACE User's Guide would be used. Average seasonal surface moisture conditions would be applied for the entire data period being processed.

2.2.7 Wind Rose

A regionally representative wind rose for the period January 1, 2001, to January 31, 2006, from the Elko airport is shown in **Figure 2-1**. The wind rose depicts wind speeds and directions and shows that the predominant winds in the region are from the southwest with a secondary maximum from the east. This Elko Airport wind rose is shown only to provide a sense of the wind fields that predominate in the region, and would not necessarily be the wind data of choice for refined modeling. Data used in the actual modeling will be included in the technical report.

[1] Available at http://edcftp.cr.usgs.gov/pub/data/landcover/states/.

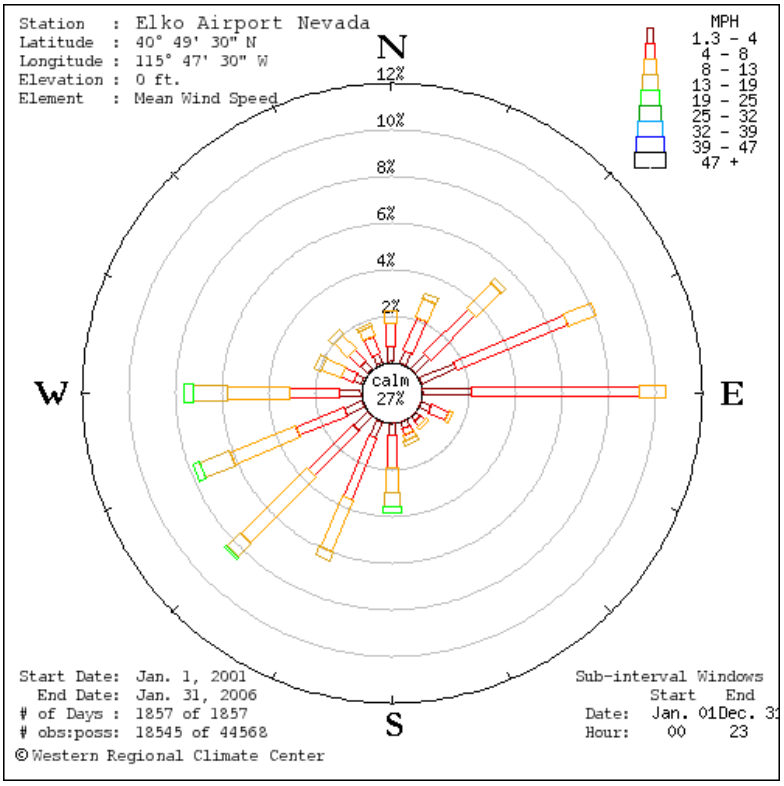

Figure 2-1 Elko Airport Wind Rose for the Period January 1, 2001, through January 31, 2006

2.2.8 Property Boundary and Receptor Network

The ambient air boundary and Cartesian coordinate grid will be defined using UTM Zone 11 NAD83 coordinates. For the screening analysis, receptors will be spaced at 1-m intervals from the facility ambient air boundary to a distance of 2 km. If it is determined that a refined analysis is required, several receptor grids of varying resolution will be processed using AERMAP. At a minimum, the grids will consist of a set of nested receptors placed at:

- 25-m resolution along the facility ambient air boundary.
- 50-m resolution extending from the boundary to 500 m from the boundary.
- 100-m resolution extending from 500 m to 1 km from the boundary.
- 500-m resolution extending from 1 km to 5 km from the boundary.
- 1,000-m resolution extending from 5 km to 10 km from the boundary. Figures showing the proposed receptor grids would be overlaid onto topographic maps.

If the maximum predicted impact exceeds 75 percent of an ambient air quality standard occurs outside the 50-m resolution grid, and it is predicted that facility sources significantly contribute the maximum predicted impact, an additional refined (50-m resolution) Cartesian grid will be developed around the maximum impact receptor. Receptor elevation and critical hill height data will be obtained from USGS National Elevation Data (NED) using the AERMAP terrain processor. Although use of NED data differs from guidance received from the NDEP, the latest version of the AIG recommends the use of NED data. AERMOD will be run using the default elevated terrain option. To ensure that the correct critical hill

height for each receptor is chosen, NED data provided to AERMAP will cover the entire receptor grid, plus a sufficient buffer to ensure correct critical hill heights are identified.

2.2.9 Facility Digitization and Plume Downwash

Facility sources and structures will be obtained from an electronic plot plan and digitized in UTM Zone 11 NAD83 coordinates. The effects of plume downwash will be considered for all project point sources. Direction-specific building dimensions will be calculated using the current version of the USEPA-approved Building Profile Input Program (BPIPPRM Version 04274).

Only permanent structures (i.e., buildings) will be included in the plume building downwash analysis. Specifically, temporary storage piles will not be considered to be structures that may produce plume downwash. The base elevation of all structures and sources will be obtained by running the AERMAP terrain processor for each source using NED data. Structure base elevations will be set equal to the base elevation of the source that is associated with each structure.

A simplified plot plan of the facility showing the location of all structures and point sources to be used in the plume downwash calculations will be included in the modeling report.

3.0 Emission Inventory and Source Characterization

3.1 Facility Sources

Facility sources at Hollister include point PM sources such as a shotcrete batch plant, ore stock piles, ore load outs, diesel stationary engines for electrical generation, and a diesel stationary engine for a water pump. Portable sources on the mine property include drill rigs used for mining exploration. Up to two drill rigs may operate at any one time, but the locations are not fixed for more than 3 to 4 weeks. The drill rigs are relatively small sources of gaseous emissions and use on average, 220 horsepower diesel engines. Drilling also is a small source of fugitive dust. Fugitive dust sources are primarily related to unpaved haul roads on the mine and unpaved county roads used by trucks to transport ore to other locations for processing. No crushing or other processing of ore takes place at the Hollister location.

The Proposed Action includes the discontinued use of the two large stationary engines currently used for electrical generation, since the mine is proposing to construct an electrical transmission line to the mine site.

Ore processing is planned at one of two alternative processing facilities, Esmeralda or Midas. These facilities would be fugitive PM sources (load outs and storage piles), and gaseous emissions (NO_X, SO_2, CO, and hazardous air pollutants [HAPs]) from heaters, boilers, tanks, etc. All fugitive PM sources will be modeled as volume sources. Volume source dimensions will be determined by considering the movement of the plume sources during the course of an hour. All fugitive sources including roads will be assumed to function at the proposed maximum hourly and annual throughput rates. The ore processing facilities also are possible sources of mercury and other HAPs emissions from thermal processes.

3.2 Off-site Sources

No off-site sources were identified for inclusion in the cumulative impact analysis.

4.0 Ambient Air Quality Impact Analyses and Report

This section describes the refined modeling ambient air quality impact analyses that will be performed assuming that the screening approach raises concerns about the level of impacts from the project. They include the significant impact analysis, and a cumulative analysis for comparison to the AAQS. Since the mine is not located in a PSD-triggered air management area of Nevada for SO_2 and PM_{10}[2] the Nevada Bureau of Air Quality Planning is not required to track increment consumption for these pollutants. Modeling results will be compared with Class II PSD increment thresholds; however, a formal PSD increment consumption analysis is not required for the mining facility, which is a minor source of emissions. Comparisons to PSD Increments are for informational purposes only and the analysis does not constitute a Regulatory Increment Consumption Analysis. Details on how each analysis will be performed are described below.

4.1 AAQS Analyses

Compliance with the AAQS will be determined for all criteria pollutants in a 2-step process using one of the modeling tools, SCREEN3 or AERMOD. Initial estimates will be performed with SCREEN3. Pollutants determined to have impacts less than AAQS using SCREEN3 will be deemed to not cause or contribute to a violation of the AAQS, and as such, no further analysis would be performed.

The AAQS are the maximum concentrations allowed in terms of total pollutant levels in ambient air. Compliance with the AAQS will be based on the total estimated air quality concentrations, which will be the sum of the following:

- Modeled impacts resulting from all facility sources modeled at their proposed potential emission rates;
- Modeled impacts due to off-site sources; and
- Background concentrations.

For 24-hour PM_{10} impacts, the highest-sixth-high modeled impact will be used for determining compliance with the AAQS. For 24-hour $PM_{2.5}$ impacts, the highest-eighth-high modeled impact will be used for determining compliance with the AAQS. The remaining pollutants and averaging periods will use the highest-first-high or highest-second-high modeled impacts in compliance with the form of the standard, as indicated in **Table 4-1,** for determining compliance with the AAQS. All short-term averaging periods will use combined 5-year meteorological data files. For the annual averaging period, each year of meteorology will be run separately and the maximum year will be reported.

Total estimated air quality concentrations will be compared to the most stringent AAQS. Primary $PM_{2.5}$ emissions will be modeled for determining compliance with the $PM_{2.5}$ AAQS. There is no guideline model for estimating condensable $PM_{2.5}$ impacts.

[2] See http://ndep.nv.gov/bapc/download/class1/psd_map.pdf for a map of Nevada state PSD-trigger areas. The mine is located east of hydrographic area 064 and north of area 061L.

Table 4-1 AAQS and Class II PSD Increments

Pollutant	Averaging Period	AAQS	Class II PSD Increment
PM_{10}	24-hour	150 µg/m^3 (1)	30 µg/m^3
	Annual	50 µg/m^3 (2)	17 µg/m^3
$PM_{2.5}$	24-hour	35 µg/m^3 (5)	NA
	Annual	15 µg/m^3 (5)	NA
SO_2	1-hour	75 ppb	NA
	3-hour	1,300 µg/m^3 (6)	512 µg/m^3
	24-hour	365 µg/m^3 (6)	91 µg/m^3
	Annual	80 µg/m^3	20 µg/m^3
NO_2	1-hour	0.100 ppm	25 µg/m^3
	Annual	0.053 ppm	25 µg/m^3
CO	1-hour	35 ppm (6)	NA
	8-hour	6 ppm(7)	NA

1 Not to be exceeded more than once per year. Reported as the highest-sixth-high impact using 5 years of meteorology.

2 The annual PM_{10} NAAQS was revoked by USEPA in 2006 (71 Federal Register 61144).

3 The significant impact levels for $PM_{2.5}$ are the lowest levels proposed by USEPA.

4 The significant impact levels for 1-hour SO_2 have not been set or proposed by USEPA.

5 To attain this standard, the 3-year average of the 98th percentile of the 24-hour concentrations at each population-oriented monitor within an area must not exceed the standard; reported as the highest-eighth-high impact using 5 years of meteorology using POLLUTID of "PM25" in AERMOD.

6 Not to be exceeded more than once per year; reported as highest-second-high impact.

7 The NDEP AAQS for facilities over 5,000 feet is 6 parts per million (ppm), rather than the NAAQS of 9 ppm.

4.2 Air Quality Related Values Analysis

SCREEN3 will be used to evaluate both direct Project and cumulative PSD Class I increment and sulfur and nitrogen deposition impacts at Yosemite NP, the closest Class I area to the Esmeralda Mill. The Class I visibility analysis will be performed using VISCREEN. Impacts to Regional Haze also will be evaluated based on the emissions from Esmeralda Mill.

FLAG recommends that visibility analyses for sources located within 50 km of the Class I area use the VISCREEN model, as described on page 30 of the FLAG document. Background visual range will be based upon FLAG average reconstructed natural conditions. A background 1-hr ozone concentration will be used, and primary sulfate emissions will be estimated as 2 percent of the SO_2 emissions. The cumulative visibility analysis will include VISCREEN analyses for other cumulative sources (with distances adjusted as necessary to account for geographic separation of emission units at each source). The cumulative visibility impacts will then be determined by summing the frequencies of impacts that are above the VISCREEN thresholds for all sources.

The PM_{10} and $PM_{2.5}$ impact analysis at Yosemite NP will not consider fugitive dust emissions from construction or vehicle travel. This assumption is based on supporting documentation from the Western

Regional Air Partnership analyses of mechanically generated fugitive dust emissions that suggest that particles larger than $PM_{2.5}$ tend to deposit out near the emission sources

4.3 HAPs Modeling

Mercury emissions would be assessed by two different methods. Particle bound mercury could be released from surfaces disturbed by mining activities including construction, on-site traffic, and transport of ore to a mill for processing. Particle bound mercury would represent a small fraction of the fugitive dust released for these mine activities, and a conservative estimate of mercury emissions would be made based on the modeling results described above for PM_{10} fugitive dust.

Other forms of mercury, most likely elemental (gaseous) mercury could be released during thermal processes related to gold recovery from the ore. Ore processing is planned at either the Esmeralda Mill off-site facility or at the Midas Mill off-site facility. Additional modeling, SCREEN3 or AERMOD, may be required for these facilities in addition to the modeling performed for the mine itself.

Direct releases of elemental and particle bound mercury from either of the mill sites can be assessed in much the same way as any other pollutant using models such as AERMOD. Determining long range fate, transport, and transformation to oxidized species that eventually are deposited back on earth requires highly sophisticated photochemical modeling, which is outside the scope of this analysis.

5.0 References

Nevada Department of Environmental Quality Bureau of Air Pollution Control (NDEP-BAPC). 2008. Nevada Bureau of Air Pollution Control General Air Dispersion Modeling Guidelines. Available at http://ndep.nv.gov/bapc/qa/Model_Guide.pdf. September, 2008.

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_____. 2005. Guideline on Air Quality Models. Published as 40CFR58 Appendix W. November 9, 2005.

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Attachment 2

Supporting Modeling Calculations

The SCREEN3 Model was run for all sources using a 1.0 g/s emission rate. The SCREEN3 maximum impact for a 1-hour averaging period was then multiplied by the estimated g/s emission rates shown in Chapter 3.0 for each pollutant and source type. To calculate the impacts for pollutant/averaging periods that are longer than 1-hour, the EPA scaling factors for the 1-hour modeled impacts, as shown in **Table 5-1**, are used to estimate impacts for every averaging period. The modeled output file and the impact calculations are show below for each source type: stationary sources; drill rigs; and ore hauling. The model predicted maximum impact that is used for the calculated impact and is highlighted in yellow.

Stationary Sources – Proposed Action

SCREEN3 Generator Results

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 96043 ***

Generators

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = POINT

EMISSION RATE (G/S) = 1.00000

STACK HEIGHT (M) = 4.5700

STK INSIDE DIAM (M) = .4100

STK EXIT VELOCITY (M/S)= 52.7300

STK GAS EXIT TEMP (K) = 733.1500

AMBIENT AIR TEMP (K) = 293.0000

RECEPTOR HEIGHT (M) = .0000

URBAN/RURAL OPTION = RURAL

BUILDING HEIGHT (M) = .0000

MIN HORIZ BLDG DIM (M) = .0000

MAX HORIZ BLDG DIM (M) = .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = 13.046 M**4/S**3; MOM. FLUX = 46.698 M**4/S**2.

*** FULL METEOROLOGY ***

****

*** SCREEN AUTOMATED DISTANCES ***

****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
589.	24.74	4	8.0	8.0	2560.0	22.95	42.33	21.55	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 589. M:

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
589.	24.74	4	8.0	8.0	2560.0	22.95	42.33	21.55	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

*** SUMMARY OF SCREEN MODEL RESULTS ***

****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	24.74	589.	0.

2 Cummins Gen SCREEN3 impacts (ug/m3 per g/s) :

24.74	**1-hr**	**< 589m from stack=fenceline**
24.74	3-hr	1.0 scaling factor
17.32	8-hr	0.7 ""
9.90	24-hr	0.4 ""
2.47	annual	0.1 ""

Short-term Emissions (g/s)		Annual Emissions (g/s)	
8.34E+00	NOx	4.76E-01	NOx
8.00E-01	CO	4.57E-02	CO
1.30E+00	SO2	7.42E-02	SO2
1.20E-01	PM10	6.85E-03	PM10
1.20E-01	PM2.5	6.85E-03	PM2.5

Pollutant	Averaging Time	Impact (ug/m3)
NO2	1-hr	154.8
NO2	Annual	0.9
CO	1-hr	19.8
	8-hr	13.9
SO2	1-hr	32.2
	3-hr	32.2
	24-hr	12.9
	Annual	0.2
PM10	24-hr	1.2
	annual	0.0
PM2.5	24-hr	1.2
	annual	0.0

Drill Rig Results

SCREEN3 Drill Rig Results

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 96043 ***

drill_rig_engine

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = POINT

EMISSION RATE (G/S) = 1.00000

STACK HEIGHT (M) = 6.1000

STK INSIDE DIAM (M) = .3800

STK EXIT VELOCITY (M/S)= 25.0000

STK GAS EXIT TEMP (K) = 700.0000

AMBIENT AIR TEMP (K) = 293.0000

RECEPTOR HEIGHT (M) = .0000

URBAN/RURAL OPTION = RURAL

BUILDING HEIGHT (M) = .0000

MIN HORIZ BLDG DIM (M) = .0000

MAX HORIZ BLDG DIM (M) = .0000

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = 5.146 M**4/S**3; MOM. FLUX = 9.444 M**4/S**2.

*** FULL METEOROLOGY ***

****

*** SCREEN AUTOMATED DISTANCES ***

****

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	1	1.0	1.0	320.0	79.30	1.73	1.69	NO
100.	70.70	3	10.0	10.0	3200.0	13.42	12.58	7.63	NO
200.	71.49	4	10.0	10.0	3200.0	13.42	15.70	8.75	NO
300.	66.10	4	8.0	8.0	2560.0	15.25	22.76	12.37	NO
400.	57.31	4	5.0	5.0	1600.0	20.74	29.75	15.83	NO
500.	50.96	4	4.5	4.5	1440.0	22.37	36.44	18.88	NO
600.	45.36	4	4.0	4.0	1280.0	24.40	43.04	21.85	NO
700.	40.88	4	3.5	3.5	1120.0	27.01	49.55	24.77	NO
800.	37.30	4	3.0	3.0	960.0	30.50	56.01	27.67	NO
900.	34.16	4	2.5	2.5	800.0	35.38	62.45	30.63	NO
1000.	31.66	4	2.5	2.5	800.0	35.38	68.64	33.17	NO
1100.	29.19	4	2.5	2.5	800.0	35.38	74.78	35.14	NO
1200.	27.38	4	2.0	2.0	640.0	42.70	81.12	37.58	NO
1300.	25.77	4	2.0	2.0	640.0	42.70	87.15	39.41	NO
1400.	25.08	5	1.0	1.0	10000.0	57.41	70.75	30.50	NO

1500.	25.63	5	1.0	1.0	10000.0	57.41	75.14	31.55	NO
1600.	26.00	5	1.0	1.0	10000.0	57.41	79.51	32.58	NO
1700.	26.23	5	1.0	1.0	10000.0	57.41	83.87	33.59	NO
1800.	27.21	6	1.0	1.0	10000.0	48.68	59.13	23.61	NO
1900.	28.11	6	1.0	1.0	10000.0	48.68	61.98	24.22	NO
2000.	28.88	6	1.0	1.0	10000.0	48.68	64.83	24.81	NO

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 1. M:

127.	78.62	3	10.0	10.0	3200.0	13.42	15.78	9.54	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

*** SUMMARY OF SCREEN MODEL RESULTS ***

****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)

SIMPLE TERRAIN 78.62 127. 0.

Pollutant	Averaging Period	Impact ($\mu g/m^3$)
NO_2	1-hr	47.1
	Annual	3.4
CO	1-hr	25.0
	8-hr	17.5
SO_2	1-hr	4.71E-02
	3-hr	4.71E-02
	24-hr	1.88E-02
	Annual	3.44E-03
PM_{10}	24-hr	5.77E-01
	annual	1.05E-01
$PM_{2.5}$	24-hr	5.77E-01
	annual	1.05E-01

Ore Hauling – Proposed Action

The impacts from ore hauling is similar to the process for emergency generators and drilling; however there are multiple emissions sources for hauling: unpaved road dust from heavy-duty and light weight pick-up trucks; and tailpipe emissions from heavy-duty and light weight pick-up trucks. The four emissions sources were modeled separately and the impacts were and multiplied by the estimated g/s emission rate for each of these activities. Then the impacts were added together for each source to arrive at a total impact for ore hauling.

SCREEN3 Haul Truck Road Dust Results

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 96043 ***

Unpaved road dust - heavy haul

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = VOLUME

EMISSION RATE (G/S) = 1.00000

SOURCE HEIGHT (M) = 3.2004

INIT. LATERAL DIMEN (M) = 5.5848

INIT. VERTICAL DIMEN (M) = 1.4886

RECEPTOR HEIGHT (M) = .0000

URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = .000 M**4/S**2.

*** FULL METEOROLOGY ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
14.	7881.	3	1.0	1.0	320.0	3.20	7.35	2.64	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

*** SUMMARY OF SCREEN MODEL RESULTS ***

****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	7881.	14.	0.

SCREEN3 Pickup Truck Road Dust Results

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 96043 ***

Unpaved road dust - pickup

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = VOLUME

EMISSION RATE (G/S) = 1.00000

SOURCE HEIGHT (M) = 1.5240

INIT. LATERAL DIMEN (M) = 5.5848

INIT. VERTICAL DIMEN (M) = .7088

RECEPTOR HEIGHT (M) = .0000

URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = .000 M**4/S**2.

*** FULL METEOROLOGY ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:									
13.	0.1907E+05	4	1.0	1.0	320.0	1.52	6.64	1.42	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

*** SUMMARY OF SCREEN MODEL RESULTS ***

****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	0.1907E+05	13.	0.

SCREEN3 Haul Truck Tailpipe Results

*** SCREEN3 MODEL RUN ***

*** VERSION DATED 96043 ***

Tailpipe emissions - heavy haul

SIMPLE TERRAIN INPUTS:

SOURCE TYPE = VOLUME

EMISSION RATE (G/S) = 1.00000

SOURCE HEIGHT (M) = 2.5000

INIT. LATERAL DIMEN (M) = 5.5848

INIT. VERTICAL DIMEN (M) = 2.3300

RECEPTOR HEIGHT (M) = .0000

URBAN/RURAL OPTION = RURAL

THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.

THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.

BUOY. FLUX = .000 M**4/S**3; MOM. FLUX = .000 M**4/S**2.

*** FULL METEOROLOGY ***

*** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 10. M:									
13.	.1276E+05	6	1.0	1.0	10000.0	2.50	6.09	2.59	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

*** SUMMARY OF SCREEN MODEL RESULTS ***

****

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
SIMPLE TERRAIN	0.1276E+05	13.	0.

SCREEN3 Pickup Truck Tailpipe Results

```
 ***  SCREEN3 MODEL RUN  ***
 *** VERSION DATED 96043 ***
Tailpipe emissions - pickup


SIMPLE TERRAIN INPUTS:
   SOURCE TYPE             =       VOLUME
   EMISSION RATE (G/S)     =     1.00000
   SOURCE HEIGHT (M)       =       .6096
   INIT. LATERAL DIMEN (M)  =      5.5848
   INIT. VERTICAL DIMEN (M) =      2.3300
   RECEPTOR HEIGHT (M)     =       .0000
   URBAN/RURAL OPTION      =       RURAL
THE REGULATORY (DEFAULT) MIXING HEIGHT OPTION WAS SELECTED.
THE REGULATORY (DEFAULT) ANEMOMETER HEIGHT OF 10.0 METERS WAS ENTERED.
BUOY. FLUX =     .000 M**4/S**3;  MOM. FLUX =     .000 M**4/S**2.
*** FULL METEOROLOGY ***
*** TERRAIN HEIGHT OF    0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***
  DIST     CONC           U10M   USTK  MIX HT   PLUME   SIGMA   SIGMA
   (M)   (UG/M**3)   STAB  (M/S)  (M/S)    (M)   HT (M)   Y (M)   Z (M)  DWASH
-------  ----------  ----  -----  -----  ------  ------  ------  ------  -----
MAXIMUM 1-HR CONCENTRATION AT OR BEYOND    10. M:
    13.   0.1988E+05    6     1.0    1.0 10000.0     .61    6.09    2.59    NO
 DWASH=   MEANS NO CALC MADE (CONC = 0.0)
 DWASH=NO MEANS NO BUILDING DOWNWASH USED
 DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED
 DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED
 DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB
    ****************************************
    *** SUMMARY OF SCREEN MODEL RESULTS ***
    ****************************************
 CALCULATION        MAX CONC    DIST TO   TERRAIN
  PROCEDURE        (UG/M**3)    MAX (M)    HT (M)
```

---------- ---------- ------- -------

SIMPLE TERRAIN 0.1988E+05 13. 0.

The predicted impacts for each vehicle/emission type combination are shown in the tables below and the total combined impact plus background can be seen in **Table 5-5**.

Heavy-Duty Hauler Unpaved Road Dust Impacts		
Pollutant	**Averaging Time**	**Impact ($\mu g/m^3$)**
NO_2	1-hr	0.0
	Annual	0.0
CO	1-hr	0.0
	8-hr	0.0
SO_2	1-hr	0.0
	3-hr	0.0
	24-hr	0.0
	Annual	0.0
PM_{10}	24-hr	12.2
	annual	1.2
$PM_{2.5}$	24-hr	1.2
	annual	0.1

Pickup Truck Unpaved Road Dust Impacts		
Pollutant	**Averaging Time**	**Impact ($\mu g/m^3$)**
NO_2	1-hr	0.0
	Annual	0.0
CO	1-hr	0.0
	8-hr	0.0
SO_2	1-hr	0.0
	3-hr	0.0
	24-hr	0.0
	Annual	0.0
PM_{10}	24-hr	7.7
	annual	0.8
$PM_{2.5}$	24-hr	0.8
	annual	0.1

Heavy-Duty Hauler Tailpipe Impacts		
Pollutant	**Averaging Time**	**Impact ($\mu g/m^3$)**
NO_2	1-hr	0.8
	Annual	0.0
CO	1-hr	0.4
	8-hr	0.3
SO_2	1-hr	0.0
	3-hr	0.0
	24-hr	0.0
	Annual	0.0
PM_{10}	24-hr	0.0
	annual	0.0
$PM_{2.5}$	24-hr	0.0
	annual	0.0

Pickup Truck Tailpipe Impacts		
Pollutant	**Averaging Time**	**Impact ($\mu g/m^3$)**
NO_2	1-hr	0.5
	Annual	0.0
CO	1-hr	0.2
	8-hr	0.1
SO_2	1-hr	0.0
	3-hr	0.0
	24-hr	0.0
	Annual	0.0
PM_{10}	24-hr	0.0
	annual	0.0
$PM_{2.5}$	24-hr	0.0
	annual	0.0