United States Department of the Interior
Bureau of Land Management

Battle Mountain Field Office
Battle Mountain, Nevada

July 2007

Cortez Hills Expansion Project

NVN-067575

Draft Environmental Impact Statement

NV063-EIS06-011

Volume II

Photo Courtesy of the Eureka Sentinel Museum

COOPERATING AGENCY:

Nevada Department of Wildlife

BLM Mission Statement

The Bureau of Land Management is responsible for the stewardship of our public lands. It is committed to manage, protect, and improve these lands in a manner to serve the needs of the American people for all times.

Management is based upon the principles of multiple use and sustained yield of our nation's resources within a framework of environmental responsibility and scientific technology. These resources include recreation, rangelands, timber, minerals, watershed, fish and wildlife, wilderness, air and scenic, scientific, and cultural values.

BLM/BM/ES-07/007+1793

Cover: Photo of historic Cortez townsite looking northeast toward the site of the proposed Cortez Hills Expansion Project. Printed with permission of Eureka Sentinel Museum, Eureka, Nevada.

TABLE OF CONTENTS

VOLUME II

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES 3.0-1

3.1 Geology and Minerals 3.1-1
3.1.1 Affected Environment 3.1-1
3.1.2 Environmental Consequences 3.1-14
3.1.3 Cumulative Impacts 3.1-25
3.1.4 Monitoring and Mitigation Measures 3.1-29
3.1.5 Residual Adverse Effects 3.1-30

3.2 Water Resources and Geochemistry 3.2-1
3.2.1 Affected Environment 3.2-1
3.2.2 Environmental Consequences 3.2-38
3.2.3 Cumulative Impacts 3.2-95
3.2.4 Monitoring and Mitigation Measures 3.2-99
3.2.5 Residual Adverse Effects 3.2-101

3.3 Soils and Reclamation 3.3-1
3.3.1 Affected Environment 3.3-1
3.3.2 Environmental Consequences 3.3-6
3.3.3 Cumulative Impacts 3.3-14
3.3.4 Monitoring and Mitigation Measures 3.3-14
3.3.5 Residual Adverse Effects 3.3-14

3.4 Vegetation 3.4-1
3.4.1 Affected Environment 3.4-1
3.4.2 Environmental Consequences 3.4-13
3.4.3 Cumulative Impacts 3.4-22
3.4.4 Monitoring and Mitigation Measures 3.4-24
3.4.5 Residual Adverse Effects 3.4-25

3.5 Wildlife and Fisheries Resources 3.5-1
3.5.1 Affected Environment 3.5-1
3.5.2 Environmental Consequences 3.5-18
3.5.3 Cumulative Impacts 3.5-38
3.5.4 Monitoring and Mitigation Measures 3.5-40
3.5.5 Residual Adverse Impacts 3.5-42

3.6 Range Resources ... 3.6-1
3.6.1 Affected Environment ... 3.6-1
3.6.2 Environmental Consequences ... 3.6-2
3.6.3 Cumulative Impacts ... 3.6-8
3.6.4 Monitoring and Mitigation Measures ... 3.6-9
3.6.5 Residual Adverse Effects ... 3.6-9

3.7 Paleontological Resources ... 3.7-1
3.7.1 Affected Environment ... 3.7-1
3.7.2 Environmental Consequences ... 3.7-2
3.7.3 Cumulative Impacts ... 3.7-4
3.7.4 Monitoring and Mitigation Measures ... 3.7-4
3.7.5 Residual Adverse Effects ... 3.7-4

3.8 Cultural Resources ... 3.8-1
3.8.1 Affected Environment ... 3.8-1
3.8.2 Environmental Consequences ... 3.8-9
3.8.3 Cumulative Impacts ... 3.8-14
3.8.4 Monitoring and Mitigation Measures ... 3.8-14
3.8.5 Residual Adverse Impacts ... 3.8-14

3.9 Native American Traditional Values ... 3.9-1
3.9.1 Affected Environment ... 3.9-1
3.9.2 Environmental Consequences ... 3.9-19
3.9.3 Cumulative Impacts ... 3.9-25
3.9.4 Monitoring and Mitigation Measures ... 3.9-70
3.9.5 Residual Adverse Effects ... 3.9-71

3.10 Air Quality ... 3.10-1
3.10.1 Affected Environment ... 3.10-1
3.10.2 Environmental Consequences ... 3.10-5
3.10.3 Cumulative Impacts ... 3.10-20
3.10.4 Monitoring and Mitigation Measures ... 3.10-22
3.10.5 Residual Adverse Impacts ... 3.10-23

3.11 Land Use and Access ... 3.11-1
3.11.1 Affected Environment ... 3.11-1
3.11.2 Environmental Consequences ... 3.11-4
3.11.3 Cumulative Impacts ... 3.11-11
3.11.4 Monitoring and Mitigation Measures ... 3.11-11
3.11.5 Residual Adverse Effects ... 3.11-12

3.12 Recreation and Wilderness 3.12-1
3.12.1 Affected Environment 3.12-1
3.12.2 Environmental Consequences 3.12-4
3.12.3 Cumulative Impacts 3.12-8
3.12.4 Monitoring and Mitigation Measures 3.12-10
3.12.5 Residual Adverse Effects 3.12-10

3.13 Social and Economic Values 3.13-1
3.13.1 Affected Environment 3.13-1
3.13.2 Environmental Consequences 3.13-4
3.13.3 Cumulative Impacts 3.13-21
3.13.4 Monitoring and Mitigation Measures 3.13-22
3.13.5 Residual Adverse Effects 3.13-22

3.14 Environmental Justice 3.14-1
3.14.1 Affected Environment 3.14-1
3.14.2 Environmental Consequences 3.14-6
3.14.3 Cumulative Impacts 3.14-9
3.14.4 Monitoring and Mitigation Measures 3.14-10
3.14.5 Residual Adverse Effects 3.14-10

3.15 Visual Resources 3.15-1
3.15.1 Affected Environment 3.15-1
3.15.2 Environmental Consequences 3.15-5
3.15.3 Cumulative Impacts 3.15-13
3.15.4 Monitoring and Mitigation Measures 3.15-13
3.15.5 Residual Adverse Effects 3.15-13

3.16 Noise 3.16-1
3.16.1 Affected Environment 3.16-1
3.16.2 Environmental Consequences 3.16-3
3.16.3 Cumulative Impacts 316-7
3.16.4 Monitoring and Mitigation Measures 3.16-8
3.16.5 Residual Adverse Effects 3.16-8

3.17 Hazardous Materials and Solid Waste 3.17-1
3.17.1 Affected Environment 3.17-1
3.17.2 Environmental Consequences 3.17-3
3.17.3 Cumulative Impacts 3.17-10
3.17.4 Monitoring and Mitigation Measures 3.17-10
3.17.5 Residual Adverse Effects 3.17-10

3.18 Relationship Between Short-term Uses of the Human Environment and the Maintenance and Enhancement of Long-term Productivity 3.18-1

3.19 Irreversible and Irretrievable Commitment of Resources 3.19-1

4.0 PUBLIC COORDINATION 4-1

4.1 Public Participation and Scoping 4-1

4.2 List of Contacts 4-2
4.2.1 Federal Agencies 4-2
4.2.2 State Agencies 4-2
4.2.3 Local Agencies 4-2
4.2.4 Tribal Organizations 4-3
4.2.5 Other Organizations 4-3

4.3 List of Agencies, Organizations, and Persons to Whom Copies of this Statement are Sent 4-3
4.3.1 Federal Agencies 4-3
4.3.2 State Agencies 4-4
4.3.3 Elected Officials 4-4
4.3.4 County and Local Agencies 4-4
4.3.5 Tribal Organizations 4-4
4.3.6 Newspapers and Libraries 4-5
4.3.7 Other Organizations 4-5
4.3.8 Industry/Business 4-5
4.3.9 Individuals 4-6

5.0 LIST OF PREPARERS AND REVIEWERS 5-1

5.1 Bureau of Land Management EIS Team 5-1

5.2 ENSR EIS Team (Third-party Consultant) 5-2

5.3 Cortez Gold Mines Reviewers 5-2

6.0 REFERENCES 6-1

7.0 GLOSSARY 7-1

8.0 INDEX 8-1

APPENDIX A – PRIOR NEPA DOCUMENTS AND PERMITS

APPENDIX B – WATER RESOURCES

APPENDIX C – WILDLIFE

APPENDIX D – CULTURAL RESOURCES AND NATIVE AMERICAN TRADITIONAL VALUES

D-1 CULTURAL RESOURCES

D-2 NATIVE AMERICAN TRADITIONAL VALUES

APPENDIX E – NOISE MEASUREMENTS

LIST OF TABLES

VOLUME II

3.0-1 Critical Elements of the Human Environment and Other Resources 3.0-2

3.2-1 Mean Annual Precipitation at Selected Regional Sites 3.2-2

3.2-2 Nevada Water Quality Standards 3.2-15

3.2-3 Hydrolithologic Units in the Study Area 3.2-17

3.2-4 2004 Estimated Annual Groundwater Budget for the HSA 3.2-22

3.2-5 Cortez/Cortez Hills Area Background Groundwater Quality 3.2-26

3.2-6 Background Groundwater Quality in the Vicinity of the Pipeline Complex 3.2-29

3.2-7 Currently Produced and Background Alluvial Water Chemistries Prior to Infiltration 3.2-31

3.2-8 Former Cortez Pit Lake Analytical Water Chemistry Data 3.2-33

3.2-9 Summary of Historic and Estimated Future Dewatering Requirements 3.2-42

3.2-10 Summary of Historic and Estimated Future Infiltration Requirements 3.2-45

3.2-11 Summary of Predicted Pit Lakes at 100 Years Post-mining under the Proposed Action 3.2-54

3.2-12 Perennial Surface Water Resources and Associated Wetland/Riparian Vegetation Potentially Impacted By Mine-related Groundwater Drawdown 3.2-57

3.2-13 Estimated Water Level Change at Water Rights in Southern Part of the HSA (Proposed Action) 3.2-59

3.2-14 Simulated Groundwater Budget for the HSA Under the Proposed Action 3.2-62

3.2-15 Model-predicted Pit Lake Water Chemistry at Year 100 .... 3.2-63

3.2-16 Modeled Composition of Waste Rock Seepage Reaching the Groundwater Table 3.2-67

3.2-17 Estimated Water Level Change at Water Rights in the Southern Part of the HSA (Cortez Hills Complex Underground Mine Alternative) 3.2-79

3.2-18 Simulated Groundwater Budget for the HSA Under the Cortez Hills Complex Underground Mine Alternative 3.2-81

3.2-19 Comparison of Predicted Water Chemistry in Underground Workings to Baseline Groundwater, Proposed Action Cortez Hills Pit Lake, and Water Quality Standards 3.2-83

3.2-20 Summary of Predicted Post-mining Pit Lakes at 100 Years Under the No Action Alternative 3.2-85

3.2-21 Estimated Water Level Change at Water Rights in the Southern Part of the HSA (No Action Alternative) 3.2-91

3.2-22 Simulated Groundwater Budget for the HSA Under the No Action Alternative 3.2-93

3.3-1 Summary of Soil Mapping Units and Characteristics 3.3-2

3.3-2 Soils in the Project Boundary 3.3-5

3.4-1 Special Status Plant Species Potentially Occurring within the Study Area 3.4-9

3.4-2 Designated Noxious and Invasive Plant Species 3.4-11

3.4-3 Attributes Associated with Piñon-juniper Woodlands in the Study Area 3.4-13

3.4-4 Acres of Vegetation Disturbed or Removed Under the Proposed Action 3.4-14

3.4-5 Acres of Vegetation Disturbed or Removed Under the Grass Valley Heap Leach Alternative 3.4-18

3.4-6 Acres of Vegetation Disturbed or Removed Under the Crescent Valley Waste Rock Alternative 3.4-19

3.4-7 Acres of Vegetation Disturbed or Removed Under the Cortez Hills Complex Underground Mine Alternative 3.4-20

3.5-1 Bat Species Potentially Occurring in the Project Vicinity 3.5-7

3.5-2 Greater Sage-grouse Lek Sites Within the Study Area 3.5-16

3.6-1 Livestock Grazing Permits for Portions of the Carico Lake, South Buckhorn, and Grass Valley Allotments Within the Study Area 3.6-4

3.6-2 Ecological Sites that Occur in the Carico Lake, South Buckhorn, and Grass Valley Allotments 3.6-4

3.6-3 Range Improvements in the Study Area 3.6-5

3.9-1 Summary of Native American Consultation 3.9-4

3.9-2 Past, Present, and Reasonably Foreseeable Actions for the Native American Traditional Values Cumulative Analysis 3.9-26

3.9-3 Traditional Use Plants Within the Native American Regional Cumulative Effects Study Area 3.6-38

3.9-4 Perennial Waters and Potentially Affected Perennial Waters within the Regional Cumulative Effects Study Area 3.9-51

3.10-1 Monthly Climate Summary 3.10-4

3.10-2 National and State of Nevada Ambient Air Quality Standards 3.10-6

3.10-3 Annual Average PM_{10} Concentrations from 1997 through 2001 ..... 3.10-12

3.10-4 Background Values for Criteria Pollutants 3.10-12

3.10-5 Summary of Air Emissions 3.10-13

3.10-6 Highest Modeled Air Pollutant Concentrations Under the Proposed Action 3.10-14

3.10-7 Highest Modeled Impacts at Sensitive Receptors Under the Proposed Action 3.10-15

3.10-8 Mercury Emissions Controls on Thermal Sources at the Existing Pipeline Mill 3.10-17

3.10-9 Actual Annual Mercury Emissions from the Existing Pipeline Mill 2002 through 2006 ..... 3.10-18

3.10-10 Actual Annual Mercury Emissions by Source in 2006 from the Existing Pipeline Mill 3.10-18

3.10-11 Calculated HAP Emissions 3.10-19

3.11-1 Land Use Authorizations and Rights-of-Way in the Project Area.. 3.11-3

3.13-1 Employment Estimates 3.13-7

3.13-2 New Construction-related Employment, Households, and Population Projects for the Proposed Action 3.13-8

3.13-3 New Underground Operations-related Employment, Households, and Population Projections for the Proposed Action 3.13-9

3.13-4 New Surface Operations-related Employment, Households, and Population Projections for the Proposed Action 3.13-10

3.13-5 New Operations-related Employment, Households, and Population Projections for Underground and Open-pit Operations for the Proposed Action 3.13-11

3.13-6 Summary of Project-related Changes to Demographic Indicators from Non-local Direct and Indirect Employment Proposed Action 3.13-13

3.13-7 Net Proceeds and Property Tax Payments for Existing Operations 3.13-13

3.13-8 New Operations-related Employment, Households, and Population Projections for Underground and Surface Operations for the Crescent Valley Waste Rock Alternative 3.13-15

3.13-9 Employment Estimates for the Cortez Hills Complex Underground Mine Alternative 3.13-17

3.13-10 New Construction-related Employment, Households, and Population Projections for the Cortez Hills Complex Underground Mine Alternative 3.13-17

3.13-11 New Underground Operations-related Employment, Households, and Population Projections for the Cortez Hills Complex Underground Mine Alternative 3.13-18

3.13-12 Project-related Changes to Demographic Indicators from Non-local Direct and Indirect Employment for the Cortez Hills Complex Underground Mine Alternative 3.13-18

3.14-1 Ethnic Composition of Study Area and State of Nevada Populations for 2000 .... 3.14-3

3.14-2 1999 Income Level of the Study Area Compared to the State of Nevada Based on a Sample 3.14-4

3.14-3 Persons Below Poverty Level by Race in the Study Area Compared with the State of Nevada 3.14-5

3.15-1 BLM Visual Resource Management Class Objectives 3.15-1

3.16-1 Typical Values of Sound Level of Common Noise Sources 3.16-2

3.16-2 Surface Mining Equipment Roster and Associated Noise Emissions 3.16-4

3.17-1 Potential Number of Mine-related Transportation Accidents Involving a Release 3.17-5

3-19-1 Irreversible and Irretrievable Commitment of Resources by the Proposed Action 3.19-2

LIST OF FIGURES

VOLUME II

3.1-1 Regional Physiographic and Hydrographic Features 3.1-3
3.1-2 Regional Geology 3.1-4
3.1-3 Geology of the Cortez Hills Area 3.1-6
3.1-4 Generalized Stratigraphic Column 3.1-7
3.1-5 Quaternary Faults in Nevada 3.1-10
3.1-6 Known and Inferred Fault Structures – Cortez Hills Complex 3.1-12
3.1-7 Seismic Events 3.1-13
3.1-8 Mapped Earth Fissures 3.1-15
3.1-9 Simulated Subsidence at the End of Dewatering – Proposed Action 3.1-23
3.1-10 Various Resources CESA 3.1-26
3.1-11 Simulated Subsidence at End of Dewatering – Cumulative Effects 3.1-28
3.2-1 Perennial Streams, Springs, and Seeps 3.2-3
3.2-2 Geothermal Resources 3.2-8
3.2-3 Monitored Seeps and Springs in the HSA 3.2-10
3.2-4 FEMA Flood Hazard Areas 3.2-12
3.2-5 Regional Groundwater Elevations Prior to Pipeline Mine Dewatering 3.2-21
3.2-6 Project Area Groundwater Elevations (December 2004) 3.2-23
3.2-7 Groundwater Sampling Locations – Cortez/Cortez Hills Area 3.2-25
3.2-8 Groundwater Sampling Locations – Pipeline and Crescent Valley Areas 3.2-28
3.2-9 Private Active Water Rights 3.2-39
3.2-10 Summary of Historic and Estimated Future Dewatering Requirements 3.2-43
3.2-11 Simulated Groundwater Table – December 2004 ..... 3.2-46
3.2-12 Proposed Action Predicted Groundwater Level Change – End of Dewatering 3.2-50
3.2-13 Proposed Action Predicted Groundwater Level Change – 25 Years Post-dewatering 3.2-51
3.2-14 Proposed Action Predicted Groundwater Level Change – 100 Years Post-dewatering 3.2-52
3.2-15 Rate of Pit Lake Development Under the Proposed Action 3.2-55
3.2-16 Underground Mine Alternative Predicted Groundwater Level Change – End of Dewatering 3.2-75
3.2-17 Underground Mine Alternative Predicted Groundwater Level Change – 25 Years Post-dewatering 3.2-76

3.2-18 Underground Mine Alternative Predicted Groundwater Level Change – 100 Years Post-dewatering 3.2-77

3.2-19 No Action Alternative Predicted Groundwater Level Change – End of Dewatering 3.2-86

3.2-20 No Action Alternative Predicted Groundwater Level Change – 25 Years Post-dewatering 3.2-87

3.2-21 No Action Alternative Predicted Groundwater Level Change – 100 Years Post-dewatering 3.2-88

3.2-22 Rate of Pit Lake Development Under the No Action Alternative 3.2-89

3.2-23 Predicted Cumulative Groundwater Level Change – End of Dewatering 3.2-96

3.2-24 Maximum Extent of Predicted Cumulative 10-foot Groundwater Drawdown 3.2-97

3.3-1 NRCS Soil Mapping Units 3.3-7

3.4-1 Vegetation Types 3.4-3

3.4-2 Seeps, Springs, and Wetland/Riparian Areas 3.4-8

3.5-1 Designated Mule Deer Range 3.5-3

3.5-2 Designated Pronghorn Range 3.5-4

3.5-3 Greater Sage-grouse Habitat 3.5-15

3.6-1 Grazing Allotments and Water-related Range Improvements 3.6-3

3.8-1 Cultural Resources and Recreation CESA 3.8-3

3.9-1 Western Shoshone Aboriginal Territory and Contemporary Shoshone Tribal Governments 3.9-7

3.9-2 Past and Present Actions, RFFAs, and Native American Traditional Values CESA 3.9-29

3.9-3 Vegetation Communities within the Native American Traditional Values CESA 3.9-36

3.9-4 Fire Areas 1998-2006 .... 3.9-41

3.9-5 Perennial Waters 3.9-50

3.9-6 Perennial Waters and Current Groundwater Drawdown and Mounding 3.9-57

3.9-7 Areas of Projected Cumulative Impact to Perennial Waters 3.9-60

3.9-8 Designated Elk Range within the Native American Traditional Values CESA 3.9-63

3.9-9 Designated Mule Deer Range within the Native American Traditional Values CESA 3.9-64

3.9-10 Designated Pronghorn Range within the Native American Traditional Values CESA 3.9-65

3.9-11 Designated Bighorn Sheep Range within the Native American Traditional Values CESA 3.9-66

3.9-12 Designated Sage-grouse Habitat within the Native American Traditional Values CESA 3.9-67

3.10-1 Wind Rose for Elko, Nevada 3.10-3

3.10-2 Air Resources CESA 3.10-21

3.11-1 Land Use Authorizations 3.11-5

3.12-1 Wilderness Study Areas 3.12-3

3.12-2 Wilderness, Social and Economic Values, and Environmental Justice CESAs 3.12-9

3.15-1 Visual Resources 3.15-3

3.15-2 Visual Simulation for KOP #1 .... 3.15-8

3.15-3 Visual Simulation for KOP #3 .... 3.15-11

3.15-4 Visual Resources CESA 3.15-14

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes the environment that would be affected by the development of the Proposed Action and the alternatives analyzed in this EIS. The baseline information summarized in this chapter was obtained from published and unpublished materials; interviews with local, state, and federal agencies; and from field and laboratory studies conducted in the project area. The affected environment for individual resources was delineated based on the area of potential direct and indirect environmental impacts for the proposed project. For 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 affected environment was more extensive (e.g., airshed, local communities, etc.).

This chapter also describes the anticipated direct and indirect impacts of the Proposed Action and the alternatives as well as potential cumulative impacts. The analysis of potential impacts from the Proposed Action assumed the implementation of the applicant-committed environmental protection measures that would be implemented in association with the proposed project (see Section 2.4.11, Applicant-committed Environmental Protection Measures). Mitigation and monitoring developed in response to anticipated impacts are recommended by the BLM for individual resources, as discussed at the end of each resource section. This chapter also identifies residual adverse 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 approximately 10-year life of the project plus 3 years for reclamation. The cumulative effects analysis for each resource addressed the potential cumulative effects within resource-specific cumulative effects study areas. In addition, a regional cumulative effects analysis was conducted for Native American traditional values over an area encompassing recent hard-rock mines in north-central Nevada plus other industrial developments, activities, and events within the Western Shoshone's traditional homeland in relative proximity to the proposed Cortez Hills Expansion Project.

This chapter is organized by environmental resource. Sections 3.1 through 3.17 describe the existing conditions and potential environmental impacts associated with each resource. The short-term use of the environment relative to the long-term productivity of resources is discussed in Section 3.18. Short-term is defined as the approximately 10-year period of project operations and 3-year period of reclamation. Long-term impacts are defined as impacts that would continue post-reclamation (beyond 13 years). The irreversible or irretrievable commitment of resources is described in Section 3.19.

The BLM's NEPA Handbook (H-1790-1) requires that all EISs address certain Critical Elements of the Human Environment. These critical elements are presented in **Table 3.0-1** along with the location in this chapter where the element is discussed. If the element does not occur within the project area and would not be affected, this is indicated in **Table 3.0-1**, and the element is not discussed further in the EIS. This elimination of nonrelevant issues follows the CEQ guidelines as stated in 40 CFR 1500.4.

Table 3.0-1
Critical Elements of the Human Environment and Other Resources

Resource	Analyzed	Not Analyzed	EIS Section Number or Rationale for Elimination
Air Quality	x		Section 3.10
Areas of Critical Environmental Concern		x	Would not be affected (No areas of critical environmental concern occur in the project vicinity.)
Cultural Resources	x		Section 3.8
Drinking Water/Groundwater Quality	x		Section 3.2
Environmental Justice	x		Section 3.14
Floodplains	x		Section 3.2
Hazardous Materials and Solid Waste	x		Section 3.17
Invasive, Non-native Species	x		Section 3.4
Migratory Birds	x		Section 3.5
Native American Religious Concerns	x		Section 3.9
Paleontological Resources	x		Section 3.7
Prime or Unique Farm Land		x	Would not be affected (No prime or unique farmlands occur in the proposed disturbance areas.)
Special Status Species	x		Sections 3.4 and 3.5
Wetlands and Riparian Zones	x		Section 3.4
Wild and Scenic Rivers		x	Would not be affected (No wild and scenic rivers occur in the project vicinity.)
Wild Horses		x	Would not be affected (The proposed project is outside the boundaries of designated wild horse herd use areas.)
Wilderness	x		Section 3.12

3.1 Geology and Minerals

3.1.1 Affected Environment

The study area for direct and indirect impacts to geology and minerals encompasses the project boundary. The cumulative effects study area encompasses the project boundary and includes surface disturbance associated with past and present actions and RFFAs within a 30-mile radius of the proposed project.

3.1.1.1 Physiographic and Topographic Setting

The study area is located within the Great Basin section of the Basin and Range physiographic province characterized by a series of generally north-trending mountain ranges separated by broad alluvial filled basins. The mountain ranges in the Basin and Range province are bounded by steep range-front faults where vertical movement on these faults has uplifted the mountain blocks relative to the valleys. Faulting associated with development of the Basin and Range province began approximately 14 million years ago and continues to the present (McCormack and Hays 1996). Continual erosion off the uplifted mountain blocks has resulted in thick accumulations of unconsolidated to poorly consolidated sediments in the valley (or basin) areas.

The study area for geology and mineral resources is shown in **Figure 3.1-1**. The proposed project encompasses portions of southern Crescent Valley and northern Grass Valley. The study area is bounded by the Cortez Mountains to the east and Toiyabe Range to the west. The site is located near the drainage divide between Crescent Valley and Grass Valley. Elevations in the project area range from 7,480 feet amsl at the summit of Mount Tenabo, located just east of the project area, to approximately 4,700 feet amsl in Crescent Valley. Crescent Valley and Grass Valley are basin features separated by the Toiyabe Range and the Cortez Mountains (**Figure 3.1-1**). These basins trend north-northeast, consistent with the Basin and Range province of central Nevada.

Overall, Crescent Valley is approximately 45 miles long and 20 miles wide and is bordered on the west by the Shoshone Range, on the east by the Cortez Mountains, and on the north by the Humboldt River. Grass Valley is a closed topographic basin approximately 40 miles long and 18 miles wide. The valley is bounded by the Toiyabe Range on the west and north, the Simpson Park Range on the east and south, and the Cortez Mountains on the northeast.

3.1.1.2 Regional Geologic Setting

The regional geologic conditions are presented in **Figure 3.1-2**. Paleozoic sedimentary rocks form the regional basement throughout the study area and have undergone a complex history of sedimentation and deformation. During the early Paleozoic Era, marine clastic and carbonate rocks were deposited in a shallow sea that represented the western continental margin of North America. These marine clastic rocks (referred to as the Western Assemblage) were deposited in the deep water to the west, while carbonate rocks (referred to as the Eastern Assemblage) were deposited in the shallow water to the east (Stewart 1980). The formations associated with the Western Assemblage are predominantly siliceous with very little carbonate, while formations associated with the Eastern Assemblage are predominately carbonate (Gilluly and Masursky 1965).

During the Late Devonian and Early Mississippian geologic periods, sedimentary deposition was interrupted, and the Paleozoic sediments were uplifted, folded, and faulted during a tectonic period referred to as the Antler Orogeny. The Roberts Mountains Thrust, a system of low angle thrust faults that has caused major deformation of the Paleozoic rocks, is the main expression of the Antler Orogeny apparent in the region today. Movement along the Roberts Mountain Thrust resulted in the displacement of the Western Assemblage up to approximately 90 miles eastward over the Eastern Assemblage (Roberts et al. 1967; Stewart 1980). As a result, the Western Assemblage occurs in the upper plate of the thrust, while the Eastern Assemblage occurs in the lower plate of the thrust (Gilluly and Masursky 1965).

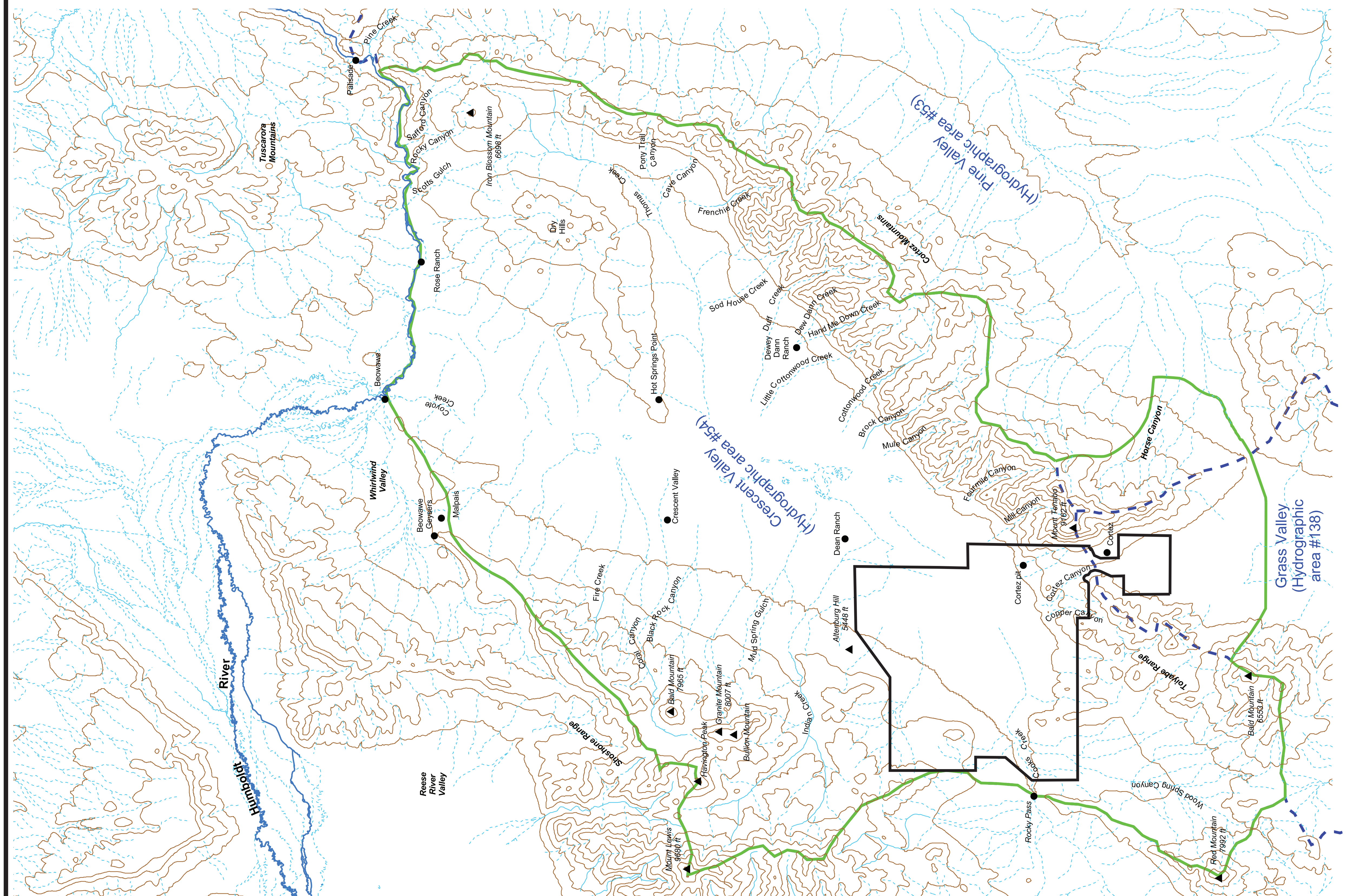
The Eastern Assemblage is believed to occur as basement rocks beneath the alluvium in Crescent Valley (Geomega 2006e) and underlies all other stratigraphic units in eastern and central Nevada. In the project vicinity, the Eastern Assemblage is exposed in the Cortez and Gold Acres windows shown in **Figure 3.1-2**. These “windows” refer to areas where uplift and erosion has removed the upper plate (Western Assemblage) exposing the lower plate (Eastern Assemblage) rocks. The Cortez window is a 2- to 3-mile-wide, north-south trending zone that extends from the margin of Crescent Valley near the existing Cortez Mine south through the Cortez Hills area and into the upper Grass Valley area (**Figure 3.1-2**). The Cortez window appears to be a continuation of the Gold Acres window located to the northwest. The Gold Acres window occurs in the Shoshone Range and is buried beneath the alluvial fill in Crescent Valley and presumably is offset by the Crescent fault near the Cortez Mine (Gilluly and Masursky 1965; McCormack and Hays 1996).

Several intrusive bodies outcrop in the southern Cortez Mountains and northern Toiyabe Range within the project vicinity (**Figure 3.1-2**) (Gilluly and Masursky 1965; Geomega 2006e). Aeromagnetic studies indicate that intrusives underlie most of the Cortez Mountains; however, except for local exposures, the intrusions generally are not exposed at the surface (Geomega 2006e; Muffler 1964).

In the northern Toiyabe Range, the basement rocks are covered by up to 8,000 feet of Tertiary-age, rhyolitic and dacitic ash flows and volcanic debris that is know as the Caetano Tuff (**Figure 3.1-2**). The Caetano Tuff accumulated in a deep rift (Geomega 2006e; Stewart and McKee 1977) and contains minor interbeds of water-laid tuff and pebble conglomerate derived from the nearby Paleozoic rocks (Gilluly and Masursky 1965).

Tertiary basalt and andesite flows occur at the eastern end of the Toiyabe Range and east of the proposed project in the Cortez Mountains, where the basalt flows are up to 200 feet thick. WMC (1995b) documented a northwest-trending magnetic anomaly that connects these basalt exposures suggesting that the basalt flows underlie alluvium in portions of Crescent Valley.

During the late Tertiary and Quaternary periods, continual uplift and erosion of the mountains have partially filled the basins with unconsolidated to poorly consolidated silt, sand, gravel, and boulders. The boundary between the mountains and the valley margins generally is covered by coalescing alluvial fan deposits, whereas the centers of the valleys are dominated by finer grained alluvium deposited by ephemeral streams

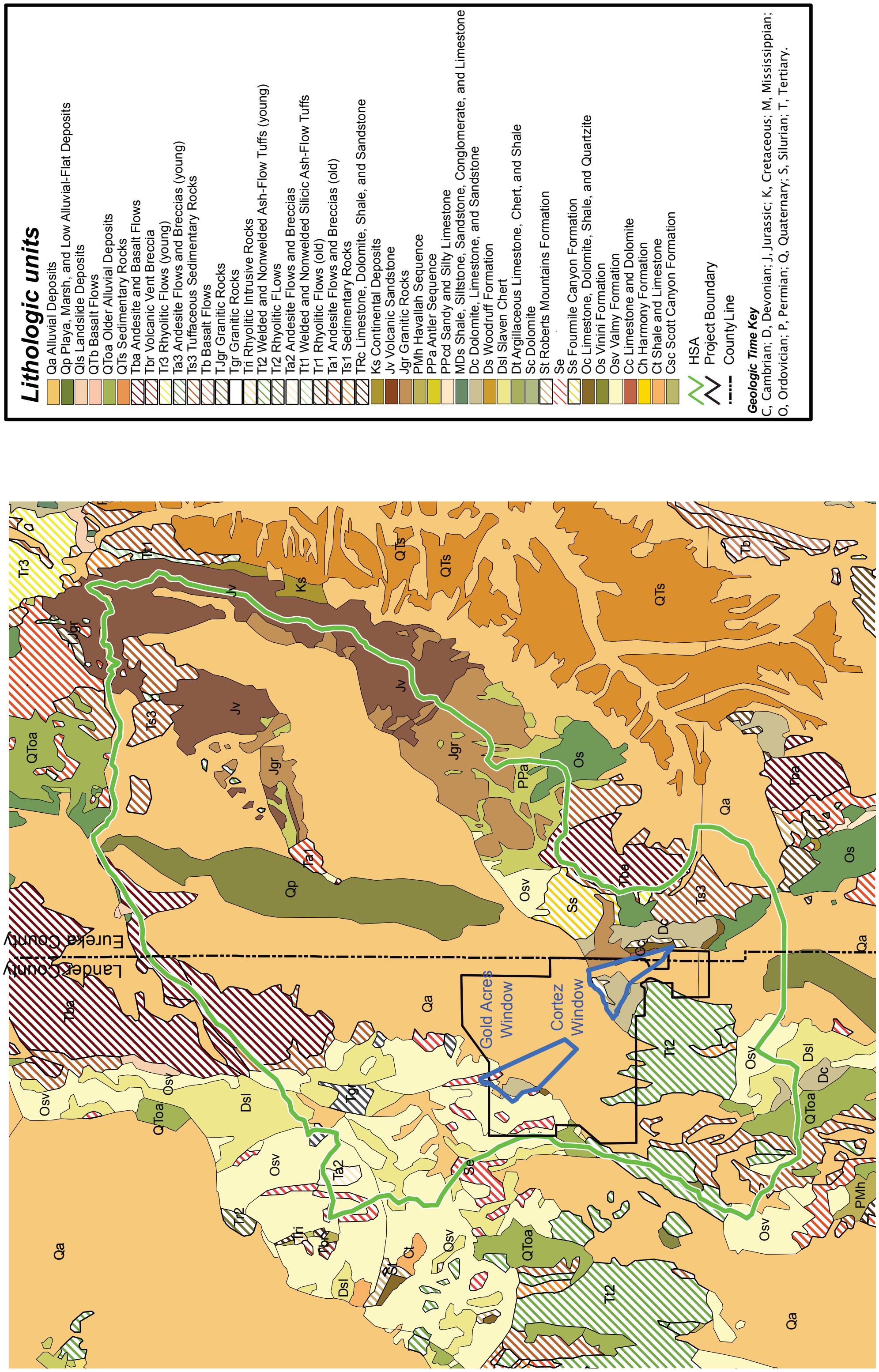


Cortez Hills Expansion Project

Figure 3.1-1

Regional Physiographic and Hydrographic Features

06/19/07



N

0 4 8 Miles

From: Turner and Bawiec 1991.

Source: Geomega 2006e.

Cortez Hills
Expansion Project

Figure 3.1-2

Regional Geology

and in playas (Stewart 1980; Stewart and McKee 1977). Alluvial sediments filling Crescent Valley are estimated to be approximately 10,000 feet thick (Gilluly and Masursky 1965). Although, the thickness of the basin-fill deposits in Grass Valley has not been explored, similar basins in north-central Nevada typically contain basin-fill deposits that are thousands of feet thick.

3.1.1.3 Regional Structures

Several major faults and fault zones occur within the project region as shown in **Figure 3.1-3**. These include the Roberts Mountain Thrust fault, Cortez fault, and Crescent Valley fault (and other basin and range faults in the Crescent Valley and Grass Valley areas).

The Roberts Mountain Thrust fault is a major regional low-angle fault zone, as discussed above. In the project vicinity, the thrust fault zone is exposed at the surface at the head of Cortez Canyon. The fault zone dips gently toward the southwest throughout the area.

The Cortez fault bounds the western margin of the Cortez Mountains and eastern margin of Grass Valley. The Cortez fault is part of the Cortez rift, a system of north to northwest–trending faults that extends from central Oregon into southern Nevada. The Cortez rift is characterized by right-lateral movement that occurred prior to 8 million years ago. The Cortez fault was reactivated during basin and range faulting during the late Tertiary. This fault has experienced an estimated 15,000 feet of horizontal (right-lateral) displacement and 3,800 feet of vertical displacement (McCormack and Hays 1996).

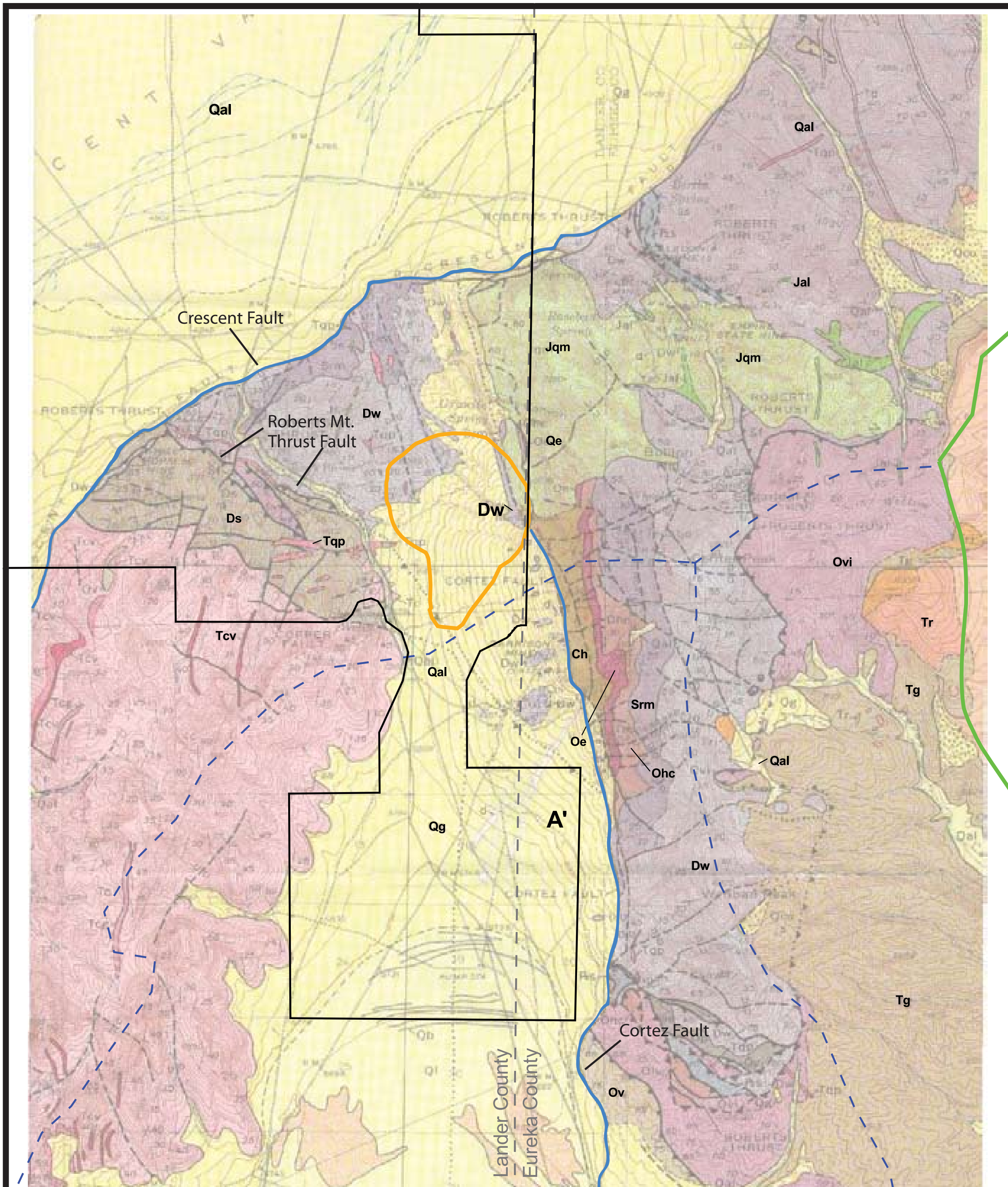
The Crescent fault is located along the eastern margin of Crescent Valley and truncates the northwest boundary of the Cortez Mountains and Toiyabe Range in the project vicinity. The Crescent fault is a steeply dipping normal fault with predominant vertical offset typical of range-front faults of the Basin and Range province. Vertical displacement along the Crescent fault is estimated be on the order of 10,000 feet (Gilluly and Masursky 1965). Other Basin and Range faults in the region include a buried fault located along the western margin of Crescent Valley (and bounding the east flank of the Shoshone Range), and an unnamed range-front fault that bounds the western margin of Grass Valley at the foot of the Toiyabe Range. Block fault movement along the Crescent, Cortez, and other unnamed range-front faults formed during extensional faulting that began in the region during the late Tertiary period (approximately 14 million years ago) and continues to the present (McCormack and Hays 1996).

3.1.1.4 Site Geology

The geology of the Cortez Hills area is shown in **Figure 3.1-3**, and the stratigraphic units and map symbols are presented in **Figure 3.1-4**.

Cortez Hills Complex

The proposed Cortez Hills Complex occurs in a feature known as the Cortez window where the upper plate rocks (Western Assemblage) have been removed, and the lower plate (Eastern Assemblage) rocks are exposed or concealed beneath surficial deposits. The proposed Cortez Hills Pit would encompass two



Legend

- Project Boundary
- Hydrographic Basin Boundary
- Proposed Cortez Hills Pit
- HSA

From: Gilluly et al. 1965.
Source: Geomega 2006e.

Note: See **Figure 3.1-4** for lithologic units.

N

0 5000 10000 Feet

Cortez Hills Expansion Project

Figure 3.1-3
Geology of the Cortez Hills Area

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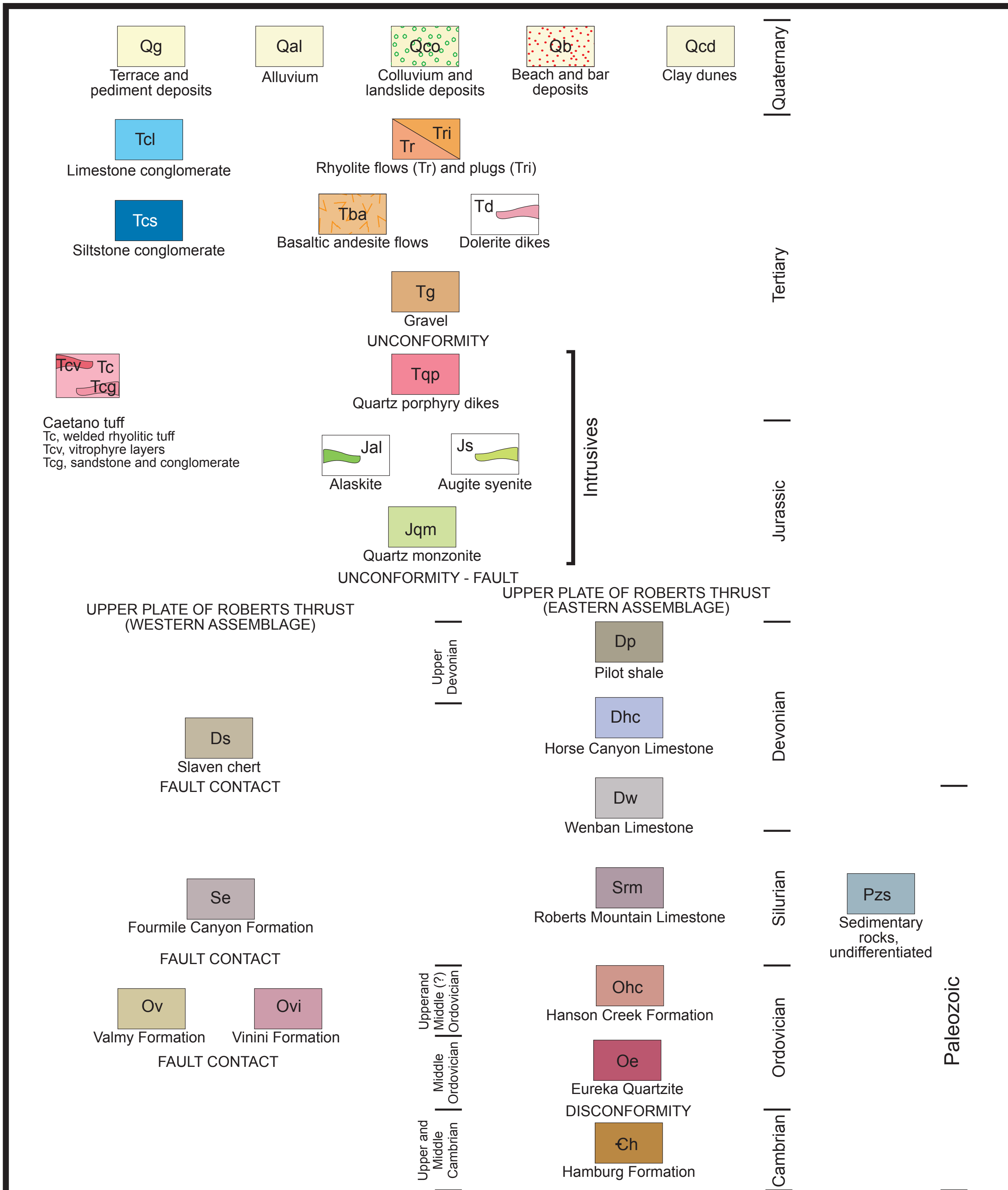


Cortez Hills Expansion Project

Figure 3.1-4
Generalized Stratigraphic Column

Source: Geomega 2006e.

06/19/07

separate deposits within a single pit footprint, including the Cortez Hills deposit hosted in Paleozoic lower plate limestones and the Pediment deposit hosted in Tertiary conglomerate.

The Cortez Hills deposit occurs in the northern portion of the proposed pit within the lower plate sequence and includes (from oldest to youngest) the Hamburg Dolomite, Eureka Quartzite, Hanson Creek Formation, Roberts Mountain Formation, Wenban Limestone, and Pilot Shale. The Paleozoic rocks are mantled by Tertiary and Quaternary alluvial and colluvial sediments.

The Pediment deposit occurs in the southern portion of the proposed pit. The Pediment deposit is hosted in a thick wedge of Tertiary conglomerate. The conglomerate ranges up to 1,000 feet thick and overlies the Wenban Limestone and other Paleozoic basement rocks in the Cortez window. The Tertiary conglomerate can be subdivided into two subunits differentiated by clast composition: a lower siltstone unit and an upper limestone unit. The siltstone conglomerate consists of heterolithic clasts, whereas the limestone subunit is monolithic. CGM geologists believe that these conglomerates formed by mass wasting of material exposed in the adjacent Cortez Mountains in the Mount Tenabo area. The core recovered from exploration borings in the study area indicates that both subunits of the conglomerate generally are cemented and relatively unfractured (Geomega 2006e). The eastern edge of the conglomerate unit is bounded by thermally altered limestone and/or marble, which gradually transitions into unaltered lower plate carbonate rocks (primarily Wenban Limestone) (Geomega 2006e). The conglomerate generally is covered by unmineralized alluvial fan and colluvial sediments that range from 10 to greater than 150 feet thick.

Pipeline Complex

The geology of the Pipeline Complex, which is located to the northwest of the proposed Cortez Hills Complex, is described in the Pipeline/South Pipeline Pit Expansion Project Final SEIS (BLM 2004e).

3.1.1.5 Mineralization and Mineral Resources

Historically, the Crescent Valley area has been a producer of gold, silver, barite, sulfur, turquoise, and lesser amounts of copper, lead, and arsenic. Valley alluvium has been mined intermittently as a source of gravel for road construction. Most of the mineral production has come from gold and barite mining operations.

The proposed project occurs within an area that has experienced extensive mineral exploration and development activities over the past 144 years. The earliest mining dates back to 1862 with the discovery of high-grade silver in the Cortez and Mill Canyon areas. Open-pit mining began at the Gold Acres Complex in 1950, at the Cortez Complex in 1969, and at the Pipeline Complex in 1996.

The Cortez Hills deposit structurally is controlled and characterized by consistent gold grades. Gold deposition generally occurs at structural intersections, and the mineralized zone plunges in a west-southwest direction. The ore is hosted within silty limestone and in brecciated, marble altered limestone. Sulfide minerals that occur in the deposit are most commonly rhombohedral pyrite (iron sulfide) grains and include less frequent occurrences of local realgar (arsenic sulfide) veinlets plus finely disseminated pyrite (iron sulfide). A deeper refractory gold horizon occurs at depth below the base of the proposed Cortez Hills Pit and would be intersected by the proposed underground mine development. These refractory horizons apparently are controlled by low-angle structures in the upper section of the Roberts Mountain Formation (CGM Undated Reference). Within the Pediment deposit (located in the southern portion of the proposed Cortez Hills Pit), gold occurs in altered and oxidized rock fragments within a siltstone conglomerate. The siltstone rock fragments in the Pediment deposit apparently were derived from erosion and mass wasting of the Roberts Mountain Formation located in the Cortez Mountains, immediately east of the project.

In the existing Cortez Pit, gold mineralization occurs primarily within the Roberts Mountain Formation. The mineralization is structurally controlled and concentrated along fault intersections, particularly where north-northwest trending high-angle faults intersect with low-angle tabular shear zones (McCormack and Hays 1996). Quartz and pyrite are common minerals in the ore zone. Gold is associated with arsenic, antimony, mercury, barium, and silver (BLM 1992).

The proposed North Gap Pit expansion would lay back a portion of the existing northwest wall of the Pipeline Pit. As described by Foo et al. (1996), the geology in the Pipeline Pit area consists of Quaternary alluvium overlying Paleozoic bedrock. The Quaternary alluvium consists of unconsolidated mixtures of sand, silt, gravel, and cobbles. The alluvium-bedrock surface dips gently (less than 10 degrees) toward the east. Ore within the deposit primarily is hosted within silty carbonates associated with the Roberts Mountain Formation and Wenban Limestone. Gold occurs as submicroscopic dissimenated grains within all alteration types. Sphalerite and pyrite are the only sulfide minerals identified in the deposit and occurs as fine disseminations (less than 2 percent) along bedding planes and fractures and open-space fillings.

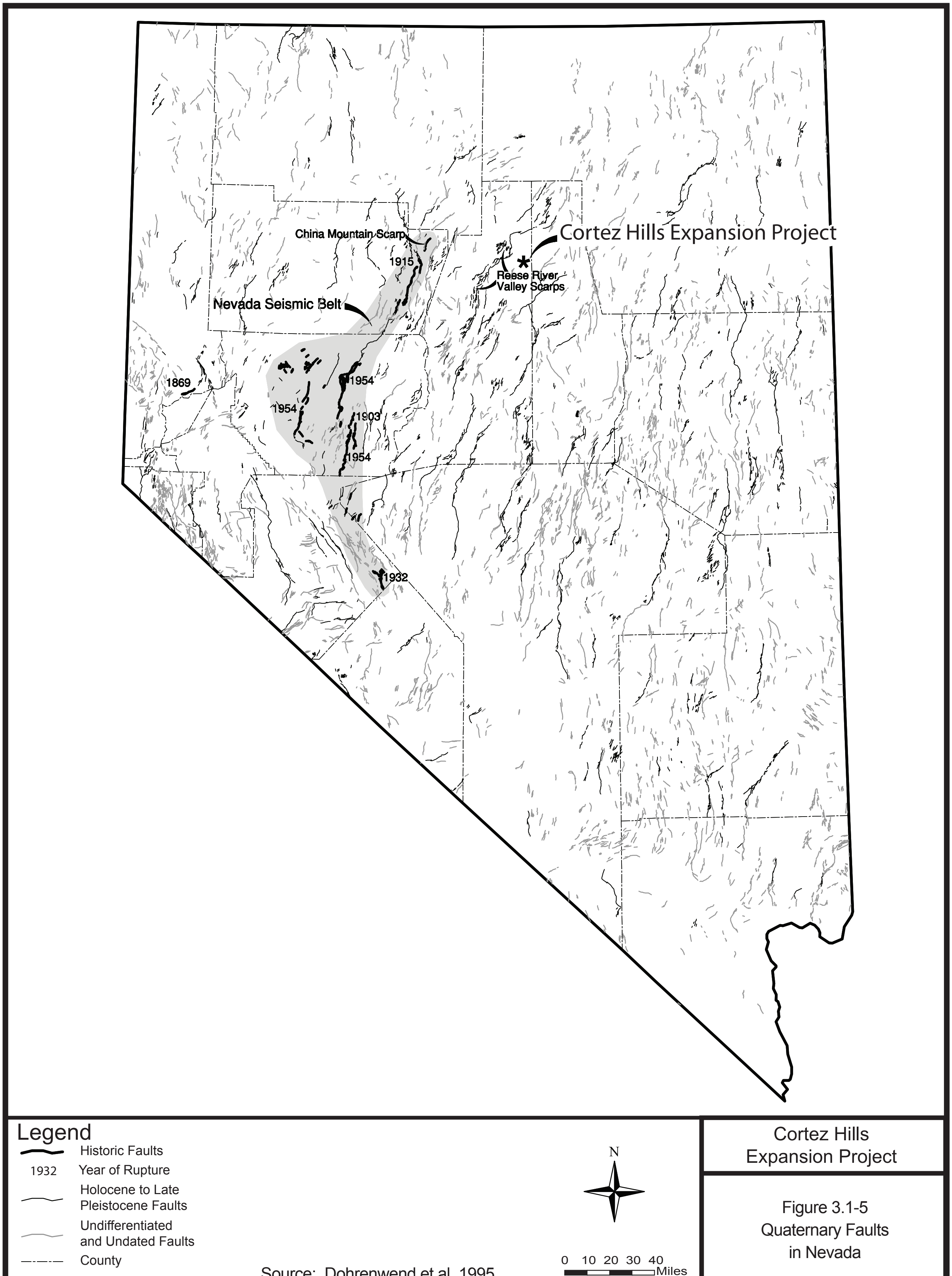
Geothermal resources occur within the cumulative effects study area as described in Section 3.2, Water Resources and Geochemistry. The potential for oil and gas reserves in the cumulative effects area is low (Garside et al. 1988). Based on BLM Battle Mountain Field Office drilling records, fewer than 30 test wells have been drilled within the area, the majority of which have occurred in the Pine Valley area.

3.1.1.6 Faulting and Seismicity

Faulting

The study area is located in a region that is characterized by active and potentially active faults and a relatively high level of historic seismicity. For the purpose of this assessment, an active fault is defined as a fault that shows evidence of displacement during the Holocene period (last 10,000 years); a potentially active fault is a fault that shows evidence of surface displacement during the late Quaternary period (last 150,000 years). Surface fault rupture typically occurs along active fault traces.

Historically, surface displacement along faults occurred in Nevada during major earthquakes in 1869, 1903, 1915, 1932, and three events in 1954 (Stewart 1980). All of these events occurred along a north-trending zone called the Nevada Seismic Belt located west of the project site (**Figure 3.1-5**). The closest historic surface displacement to the study area was in 1915, located approximately 52 miles to the west of the study area along the west flank of the Tobin Range.



Source: Dohrenwend et al. 1995.

Cortez Hills
Expansion Project

Figure 3.1-5
Quaternary Faults
in Nevada

05/29/07

Several active and potentially active faults occur in the vicinity of the project area including: 1) the Crescent fault, located approximately 0.5-mile north of the project boundary; 2) the Cortez fault, that crosses near the eastern boundary of the project area; and 3) an unnamed, shorter, east-west fault located in the Toiyabe Range, approximately 2 miles southwest of the project boundary (**Figure 3.1-6**) (Dohrenwend and Moring 1991).

Seismicity

The study area is located in a region that has experienced considerable seismic activity in historic time. Earthquake records indicate that 144 earthquake events greater than or equal to 4.0 Richter Magnitude have been recorded (U.S. Geological Survey [USGS] 2003) within a 100-mile radius of the project between 1872 and April 17, 2003. **Figure 3.1-7**[1] shows approximate locations and estimated magnitudes of the recorded seismic events relative to the proposed Cortez Hills Expansion Project. As shown in **Table 3.1-1**, the largest recorded earthquake to affect the region was a 7.7 Richter Magnitude event located approximately 52 miles west of the study area within the Nevada Seismic Belt. The closest recorded earthquake was an earthquake of magnitude 4.1 on March 18, 1974, approximately 2.5 miles from the study area (USGS 2003).

Table 3.1-1
Recorded Earthquakes with Richter Magnitude of 4.0 or Greater Within the Region[1]

Year	Month/Day	Location (latitude, longitude)		Approximate Distance from Project Site (miles)	Estimated Richter Magnitude
1872	3/23	40.0	-117.00	47.8	5.5
1915	10/3	40.5	-177.50	52.2	7.7
1945	9/18	40.6	-116.50	30.4	5.1
1966	10/22	40.6	-116.30	33.6	5.1
1984	2/16	39.858	-117.566	54.1	5.2
1974	3/18	40.167	-116.70	4.3	4.2
1974	3/18	40.200	-116.583	2.5	4.1

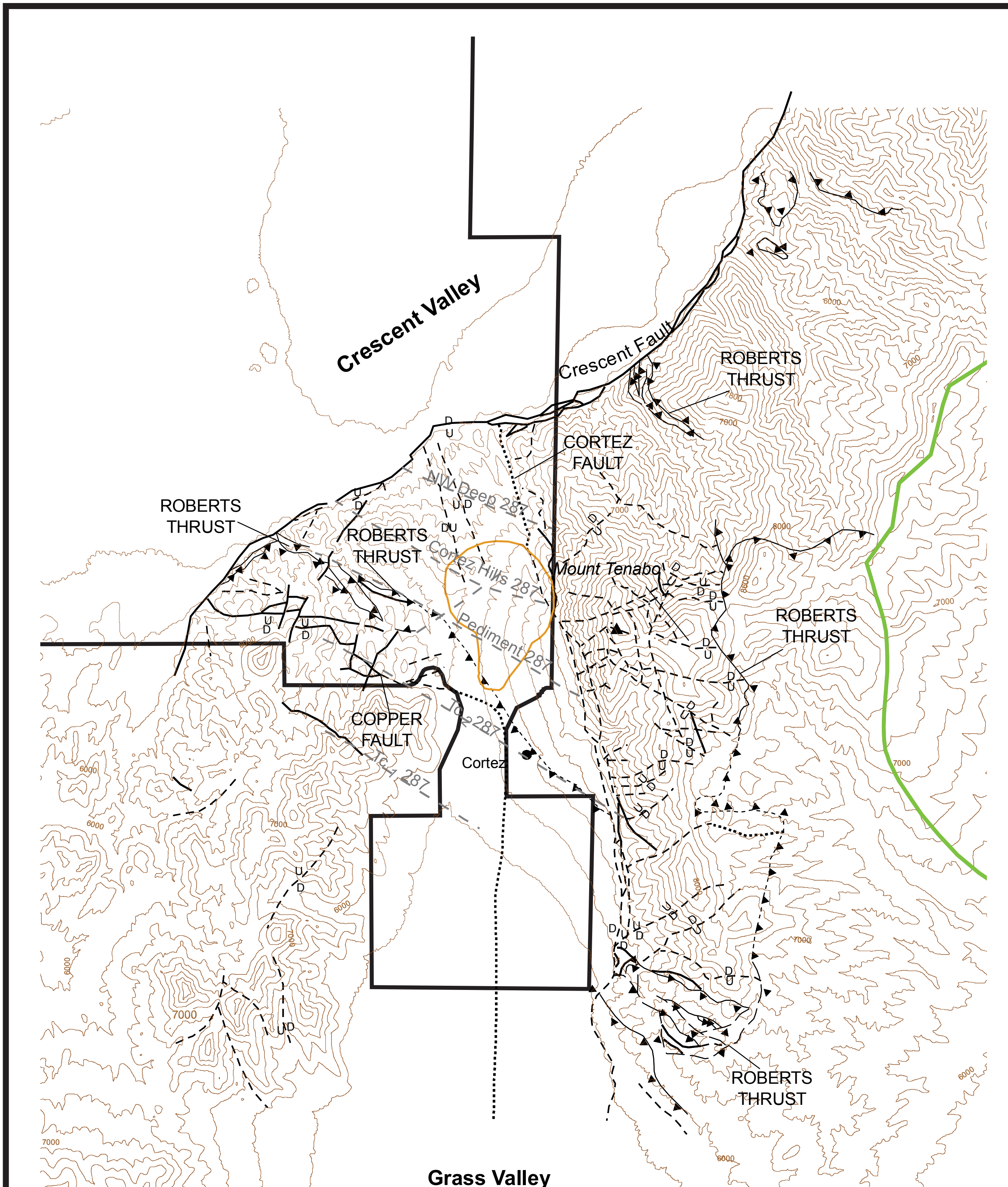
[1] Includes earthquakes located within 55 miles of the project boundary.

Source: Seismic data from USGS Earthquake Database (USGS 2003).

3.1.1.7 Ground Subsidence and Earth Fissure

The lowering of groundwater levels associated with ongoing dewatering activities at the Pipeline Pit has resulted in ground subsidence and development of earth fissures in Crescent Valley in the vicinity of the pit. In November 2002, CGM personnel discovered large erosional gullies in an area located approximately 1 mile south of the Pipeline Pit Complex that developed in response to a break of a water pipeline. The water pipeline delivered water from the existing pit dewatering system to the existing infiltration basins

[1] It is important to note that all 144 seismic events do not appear on **Figure 3.1-7** because several events occurred in the same location, and only the largest event is shown. For example, on April 21, 1934; September 24, 1934; and September 25, 1934; three separate events occurred at the same location; however, only one event appears on the figure.



Legend

- Project Boundary
- HSA
- Thrust Fault - Approximate - Concealed
  Sawteeth on Upper Plate
- Normal Fault - Approximate - Concealed
- 287 Faults
- Elevation Contours: 100-foot interval
- Proposed Cortez Hills Pit

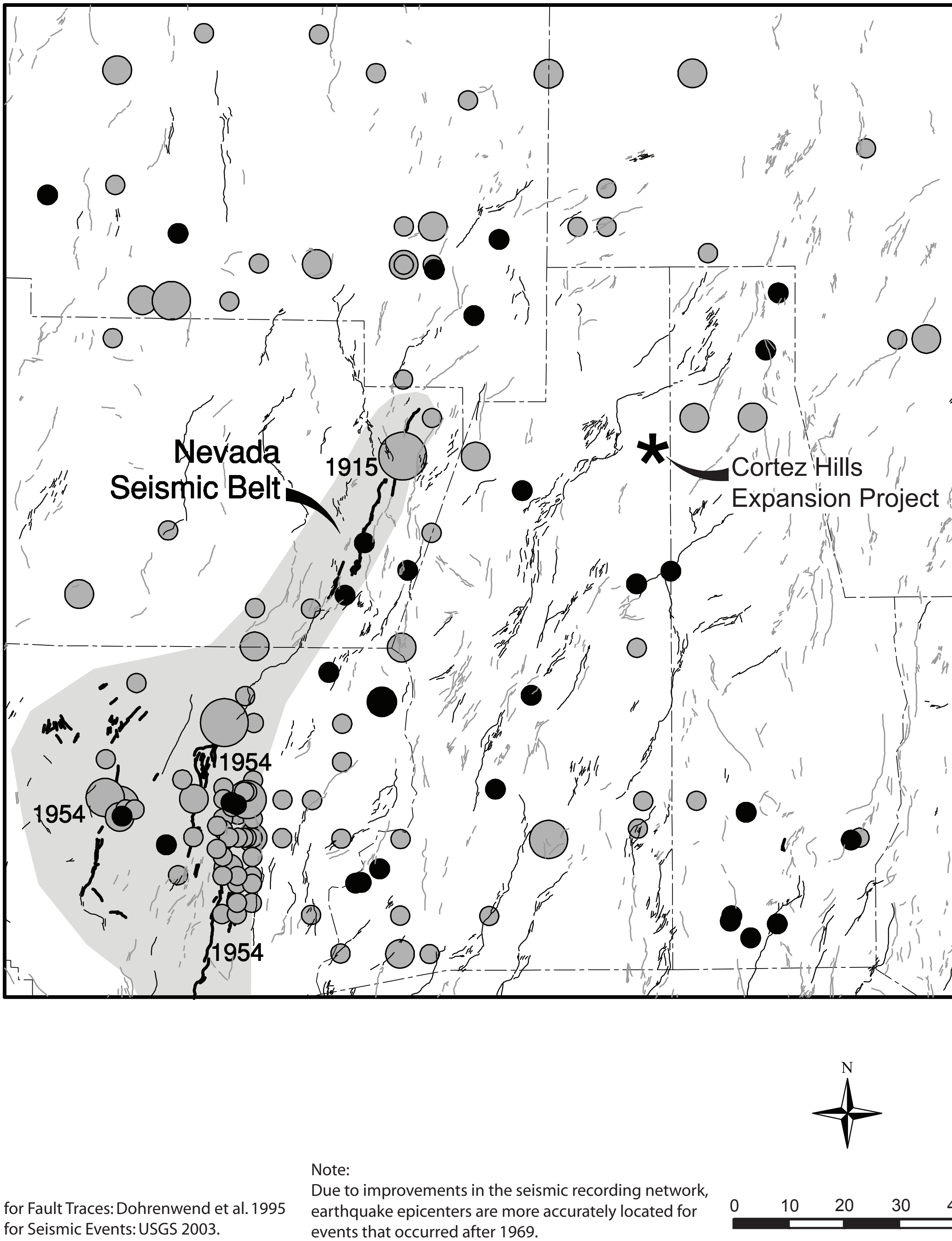
Source: Geomega 2006e.

N

0 0.5 1 2 Miles

Cortez Hills
Expansion Project

Figure 3.1-6
Known and Inferred Fault
Structures - Cortez Hills Complex



Note:
Due to improvements in the seismic recording network, earthquake epicenters are more accurately located for events that occurred after 1969.

Source for Fault Traces: Dohrenwend et al. 1995
Source for Seismic Events: USGS 2003.

Legend
Seismic Event Pre-1970
Seismic Event Post-1969
Historic Faults
Holocene to Late Pleistocene Faults
Undifferentiated and Undated Faults
County

Magnitude
> 7.0
6.0 - 6.9
5.0 - 5.9
4.0 - 4.9

Cortez Hills Expansion Project

Figure 3.1-7

Seismic Events

06/19/07

located south of the mine. The break resulted in a release of approximately 2 million gallons of water. Further evaluation of the erosional gullies indicated that the gullies were formed along earth fissures that subsequently were eroded, forming the wider fissure-gullies (AMEC Earth & Environment, Inc. [AMEC] 2003). The fissures were barely discernible by direct observation due to their narrow (0.5-inch) apertures; some fissures were identified indirectly by subtle changes in vegetation and alignment of potholes. However, erosion due to the water release along the fissures resulted in the development of gullies up to 30 feet wide and 15 feet deep. The location of the earth fissures is shown in **Figure 3.1-8**. The earth fissures are interpreted to have formed by horizontal strains associated with dewatering-induced ground subsidence (AMEC 2003).

In response to the fissures, CGM personnel backfilled the fissure gullies and protected the pipeline from further breaks. In addition, CGM sponsored a study to identify the cause of fissuring, evaluate subsidence in the vicinity of the pit and in southern Crescent Valley, and define areas of potential risk (AMEC 2003, 2005a). The results of the study were used to develop a monitoring plan for ground subsidence and earth fissuring associated with mine dewatering and water management activities (CGM 2005). The monitoring plan was submitted to and approved by the BLM. CGM's dewatering-induced subsidence management program is discussed in the Pipeline/South Pipeline Pit Expansion Project Final SEIS (BLM 2004e); the major components are summarized in Section 2.4.4.8, Dewatering and Water Management, of this EIS.

3.1.2 Environmental Consequences

Major issues related to geology and minerals include: 1) geologic hazards created or exacerbated by development of the proposed project; 2) damage to critical facilities caused by seismically induced ground shaking; 3) surface subsidence and ground deformation resulting from the lowering of the groundwater table or from underground mining; and 4) exclusion of future mineral resource availability caused by the placement of facilities (i.e., tailings, heap leach, or waste rock facilities).

Environmental impacts to geology and minerals would be significant if the Proposed Action or other alternatives result in any of the following:

- Impact to a facility caused by geologic hazards, including landslides and catastrophic slope failures or ground subsidence.
- Structural damage or failure of a facility caused by seismic loading from earthquakes.
- Restriction of future extraction of known mineral resources.
- Alteration of the geologic terrain from a project facility resulting in a geologic hazard.

3.1.2.1 Proposed Action

Direct impacts of the Proposed Action on geologic and mineral resources would include: 1) the generation and permanent disposal of approximately 1,577 million tons of waste rock, 53 million tons of tailings

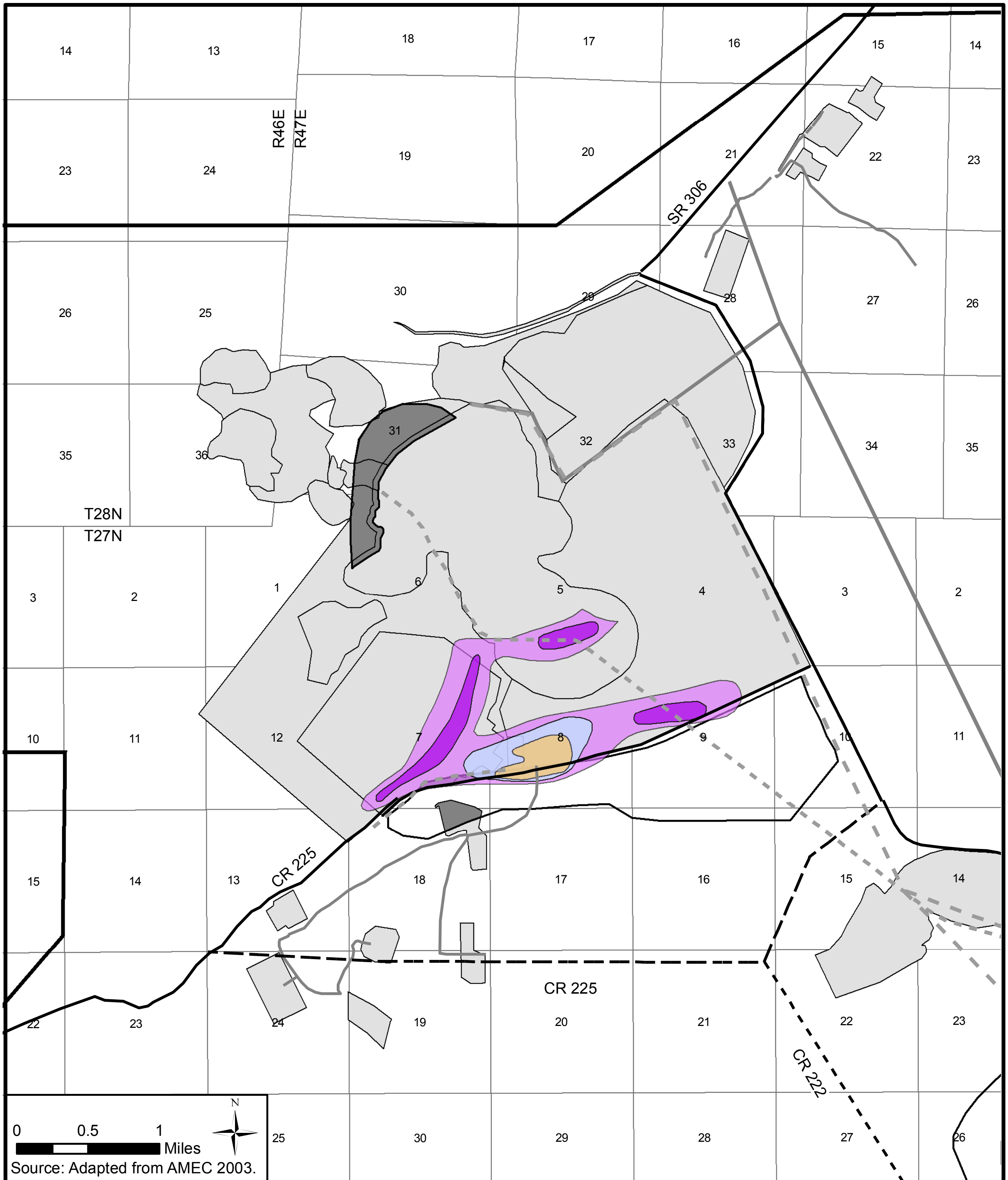


Figure 3.1-8
Mapped Earth Fissures

06/14/2007

material, and 112 million tons of spent heap leach material; 2) the removal of approximately 5 million tons of refractory ore; and 3) the mining of proven and probable ore reserves of approximately 170 million tons of ore (8 million ounces of gold).

The project would result in the permanent alteration of the landscape and disturbance of approximately 4,570 acres. This includes unreclaimed areas disturbed by open pits and reclaimed waste rock disposal areas, leach pads, and tailings impoundments that would permanently alter the natural topographic and geomorphic features in the area. Other temporary facilities (e.g., mill facilities, conveyor and powerline corridors, growth media stockpiles) that would be reclaimed to pre-mining topography would not permanently alter the natural topography or geomorphic features in the area.

Geologic Hazards and Geotechnical Considerations

Geotechnical considerations include potential damage to process and storage facilities due to ground movement during both operation and post-closure periods. Potential ground movement includes slope instability under static and earthquake loads, and settlement and ground deformation of foundation materials resulting from groundwater-induced subsidence or settlement over underground mine workings.

Waste Rock Facilities. AMEC (2005b) conducted a slope stability study for the proposed Canyon and North waste rock facilities and calculated that the minimum static and pseudostatic factors of safety for each case analyzed are above the generally accepted minimum factor of safety for waste rock facilities (1.3 static and 1.0 pseudostatic) utilizing 100-foot-thick lifts. A factor of safety is used to provide a design margin to ensure that a slope is stable and will not experience slumping or sliding. A computed factor of safety greater than or equal to 1 implies that the slope will be stable and is strong enough to support the assumed design loads. AMEC (2005b) also calculated that if 200-foot-thick lifts were constructed in the Canyon Waste Rock Facility, static slope stability factors of safety would be approximately 1.0, and pseudostatic factors of safety would be below 1.0. With 200-foot-thick lifts, some sloughing of the advancing waste rock facility face could be expected under static conditions, and the potential for movement would increase with increases in moisture and loading such as from vehicle traffic or earthquakes. AMEC concluded the 200-foot-high lifts would be feasible; however, there would be an increase in the potential for sloughing failures of a substantial amount of material as the waste rock facility increased in size. Recommendations for constructing 200-foot-high lifts included not exceeding overall slopes of 2.5:1 and limited access to the crest, face, and base to reduce the potential for rock fall or sloughing. Occasional rock fall or localized shallow sloughing of surficial materials from the face of the waste rock facility would not be considered significant geologic impacts.

Stability analyses have not been performed for the proposed South Waste Rock Facility, Cortez Waste Rock Facility, Pipeline Waste Rock Facility expansion, or backfill of the existing F-Canyon Pit or proposed North Gap Pit expansion. However, because the final overall slope would not exceed a slope design of 2.5:1, and the waste rock and foundation material properties were similar to the Canyon and North waste rock facilities, significant slope instability of these facilities would not be anticipated.

Heap Leach Facilities.

Grass Valley Heap Leach Facility. The design for the proposed Grass Valley Heap Leach Facility is summarized in Section 2.4.6.1. The facility would be located on a gently sloping alluvial fan. Subsurface investigations indicate that the site is underlain by unconsolidated gravelly silty sand that is non-plastic to low plasticity. The alluvium is dense with moderate to high strengths and is anticipated to experience moderate-to-low settlement under the assumed loads associated with heap leach construction (AMEC 2004b).

Slope stability and deformation analyses for the proposed Grass Valley Heap Leach Facility were performed by AMEC (2004b). Static factors of safety for the facility were calculated to be greater than 1.29 utilizing a textured liner under critical areas. Pseudo-static analyses for the Operational Basis Earthquake also were performed for the facility. The Operational Basis Earthquake is used as a lower level event, and facilities are anticipated to remain functional, sustaining no more than repairable damage. The Operational Basis Earthquake design calculated factors of safety greater than 1.16. This indicates that the heap leach facility would be stable under an Operation Basis Earthquake design. Pseudo-static analyses also were performed for a Maximum Critical Earthquake, which is defined as the largest event considered possible under the current tectonic regime. The analyses for the maximum event indicated that slides of sufficient mass to damage the liner near the toe probably would be created. The return period of major events is estimated at 1,000 to in excess of 2,000 years (AMEC 2004b). As a result, the probability of a catastrophic slope failure during the operational time period is presumed to be low. Groundwater levels at the site generally extend to the soil-bedrock contact ranging from 100 to 400 feet below existing grades. Therefore, the unsaturated soils are considered non-liquefiable (AMEC 2004b). In addition, the heap leach materials are not susceptible to liquefaction because of their gradational characteristics. Minor settlement would occur beneath the heap leach facility due to loading; however, it would not be great enough to impair the operation of the facility (AMEC 2004b).

Cortez Heap Leach Facility. The proposed Cortez Heap Leach Facility would be located on an alluvial fan. The alluvial sediments consist of sandy granular materials with lenses of finer-grained material. The depth to groundwater in this location is estimated at approximately 120 feet. These materials should provide a stable base for the facility. Although a geotechnical design is not available for review, based on the site conditions and depth to groundwater, stability and liquefaction are not expected to be of major concern. The facility would be designed in accordance with state and federal regulations; therefore, construction, operation and closure of the facility is not anticipated to result in significant geologic impacts.

Pit Slopes. Open-pit mines can experience periodic slope instability problems due to weak geologic materials; adversely oriented geologic structures, such as bedding, faults, and jointing; and the presence of groundwater. Impacts associated with potential instability of the pit walls during operation and post-closure are discussed below.

Cortez Hills Pit. The proposed Cortez Hills Pit (**Figure 2-3**) would have a maximum depth of approximately 2,200 feet (measured from the deepest portion of the pit to the premining ground surface), with a bottom elevation no deeper than approximately 3,800 feet amsl. The pit design would include a 200-foot-wide pit adjustment zone around portions of the pit rim to provide operational flexibility for minor pit modifications due to safety or engineering considerations during operations. The final design of the pit would be developed after initial mining to verify actual geologic conditions and pit wall performance (CGM 2007c).

A potential stability concern identified for the proposed Cortez Hills Pit is the presence of weak, highly sheared bedrock material associated with the Cortez Fault Zone that would be intersected by the pit wall in the eastern segments of the pit (BGC Engineering, Inc. [BGC] 2005; CGM 2007c). In the proposed pit area, the weak bedrock material and fault gouge (pulverized rock generated by fault movement) associated with the Cortez Fault Zone ranges from approximately 100 to 500 feet wide and dip steeply toward the west (BGC 2005; Golder 2007). For the purposes of this discussion, the weak bedrock materials associated with the Cortez Fault Zone include the shear zone, and poor quality bedrock material situated within the defined fault zone and located in the "damaged zone" adjacent to the fault zone. Groundwater in the east wall of the proposed pit occurs in low permeability bedrock units with perched and compartmentalized groundwater flow patterns that would require depressurization for stable slope conditions (BGC 2005). The pit also would be situated in an active seismic area, as described in Section 3.1.1.6. Ground acceleration caused by seismic events would have the potential to result in failure of slopes that would be marginally stable under static conditions.

BGC (2005) conducted an initial feasibility pit slope design study for the proposed Cortez Hills Pit. The BGC study identified stability concerns with respect to the presence of poor rock quality in the east pit wall associated with the Cortez Fault Zone. The BGC study also indicated that effective pore pressure reduction, and controlled blasting, would be required to minimize the potential for rock mass failure in the east pit wall. Upon completion of structural kinematic and rock failure stability analyses, a preliminary pit design meeting a required factor of safety of 1.2 under completely depressurized (dewatered) and static conditions was achieved. A factor of safety of 1.0 was achieved for seismic loading of 0.09g, which is half of the operational basis earthquake. BGC (2005) recommended: 1) the use of controlled blasting techniques to maintain a nominal cohesive strength along geologic structures that could contribute to bedrock slope failures; 2) development of a comprehensive dewatering plan (including extensive vertical dewatering wells and horizontal drains) to dissipate pore pressures and achieve the preliminary pit slope angles recommended; and 3) development of a pit wall monitoring program to measure ground movement, pore pressures, fracture locations, and slope performance during operations. Based on the study, wide catch benches and buttressing may be required to control localized slides (BGC 2005).

Golder (2007) provided a summary of the geotechnical data that have been developed subsequent to the initial feasibility study to support pit slope design for the east wall of the proposed Cortez Hills Pit. The geotechnical data summary includes the results of additional core holes completed in the east wall in 2006. The results of these subsurface investigations have been used to further define the rock mass characteristics and rock structure conditions in the east wall. Based on the results of the geotechnical investigations and concerns regarding potential impacts associated with slope instability in the east wall of the pit, CGM has established the following criteria for design and construction of the proposed Cortez Hills Pit (CGM 2007c):

- Proposed ground disturbance associated with the Cortez Hills Pit would be limited to outside and west of the geologic outcrop of Eureka Quartzite on the western flank of Mount Tenabo known as the White Cliffs;

- The Cortez Hills Pit would be no deeper than the 3,800-foot elevation;
- The open-pit operation would maximize economic ore recovery while complying with CGM and regulatory safety requirements;
- Inter-ramp and overall slope angles would be designed to avoid potential structurally-controlled ("kinematic") failures related to large-scale faults;
- Pit wall safety benches would be of an appropriate width to contain potential kinematic and rock mass failures; and
- Pit wall design parameters would conform to a minimum 1.2 factor of safety under static loading and a minimum 1.0 factor of safety under seismic loading in order to minimize rock mass failure mechanisms. Seismic loading would be evaluated in terms of pseudostatic analyses applied to limit equilibrium methods, with a pseudostatic coefficient equal to 50 percent of the peak free-field horizontal ground acceleration associated with the operational basis earthquake, in accordance with recommendations of the U.S. Army Corps of Engineers (USACE).

In addition, CGM has established guidelines for development of an integrated geotechnical monitoring program for the proposed Cortez Hills Pit, which include requirements for: 1) pit slope monitoring; 2) development of "trigger points" for corrective action if substantial slope movement is detected; 3) geotechnical pit mapping; and 4) routine review of the monitoring results and geotechnical data to develop corrective actions or optimize the final pit slope configuration, as necessary, to minimize the potential for failure during mine operations (CGM 2007b).

Implementation of the proposed mine dewatering program, minimum design criteria, and an integrated geotechnical monitoring program (with revisions to the pit design as necessary during the project life as outlined in CGM 2007b) is expected to minimize the potential risk of large-scale bedrock failures during operations. Therefore, significant impacts associated with the development of slope instability of the pit that would extend outside of the 200-foot pit adjustment zone are not anticipated during the active mining period.

Stabilization of the pit walls is not proposed as part of reclamation or closure. After the dewatering operations cease and the pit slopes are no longer actively depressurized, pore pressure would partially or fully recover. This potentially would be of consequence in the east wall where the groundwater conditions have been described as consisting of localized or compartmentalized groundwater flow systems in low permeability rock that are difficult to dewater (BGC 2005). An increase in pore pressure in the east wall would have the potential to contribute to the development of deep-seated failures in the weak bedrock materials associated with the Cortez Fault Zone over time. Potential seismic activity also could trigger slope instability. The bedrock east of the fault zone in the vicinity of the east wall of the proposed pit consists of quartz monzonite and Hamburg Limestone. The geotechnical data indicate that outside of the fault gouge zone associated with the fault, these bedrock materials are relatively competent with higher rock strength properties than the weak bedrock materials associated with the Cortez Fault Zone. For this reason, it is reasonable to conclude that deep-seated failures that potentially could develop in the post-closure period would be unlikely to extend farther east than the boundaries of the Cortez Fault Zone, as defined above. As such, there is a potential risk of failures to develop in the post-closure period that could extend outside the proposed pit boundary (see **Figure 2-3**), specifically, in the southern segment of the east wall of the Cortez Hills Pit near the proposed project boundary. Based on the mapped location of the Cortez Fault Zone and proposed pit boundary, a failure in the Cortez Fault Zone in this general location would have the potential to extend a maximum of a few hundred feet (less than 500 feet) outside of the pit boundary and outside of the proposed project boundary. A deep-seated failure in the east wall of the pit in the post-mining period would be considered a significant impact.

In the vicinity of the Cortez Hills Pit, the Eureka Quartzite outcrop (i.e., White Cliffs) occurs over 1,500 feet east of the eastern boundary of the Cortez Fault Zone. Based on the high strength properties of the quartzite, distance to the eastern pit margin, and distance to the low strength material associated with the Cortez Fault Zone, potential slope failures that could develop in the post-mining period as discussed above would not impact the White Cliffs.

Cortez Pit. Under the Proposed Action, the existing Cortez Pit boundary would remain unchanged; however, the pit bottom would be deepened approximately 100 feet (**Figure 2-3**). A 200-foot-wide pit adjustment zone around the pit rim would provide for operational flexibility. The deepened pit would have an overall depth of approximately 400 feet with overall pit slope angles ranging from 35 to 44 degrees. The existing Cortez Pit was mined between 1969 and 1973; current pit wall angles in the Cortez Pit range between 40 and 50 degrees and have not experienced substantial slope failures since mining ceased over 30 years ago. The rock exposed in the existing pit, and that would be encountered in the deepened pit, is relatively competent material. Based on the existing conditions exposed in the pit and material that would be encountered, deepening of the pit would not increase the pit wall angles beyond the current conditions and is not expected to result in significant pit wall stability problems. Therefore, deepening of the Cortez Pit is not expected to result in significant impacts associated with slope stability during operation or post-closure.

North Gap Pit Expansion. Proposed open-pit mining at the Pipeline Complex would include the development of the North Gap Pit expansion, which would involve a layback of the western wall of the currently permitted Pipeline Pit (**Figure 2-3**). The North Gap Pit expansion area would have an overall depth of approximately 700 feet, with a bottom elevation of approximately 4,400 feet amsl. A 200-foot-wide pit adjustment zone would extend around the rim of the pit expansion area, within which the pit could be laid back if necessary for safety or engineering considerations. Slope stability analyses for the North Gap Pit expansion were conducted by Golder (2005). Factors of safety for the pit design were calculated to be 1.35 and higher, indicating that the potential for slope failure in the expansion area should be minimal. Continued data collection and analysis, including groundwater monitoring, pit wall mapping, slope stability monitoring, and controlled blasting techniques, would minimize the potential for slope stability problems during active mining and backfilling of this pit expansion area. Based on the existing data and results of the stability analysis, development of the North Gap Pit expansion is not anticipated to result in significant impacts associated with slope stability during operation or post-closure.

Tailings Facilities. The proposed Cortez Tailings Facility expansion would be constructed on unconsolidated basin fill alluvial material. The alluvium consists of discontinuous lenses of fine-grained soil within predominantly sandy sediments. The depth to groundwater in the vicinity is estimated to be approximately 120 feet. AMEC (2004c) conducted slope stability analyses on the proposed Cortez Tailings Facility expansion and concluded that the tailings would not be susceptible to liquefaction, and slope stability problems are not anticipated. The facility would be designed in accordance with standard geotechnical design practices and in accordance with state and federal regulations. Therefore, construction, operation, and closure of the tailings facility is not anticipated to have a significant impact to geologic or mineral resources.

Blasting

Conventional drilling and blasting techniques would be used to facilitate the proposed surface and underground mining. Concerns were expressed in public comments regarding potential impacts of blasting to the White Cliffs and Mount Tenabo, and effects on seismicity. Based on the results of research conducted by the former U.S. Bureau of Mines (Siskind 1994), which included monitoring near blasting sites, blasting-induced ground vibration is not anticipated to result in significant impacts to bedrock exposures in the White Cliffs or Mount Tenabo. In addition, the localized blasting required for mining is not expected to result in an increase in seismic activity in the region.

Underground Mining

The proposed underground workings would encounter mineralized and altered rock with poor rock quality. In the post-closure period, localized rock collapse would be likely to occur over the workings and result in the development of localized ground deformation/subsidence-type features within the boundaries of the proposed Cortez Hills Pit. The declines are expected to have localized long-term collapse; however, they are unlikely to significantly impact surface features due to the strength and thickness of the overlying rock in relation to the dimensions of the underground openings (Golder 2006).

Dewatering-induced Surface Subsidence

The predicted drawdown and potential impacts to water resources associated with the Proposed Action dewatering scenario are addressed in Section 3.2. Additional dewatering required for the Proposed Action would increase the areal extent and magnitude of drawdown compared to current conditions. This additional dewatering would lower water levels in both fractured bedrock and basin sediments. As mine dewatering lowers the groundwater levels and water is removed from the basin fill sediments, the load born by the sediments would increase and result in compaction of the sediment causing subsidence of the ground surface. Ground subsidence also can result in the development of cracks at the surface that are known as earth fissures. As discussed in Section 3.1.1.7 (Ground Subsidence and Earth Fissure), the lowering of groundwater levels associated with past dewatering activities at CGM's operations in Crescent Valley has resulted in ground subsidence in the region surrounding the mine and development of earth fissures immediately south of the Pipeline Complex (**Figure 3.1-8**). This section summarizes the potential impacts associated with the additional subsidence that is projected to occur under the Proposed Action dewatering scenario.

Additional ground subsidence from the Proposed Action dewatering scenario was estimated using the calibrated groundwater flow model and the MODFLOW Interbed-Storage package as described in the groundwater flow modeling report for the project (Geomega 2007f). Water withdrawn from storage is released from both the expansion of water and compression of the sediments resulting in a change in storage. The mechanics of subsidence and changes in storage properties in aquifer and aquitard materials are described in Poland (1984).

The predicted subsidence resulting from the Proposed Action dewatering scenario is presented in **Figure 3.1-9**. The subsidence analysis indicates that the maximum subsidence would be less than 3 feet and would occur southeast of the Pipeline Pit. The area affected by 1 foot or greater subsidence is predicted to extend up approximately 4 miles from the pit perimeter. This additional subsidence could expand the development of earth fissures. If undetected, earth fissures potentially could damage facilities including solution-bearing facilities such as leach pads and process ponds. The only existing processing facility located within the vicinity of the predicted subsidence area is the Pipeline South Area Heap Leach Facility. There are no new leach pad or tailings facilities proposed within the predicted subsidence area. In addition, CGM's current operations include a monitoring and mitigation plan for ground subsidence and related earth fissure development for previously authorized activities (CGM 2005); the plan includes monitoring through the life of the Pipeline/South Pipeline Project. However, considering the uncertainty associated with the subsidence predictions and fissure development over the life of the proposed project, there would be a potential for damage to facilities resulting from future earth fissure development in southern Crescent Valley. Potential damage to facilities from subsidence-related fissure development would be considered a significant impact.

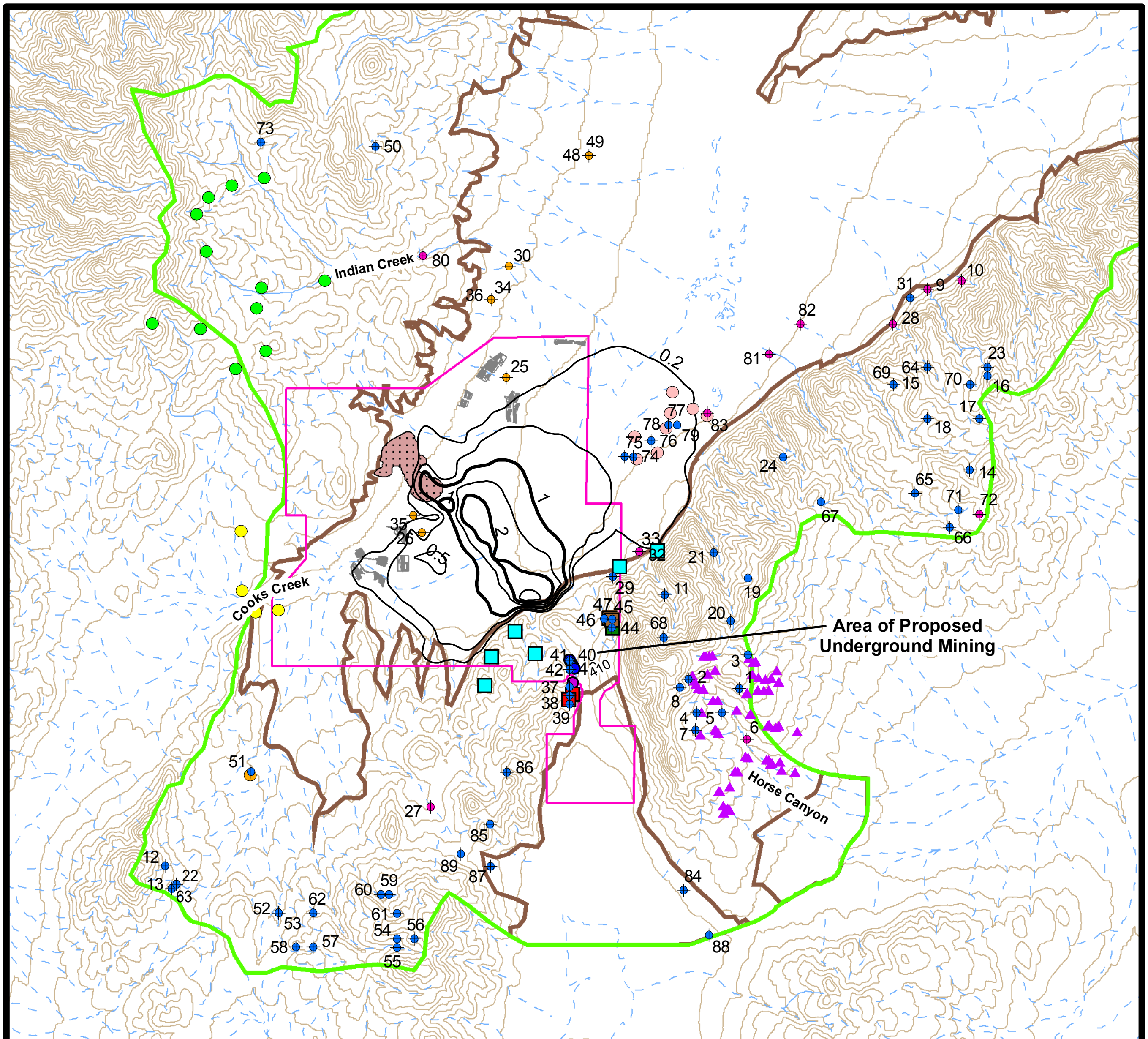
3.1.2.2 Grass Valley Heap Leach Alternative

Under this alternative, the location for the proposed Grass Valley heap leach pad and associated solution ponds and CIC facility would be moved approximate 1.5 miles to the southeast of the proposed location. For purposes of this analysis, it is assumed that the geotechnical design of the facility would be the same as for the Proposed Action. Subsurface investigations have not been conducted at this alternative location. However, based on the similar geologic setting and close proximity, it is reasonable to conclude that the general subsurface conditions at this alternative location are similar to the location identified for the Proposed Action (i.e., the alternative location is underlain by dense, unsaturated alluvial sediments). From a stability standpoint, potential impacts under this alternative essentially would be the same as those described for the Proposed Action.

3.1.2.3 Crescent Valley Waste Rock Alternative

Under this alternative, a waste rock facility would be constructed on the valley floor of Crescent Valley; the proposed Canyon Waste Rock Facility would not be constructed. The location and design of the waste rock facility are described in Section 2.5.1.2, Crescent Valley Waste Rock Alternative. Potential impacts under this alternative would be similar to those described for the Proposed Action, with the following exception.

Geotechnical site characterization and stability analyses have not been performed for the Crescent Valley Waste Rock Alternative. Based on conditions at other sites located on the floor of Crescent Valley, the facility would be located in an area underlain by alluvial basin fill sediments. The sediments are generally characterized as predominantly sandy granular material with localized discontinuous lenses of fine-grained



Monitored Seeps and Springs
- Toiyabe Catchment
- Peripheral
- East Valley
- Shoshone
- Rocky Pass
- Cortez Canyon Seeps
- Mapped Cortez Canyon Spring
- NE Toiyabe Seeps
- NE Corner Seeps and Spring
- NE Survey Area Seep
- Horse Canyon Area

Private Active Water Rights (See **Table B-2** in Appendix B)
- Groundwater
- Streams
- Springs
- Pipeline Pit
- Project Boundary
- Infiltration Basins
- HSA/Model Domain Boundary
- Elevation Contours (200-foot interval)
- Stream (dashed where intermittent)
- Basin Fill - Bedrock Contact

Subsidence
- 0.5-foot interval
- 1-foot interval

N

0 1 2 4 Miles

Note: Groundwater level changes compared to estimated groundwater levels at the end of 2004.

Source: Geomega 2007f.

Cortez Hills Expansion Project

Figure 3.1-9
Simulated Subsidence at End of Dewatering - Proposed Action

06/14/2007

soil. The depth to groundwater is estimated to be approximately 25 to 50 feet below the ground surface. Exploration data indicate that the waste rock to be placed in the proposed facilities is similar to the material in the existing Pipeline Waste Rock Facility and consists of 83 percent limestone; approximately 5 percent each of limestone conglomerate, siltstone conglomerate, and alluvium; and less than 1 percent each of dike, marble, and refractory rock. Material exposed in the Pipeline Waste Rock Facility consists primarily of sand, gravel, cobbles, and boulders. As the final overall slope would not exceed a slope design of 2.5:1, and the waste rock and foundation material properties are similar to the existing Pipeline Waste Rock Facility, significant slope instability of these facilities is not anticipated.

3.1.2.4 Cortez Hills Complex Underground Mine Alternative

Under this alternative, surface facilities at the Cortez Hills Complex would not be developed. Surface facilities associated with underground operations would be developed in existing disturbance areas at the Cortez Complex. Potential impacts to geologic and mineral resources under this alternative would be similar to those described under the Proposed Action with the following exceptions.

Under this alternative, direct impacts on geologic and mineral resources would include: 1) the generation and permanent disposal of approximately 127.6 million tons of waste rock, 35 million tons of spent heap leach material, and 16.0 million tons of tailings material; 2) the permanent removal of approximately 1.4 million tons of refractory ore; and 3) the mining of proven and probable ore reserves of approximately 52.4 total million tons of ore (3 million ounces of gold).

This alternative would result in the permanent alteration of the landscape and disturbance of approximately 1,172 additional acres. This acreage would include unreclaimed areas disturbed by open pits and reclaimed waste rock disposal areas, leach pads, and tailings impoundments that would permanently alter the natural topographic and geomorphic features in the area.

Impacts identified for the Proposed Action regarding potential slope failures in the eastern portion of the Cortez Hills Pit would not occur since this open-pit would not be developed.

The magnitude and areal extent of drawdown of groundwater in the basin fill sediments is predicted to be similar for the Proposed Action and the Underground Mine Alternative. Therefore, potential impacts associated with dewatering-induced subsidence and earth fissure development are anticipated to be similar to those described for the Proposed Action dewatering.

3.1.2.5 No Action Alternative

Under the No Action Alternative, the proposed Cortez Hills Expansion Project would not be developed and the related potential impacts to geologic and mineral resources would not occur. The existing mining and ore processing activities associated with the Pipeline/South Pipeline Project and activities associated with the Cortez Underground Exploration Project would continue under existing authorizations. Potential impacts to geologic and mineral resources previously were analyzed in the Pipeline/South Pipeline Project Final SEIS (BLM 2004e) and earlier NEPA documents for the site (BLM 2000a, 1996a) as well as the Cortez Underground Exploration Project EA (BLM 2006a). The only significant impact to geologic and mineral resources identified in these documents was the restriction of future mineral resource extraction due to placement of waste rock in the Pipeline/South Pipeline/Gap/Crossroads open pits.

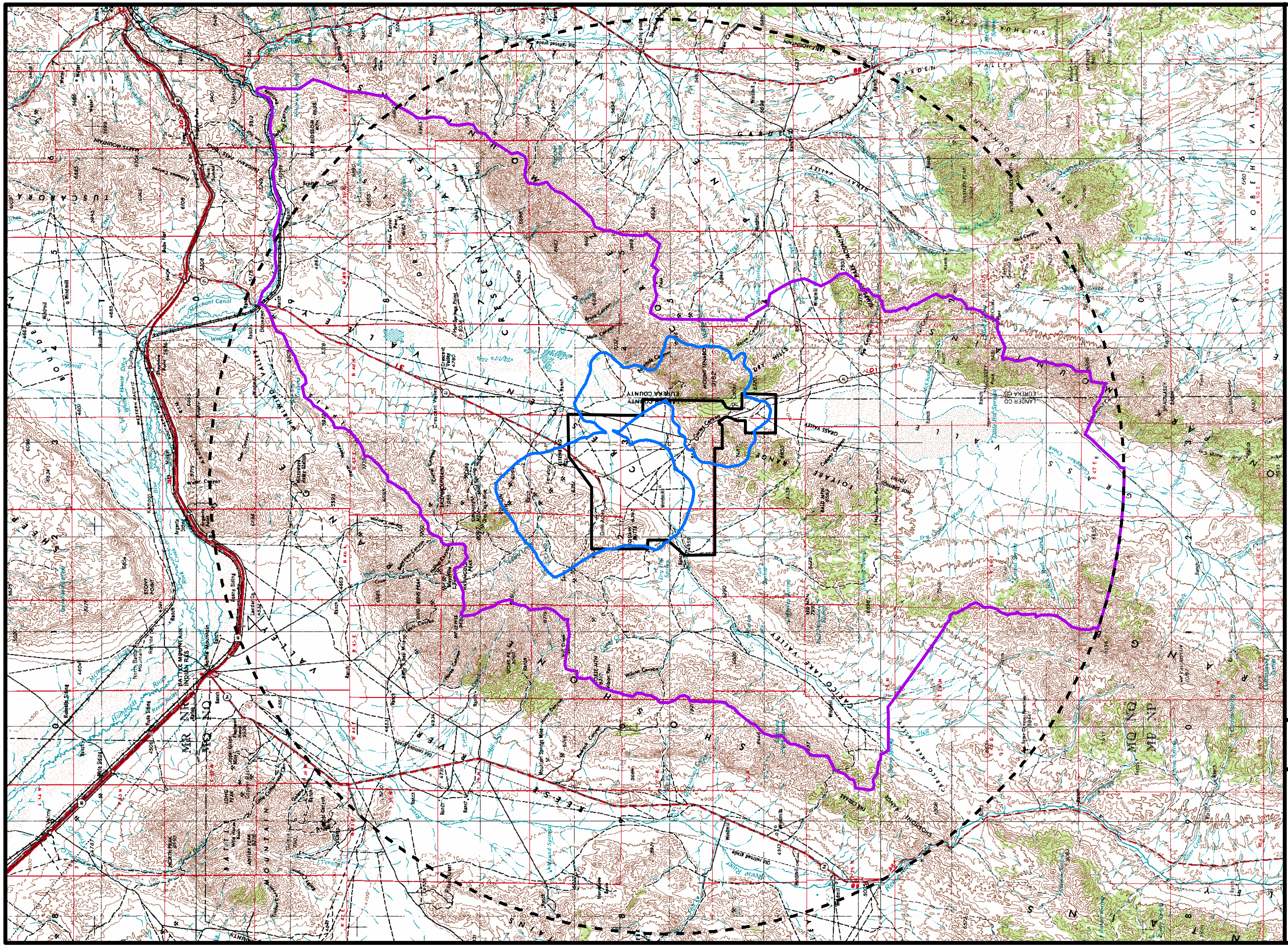
The predicted drawdown and potential impacts to water resources associated with the No Action dewatering scenario are addressed in Section 3.2. Dewatering required for the currently permitted operation in the future would increase the areal extent and magnitude of drawdown compared to current conditions. This additional dewatering would lower water levels in both fractured bedrock and the basin sediments. As mine dewatering lowers the groundwater levels and water is expelled from the basin fill sediments, the load born by the sediments would increase and result in compaction of the sediment causing subsidence of the ground surface. Ground subsidence also can result in the development of cracks at the surface that are known as earth fissures.

As discussed in Section 3.1.1.7 (Ground Subsidence and Earth Fissure), the lowering of groundwater levels associated with past dewatering activities at CGM's operations in Crescent Valley has resulted in ground subsidence in the region surrounding the mine and the development of earth fissures (**Figure 3.1-8**). The predicted subsidence resulting from the No Action dewatering scenario is similar to the Proposed Action shown in **Figure 3.1-9**. The subsidence analysis indicates that the maximum subsidence would be up to approximately 2.5 feet and would occur southeast of the Pipeline Pit. The area affected by 1 foot or greater subsidence is predicted to extend up to approximately 4 miles from the pit perimeter. This additional subsidence could expand the development of earth fissures. If undetected and unmitigated, earth fissures could potentially damage solution-bearing facilities such as leach pads and process ponds. The only existing facility located within the vicinity of the predicted subsidence area is the South Area Heap Leach Facility. There are no new leach pad or tailings facilities proposed within the predicted subsidence area. In addition, CGM's current operations include a dewatering-induced subsidence management plan (CGM 2005). However, considering the uncertainty associated with the subsidence predictions and fissure development there is a potential for damage to facilities resulting from future earth fissure development in southern Crescent Valley. Potential damage to facilities from subsidence-related fissure development is considered a significant impact. Continued implementation of the dewatering-induced subsidence management plan should detect and mitigate significant impacts associated with subsidence and earth fissure development.

3.1.3 Cumulative Impacts

The cumulative effects study area for geology and minerals is shown in **Figure 3.1-10**. The past and present actions and RFFAs in this area are identified in **Table 2-16**; their locations are shown in **Figure 2-22**. Mineral production in these areas has included gold, silver, barite, sulfur, turquoise and lesser amounts of copper, lead, and arsenic. Most of the mineral production has come from gold and barite mining operations. In addition, the basin fill material has been mined intermittently as a source of gravel 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 cumulative effects study area has included exploration (drilling, trenching, sampling, and road construction), open-pit and underground mining, and construction of waste rock, heap leaching, ore milling and processing, and tailings disposal facilities. For the purpose of this evaluation,



N

0 2 4 6 8 Miles

Legend

Hazardous Materials CESA

Geology and Minerals, Paleontological Resources, Soils, Vegetation, Wildlife and Fisheries, Land Use and Access, and Noise CESA

Range CESA

10-foot Groundwater Drawdown Contour

Note: The CESA for vegetation and wildlife and fisheries also includes the wetland/riparian areas and surface water features within the modeled cumulative groundwater 10-foot drawdown contour. The CESA for access and hazardous materials also includes the primary access routes to the project area. The Lander/Eureka county line was adjusted subsequent to the date of this USGS map base.

Cortez Hills Expansion Project

Figure 3.1-10

Various Resources CESA

06/22/2007

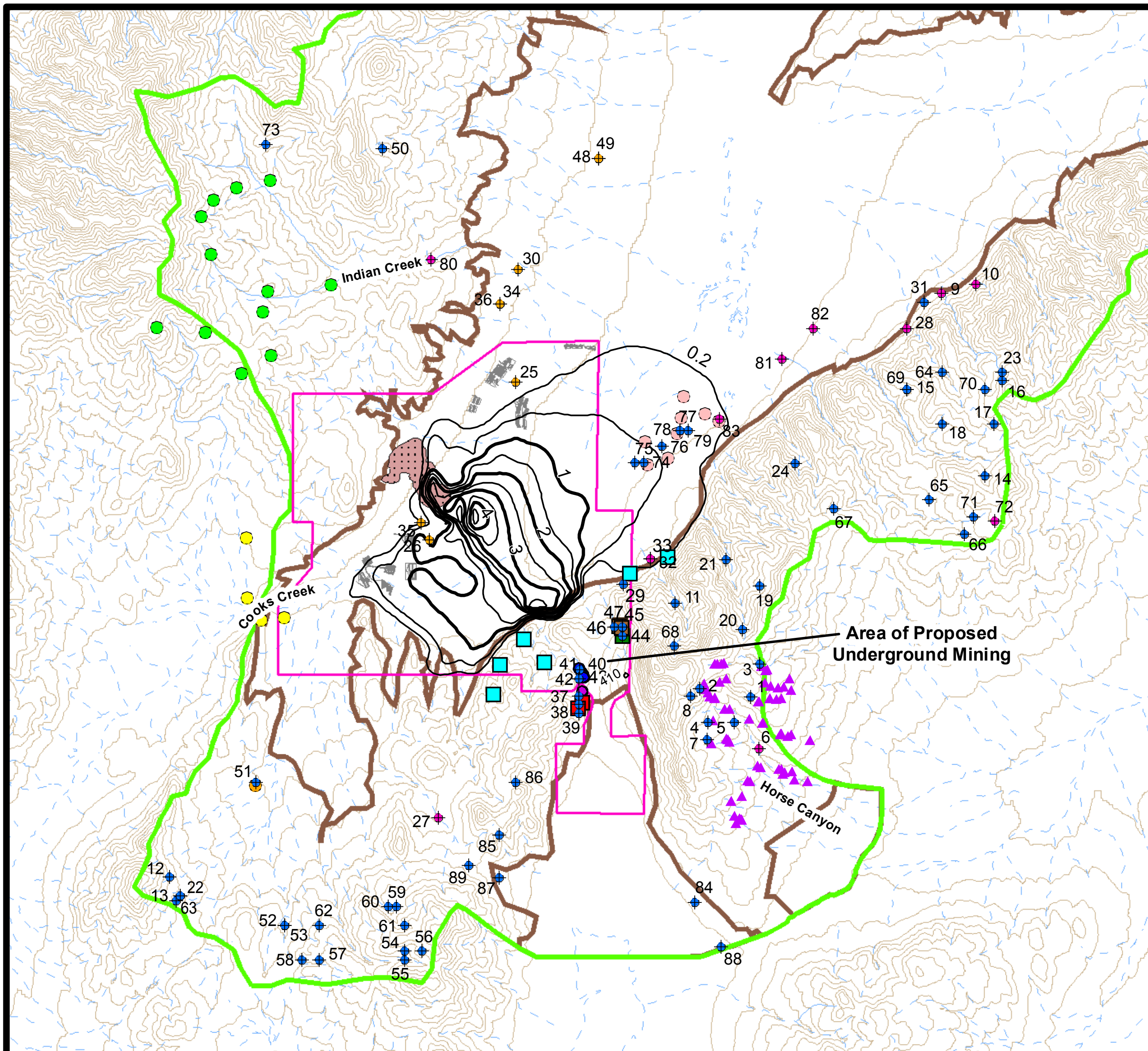
"disturbed" areas (or geologic disturbance) is defined to include mine components such as open pits, waste rock areas, leach pads, and tailings impoundments that permanently alter the natural topographic and geomorphic features in the area, even if reclaimed. In addition to mining, other developments in the region include agricultural development and utilities/community development. Large portions of the area also have been affected by wildfires (**Table 2-16**). For the purposes of this evaluation, agricultural, utility, and community development, and wildfires are not considered to result in a geologic disturbance as defined above.

Based on available information, past and present and reasonably foreseeable future mining-related activities have, or would, result in approximately 18,588 acres of disturbance within the cumulative effects study area, an unquantifiable portion of which has, or would, result in a permanent alteration of the natural topography. Of the 6,792 total acres of disturbance that would occur under the Proposed Action, the project incrementally would increase the permanent alteration of topography in the cumulative effects study area on approximately 4,570 acres.

As discussed in Section 3.1.1.7, Ground Subsidence and Earth Fissure, the lowering of groundwater levels associated with existing dewatering activities at CGM's existing operations in Crescent Valley has resulted in ground subsidence in the region surrounding the Pipeline Complex and the development of earth fissures (**Figure 3.1-8**). Additional dewatering required for the Proposed Action incrementally would increase the areal extent and magnitude of groundwater drawdown compared to current conditions and result in an increase in subsidence in the southern portion of Crescent Valley. The total cumulative subsidence from the past, present, and projected future dewatering activities was predicted using the same methodology summarized in Section 3.1.2.1, Proposed Action (Geomega 2007f). The predicted subsidence resulting from the cumulative dewatering scenario is presented in **Figure 3.1-11**. The subsidence analysis indicates that the maximum cumulative subsidence would be on the order of 5 feet and would occur southeast of the existing Pipeline Pit. The area affected by 1 foot or greater subsidence is predicted to extend up to 5 miles across southern Crescent Valley. This additional subsidence could expand the development of earth fissures. If undetected and unmitigated, earth fissures potentially could damage solution-bearing facilities such as leach pads and process ponds. The only existing facility located within the vicinity of the predicted subsidence area is the existing Pipeline South Area Heap Leach Facility. There are no new leach pad or tailings facilities proposed within the predicted subsidence area. Current CGM operations include a dewatering-induced subsidence management program, as previously discussed for the Proposed Action. Continued implementation of the dewatering-induced subsidence management plan through the life of the project would detect and mitigate any significant cumulative impacts associated with subsidence and earth fissure development.

Other Action Alternatives. The estimated cumulative impacts to geology and mineral resources associated with the Grass Valley Heap Leach and Crescent Valley Waste Rock alternatives would be similar to those described for the Proposed Action, based on similar disturbance and dewatering rates.

The Cortez Hills Complex Underground Mining Alternative would result in 1,172 acres of additional disturbance and permanent alteration of topography, approximately 3,398 fewer acres than under the Proposed Action. Because the general magnitude and areal extent of drawdown in the basin fill sediments is predicted to be similar for both the Proposed Action and this alternative, potential cumulative impacts



Monitored Seeps and Springs
- Toiyabe Catchment
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- Streams
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- Pipeline Pit
- Project Boundary
- Infiltration Basins
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- Basin Fill - Bedrock Contact
- Elevation Contours (200-foot interval)
- Stream (dashed where intermittent)

Subsidence
- 0.5-foot interval
- 1-foot interval

N

0 1 2 4 Miles

Note: Groundwater level changes compared to estimated groundwater levels at the end of 2004.

Source: Geomega 2007f.

Cortez Hills Expansion Project

Figure 3.1-11
Simulated Subsidence at End of Dewatering - Cumulative Effects

06/14/2007

associated with dewatering-induced ground subsidence are estimated to be generally the same as those previously described for the Proposed Action.

3.1.4 Monitoring and Mitigation Measures

Issue: Geotechnical designs for some waste rock, heap leach, and tailings facilities were not available for review as part of the EIS.

Mitigation Measure GM-1: Facility Design: Proposed waste rock facilities, heap leach pads, and tailings facilities, would be designed, constructed, monitored, and maintained in a stable manner during both the operation and post-mining periods. Stability analyses would be performed for the Cortez and Pipeline waste rock facility expansions, Cortez Heap Leach Facility, and Cortez Tailings Facility to demonstrate that all proposed facilities would remain functional after the passage of an Operational Basis Earthquake, and would not fail catastrophically or release tailings or fluids during a Maximum Credible Earthquake. The minimum factors of safety for all slope designs would be determined as part of the permits, inspections, and approvals granted by the NDEP, NDWR, Dam Safety Division, and the BLM.

Effectiveness: Proper design, construction, and maintenance of the facilities outlined in GM-1 would effectively minimize potential impacts associated with facility stability during the operation and post-mining periods.

Issue: Subsidence southeast of the Pipeline Pit is predicted to continue with the extended dewatering program associated with the Proposed Action.

Mitigation Measure GM-2: Subsidence and Earth Fissures: The current “Monitoring Plan for Ground Subsidence and Related Earth Fissure Development near the Pipeline Mine” (CGM 2005) would be revised to include subsidence and fissure monitoring and mitigation through the life of the project within the predicted area to be affected by dewatering-induced ground subsidence or as approved by the BLM and NDEP.

Effectiveness: Implementation of this measure would extend monitoring through the extended dewatering program associated with the Proposed Action.

Issue: There would be a potential for slope failures in the east wall of the Cortez Pit in the post-mining period.

Mitigation Measure GM-2: The potential for failure of the east wall of the Cortez Hills Pit in the post-closure period would be reduced by: 1) pit slope monitoring; 2) development of “trigger points for mitigation” if significant slope movement is detected; 3) geotechnical pit mapping; and 4) routine review of the monitoring results and geotechnical data to develop corrective actions or optimize the final pit slope configuration as necessary to minimize the potential for failure during mine operations (CGM 2007b,c). The results of the pit slope monitoring, geotechnical data collection, modifications to pit design, and development of corrective actions would be provided in an annual report to the BLM for the life of the project. In addition, the final pit slope would be designed to conform to a minimum factor of safety of 1.0 under seismic loading for potential failure surfaces that could extend to the quartzite outcrop on the western flank of Mount Tenabo known as the White Cliffs, which is located east of the proposed pit crest. Seismic loading would be evaluated in terms of pseudostatic analyses applied to limit equilibrium methods, with a coefficient equal to 50 percent of the peak free-field horizontal ground acceleration associated with an earthquake event expected to occur on the average of once every 1,000 years. Other measures to address long-term stability of the east wall of the Cortez Hills Pit (such as slope buttressing) would be evaluated as mining progresses and provided in the final closure plan based on the results of pit slope monitoring, geotechnical data collection, and stability analysis.

Effectiveness: Implementation of mitigation measure GM-2 is expected to reduce, but may not entirely eliminate, the potential risk of slope failures developing over the long term in the east wall of the Cortez Hills Pit during the post-closure period.

3.1.5 Residual Adverse Effects

Residual adverse effects to geology as a result of the proposed project would include the potential for deep-seated slope failures to occur in the eastern portion of the Cortez Hills Pit, particularly in the post-mining period, that could result in expansion of the area of disturbance. Implementation of Mitigation Measure GM-2 would reduce, but may not entirely eliminate, the potential risk of slope failures developing over the long term in the east wall of the Cortez Hills Pit during the post-closure period.