3.1 Geology and Minerals

The study area for direct and indirect impacts to geology and minerals is defined as the proposed POO expansion area and conversion areas associated with copper recovery within the existing POO boundary. The CESA includes the area within a modified Battle Mountain Mining District boundary (**Figure 3.1-1**). The geologic conditions discussed below also provide the background information for characterizing the hydrogeologic conditions, which are discussed in Section 3.2, Water Resources and Geochemistry.

3.1.1 Affected Environment

3.1.1.1 Physiographic and Topographic Setting

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

The topography and physiographic features of the region for geology and minerals are shown in **Figure 3.1-1**. The proposed project is located in the southern portion of the Battle Mountain Range, which trends north-south and is approximately 18 miles long and 12 miles wide. The highest peak is North Peak at 8,550 feet amsl. The Battle Mountain Range is flanked by the Buffalo Valley to the west, the Reese River Valley to the east, and the Humboldt River to the north and northeast. Buffalo Valley is a closed basin with a valley floor elevation of approximately 4,600 feet amsl. The Humboldt River near the Town of Battle Mountain is situated at an approximate elevation of 4,500 feet amsl. The tributaries in Buffalo Valley drain generally to the south toward a playa lake in Buffalo Valley; drainage into the Reese River Valley flows toward the Reese River, a tributary of the Humboldt River.

3.1.1.2 Regional Geologic Setting

The regional geologic conditions cross-sections and major geologic units are shown in Figures 3.1-1, 3.1-2, and 3.1-3 in the Phoenix Project Final EIS (BLM 2002a). The major geologic units, from oldest to youngest, include the late Cambrian Harmony Formation, Middle and Early Ordovician Valmy Formation, Devonian Scott Canyon Formation, Mississippian to Permian Havallah and Pumpernickel formations, and Pennsylvanian to Permian Antler Sequence; however, because of thrusting, these formations do not occur in stratigraphic order.

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. The marine clastic rocks (Harmony, Valmy, and Scott Canyon formations) were deposited in the deep water to the west, while carbonate rocks were deposited in the shallow water to the east (Stewart 1980). During the Late Devonian and Early Mississippian periods, sedimentary deposition was interrupted, and the Paleozoic sediments were uplifted, folded, and thrusted by the Antler Orogeny. During the Antler Orogeny, thrusting occurred in several stages. The oldest thrust is the Roberts Mountain thrust, which moved the Scott Canyon Formation 90 miles eastward over the carbonate rocks (Baker Consultants, Inc. 1997; Roberts 1964; Stewart 1980). This thrust and the carbonate rocks do not crop out within the study area (Roberts 1964); however, they probably occur at depths greater than 4,600 meters (Theodore and Roberts 1971) (approximately 15,000 feet). Subsidiary thrusts (Valmy and Dewitt thrusts) associated with the Antler Orogeny reversed the stratigraphic sequence in the area (Figure 3.1-3 in the Phoenix Project Final EIS [BLM 2002a]).

The Antler Orogeny also created a highland that persisted from the Mississippian period to the Permian period (Stewart 1980). Erosion of the Antler highlands during the Pennsylvanian and Permian periods produced the Antler Sequence, which lies unconformably on top of the early Paleozoic rocks. The Antler Sequence (an in situ assemblage) consists of shallow marine siltstone, sandstone, conglomerate, and limestone (Doebrich 1995). The Battle Formation, Antler Peak Limestone, and the Edna Mountain Formation make up the Antler Sequence (Figure 3.1-3 in the Phoenix Project Final EIS [BLM 2002a]).

To the west of the Antler highlands, Mississippian to Permian Havallah and Pumpernickel formations were deposited (Murchey 1990). Both of these formations represent deep water sediments. The Pumpernickel Formation is composed of argillite, cherty siltstone, radiolarian chert interbedded with greenstone, sparse sandstone, and conglomerate (Baker Consultants, Inc. 1997; Theodore and Blake 1975). The Havallah Formation is a complex assemblage of volcaniclastic greenstone, deep water clastic rocks, radiolarian chert, and basalt at the base (Doebrich 1995). Together, the Pumpernickel and Havallah formations make up the Havallah Sequence (Theodore and Blake 1975).

During the Late Permian to Early Triassic time, the Sonoma Orogeny thrust the Havallah Sequence 45 miles eastward over the Antler Sequence along the Golconda thrust (Siberling and Roberts 1962). The Havallah Formation was thrust over the Pumpernickel Formation by the Willow Creek thrust. In addition to the thrusting, the Sonoma Orogeny locally folded the Antler Sequence, which lies below the Golconda thrust.

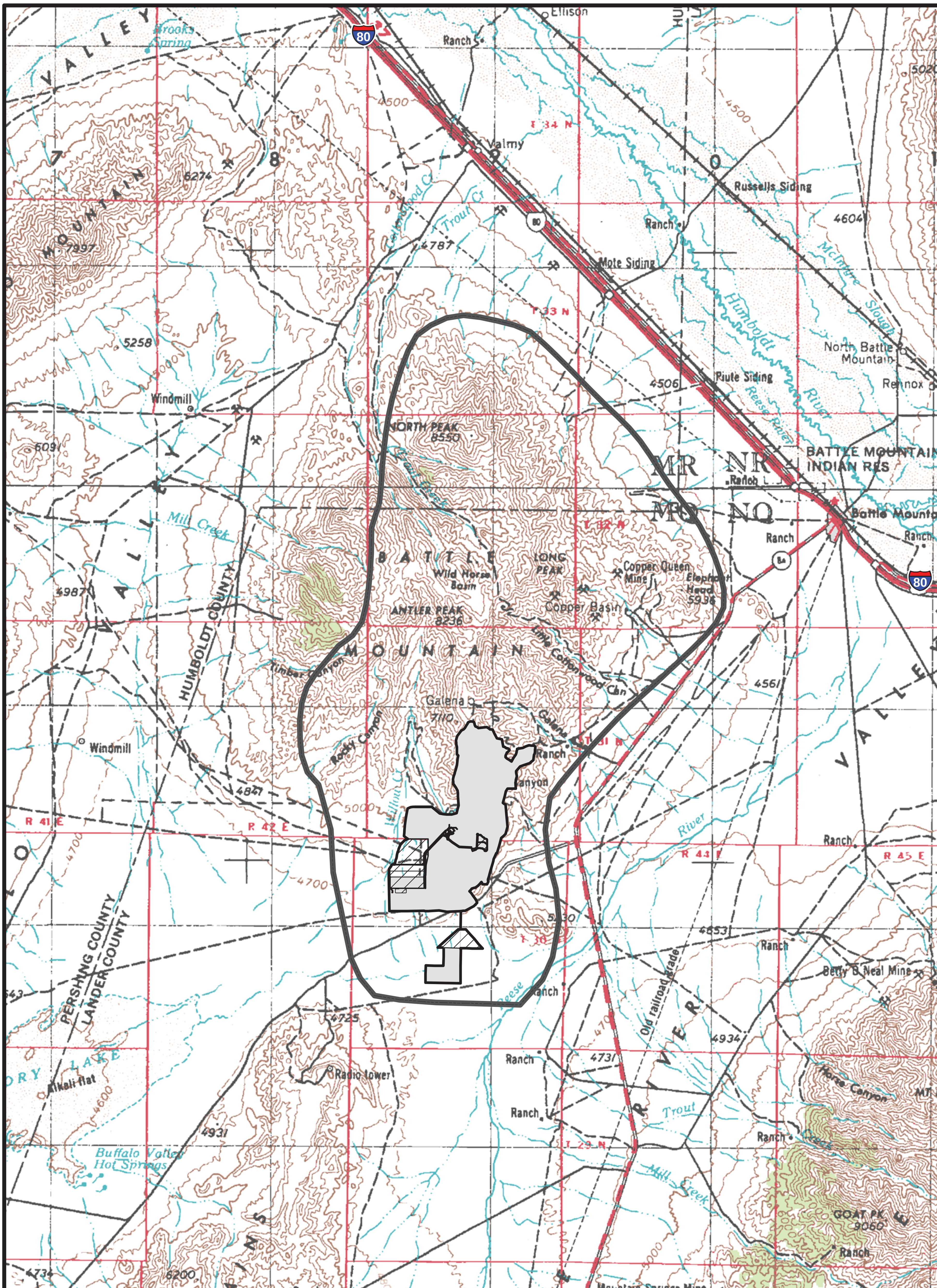
Tectonism developed throughout the rest of the Mesozoic era, causing northwest-trending faults and broad open folds. Due to the deformation caused by faulting and folding, particularly in the late Cretaceous period, magnetism resulted in monzogranite stocks that contain mineable minerals (molybdenum, copper, silver, and gold) (Baker Consultants, Inc. 1997).

Beginning in the late Cretaceous period, the area was block-faulted by a series of normal faults that created the basin and range topography that characterize the region. Broad valleys in the region, such as Buffalo Valley and Reese River Valley, were formed as down-dropped blocks between uplifted mountain ranges. In Copper Canyon, north-south Tertiary normal faults also are important for localizing ore and for controlling emplacement of granodiorite (Theodore and Blake 1975). The major north-striking, west-dipping faults include the Virgin, Hayden, Monitor, Copper Canyon, and Plumas. Associated with the extensional block faulting, widespread igneous activity emplaced granodiorite stocks and dikes. During the middle Tertiary period, volcanic activity led to the deposition of ash-flow tuffs, which are hundreds to thousands of feet thick (Baker Consultants, Inc. 1997).

During the late Tertiary and Quaternary time, uplift and subsequent erosion of the mountains created from the block-faulting have partially filled the basin with poorly consolidated to unconsolidated silt, sand, gravel, and boulders deposited primarily as a series of coalescing alluvial fans. The center of the valleys are dominated by river alluvium along the ephemeral rivers and playa lake deposits associated with the Buffalo Valley playa lake. The thickness of these deposits ranges from a thin veneer on pediment slopes to a thousand feet or more near the central portions of the basins (Figure 3.1-2 in the Phoenix Project Final EIS [BLM 2002a]).

3.1.1.3 Site Geology

The geology of the entire Phoenix Mine site and vicinity is described in Section 3.1.1.3 in the Phoenix Project Final EIS (BLM 2002a). The geology in the vicinity of the proposed HLFs and SX-EW Facility located in the southern portion of the mine site is shown in **Figure 3.1-2**. The proposed HLFs and SX-EW Facility would be situated on alluvial fan deposits of Quaternary age. Basalt flows are exposed on the ridge east to northeast of the proposed Reona Copper HLF. The alluvial fans are composed of unconsolidated gravel, sand, and silt.



Legend

- Geology and Minerals, Paleontological Resources, and Hazardous Materials and Solid Waste CESA
- Proposed POO Boundary
- Proposed Action
- Proposed Action Linear Feature
- Permitted Disturbance

Note: The Hazardous Materials and Solid Waste CESA also includes the main transportation routes to the mine site as described in Section 3.16, Hazardous Materials and Solid Waste.

Source: BLM 2008e.

Phoenix Copper Leach Project

Figure 3.1-1

Geology and Minerals, Paleontological Resources, and Hazardous Materials and Solid Waste CESA

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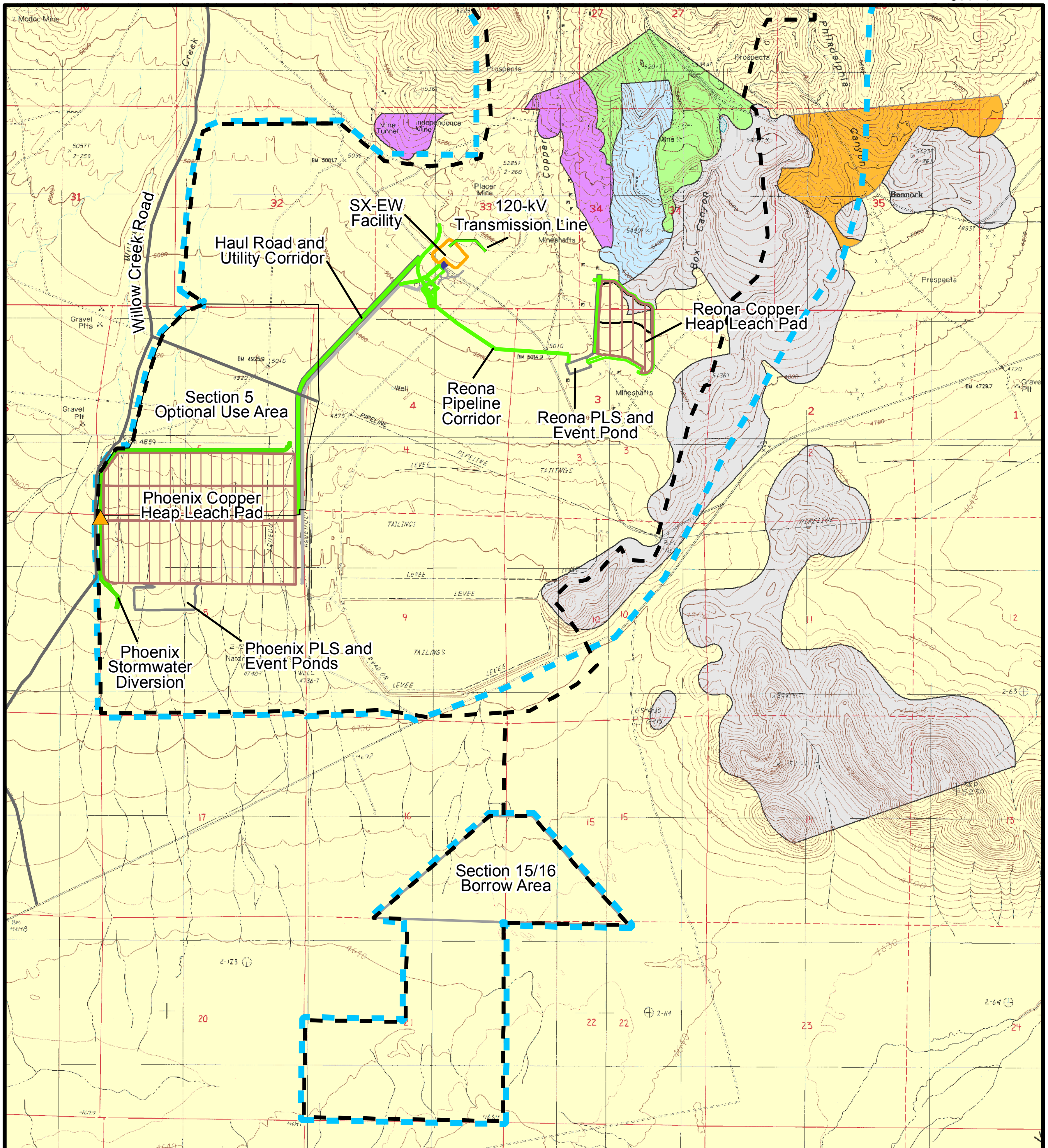


Legend

- Proposed POO Boundary
- Proposed Fenceline
- Proposed Linear Feature
- Proposed Production Well
- Copper Heap Leach Pads
- Younger and Older Alluvium
- Basalt Flows
- Pumpernickel Formation
- Battle Formation
- Harmony Formation
- Scott Canyon Formation

N

0 0.5 1 Miles

Source: SWC 2007; Newmont 2010a.

Phoenix Copper Leach Project

Figure 3.1-2

Geologic Map

05/23/2011

The proposed Phoenix Copper HLF would be located on a gently sloping, alluvial fan. Geotechnical investigations were conducted by SWC to define the subsurface conditions for the design of the facility in Section 8. These subsurface investigations included drilling 7 test borings to depths ranging from 40 to 102 feet and excavating 25 test pits ranging from 19 to 22 feet. The results of the subsurface investigations indicate that the study area is underlain by unconsolidated, interbedded granular alluvial material consisting of silty gravel, sandy gravel, and silty sand. The geotechnical investigations of the foundation conditions at the study area indicate that these sediments are dense to very dense, and non-plastic. The water table was not encountered within the depth of geotechnical exploration borings (102 feet) (SWC 2007).

Three condemnation holes were drilled along an east-west line in the northern portion of Section 8 in 2006 (Newmont 2008c) to investigate the subsurface conditions in the vicinity of proposed Phoenix Copper HLF. The results of the drilling indicate that the area is underlain by thick sequence of older and younger alluvial deposits. Two of the borings (PHX 11345 and PHX 11344) were drilled to depths of 495 feet and 520 feet, respectively, and terminated in older alluvium. The third boring (PHX 11343) encountered the base of the older alluvial deposits at 800 feet and terminated in the volcanic tuff at 860 feet. A basalt flow ranging from 25 to 40 feet thick, emplaced within the older alluvial deposits, was encountered in two of the borings (PHX 11345 and PHX 11344) at a depth of 425 and 455 feet, respectively. The basalt flow was not encountered beneath the northwest corner of Section 8 (i.e., PHX 11343).

The proposed Reona Copper HLF would be located on a southward sloping alluvial fan. Geotechnical investigations were conducted by SWC to define the subsurface conditions for the design of the facility. These subsurface investigations included drilling 4 test borings to depths ranging from 20 to 110 feet and excavating 24 test pits ranging from 11 to 22 feet. The results of the subsurface investigations indicate that the study area is underlain by unconsolidated, interbedded granular alluvial sediments consisting of silty sands, sandy gravels, gravelly sands, and silty gravels. The geotechnical investigations of the foundation conditions at the study area indicate that these sediments are dense to very dense, and non-plastic. The water table was not encountered within the depth of geotechnical exploration borings (110 feet) (SWC 2007).

3.1.1.4 Mineralization

The existing Phoenix Mine lies within the Battle Mountain Mining District at the north end of the northwest-trending Battle Mountain-Eureka mineral belt. Mineral development is related to a Tertiary-age granodiorite that has intruded the Paleozoic sedimentary rocks (Theodore et al. 1990). Hydrothermal fluids associated with the intrusion caused the mineralization and are associated with the local normal faults that acted as conduits. Mineral deposits located within the Phoenix Mine boundary include a variety of mineralized skarn and pluton-related mineral occurrences. Mineralization within the Phoenix Mine boundary includes both base metals (copper and molybdenum) and precious metals (gold and silver). A description of historic mineral occurrences and ore geology for existing pits and new or expanded pits included within the Phoenix Mine are summarized in Section 3.1.1.4 in the Phoenix Project Final EIS (BLM 2002a).

3.1.1.5 Faulting and Seismicity

Faulting

The proposed project is located in a region that is characterized by active and potentially active faults and a relatively high level of historic seismicity. An active fault is one that shows evidence of displacement during the Holocene period (last 10,000 years), and a potentially active fault is a fault that shows evidence of surface displacement during the late Quaternary period (last 150,000 years). Historically, surface displacement along faults occurred in Nevada during major earthquakes in 1869, 1903, 1915, 1932, and three events in 1954 (Stewart 1980). All of these events occurred along a north-trending zone called the Nevada Seismic Belt located west of the study area. The closest historic surface displacement to the study area was in 1915 along the China Mountain Scarp in the Tobin Range approximately 20 miles to the west-northwest. Surface fault rupture typically occurs along active fault traces.

The nearest mapped active and potentially active faults are shown in **Figure 3.1-3**. Major faults located within a 50-kilometer (km) (31-mile) radius of the Phoenix Mine and their estimated maximum magnitude earthquake and resultant ground motion at the mine site are presented in **Table 3.1-1**. There are no known active faults in the immediate vicinity of the mine site. The Battle Mountain fault and the North Fish Creek Mountains fault are the nearest potentially active faults. These faults are located approximately 7 miles west and southwest of the mine site, respectively. The Shoshone Range fault zone is located along the east margin of the Reese River Valley, approximately 11 miles east of the mine site; while the Buffalo Valley fault zone is located along the west margin of Buffalo Valley approximately 16 miles west of the mine site (**Figure 3.1-3**). As shown in **Table 3.1-1**, the largest estimated ground motion at the Phoenix Mine would be generated by the maximum magnitude event on the Shoshone Range fault zone.

Table 3.1-1 Major Faults within a 50-kilometer (31-mile) Radius of the Phoenix Mine

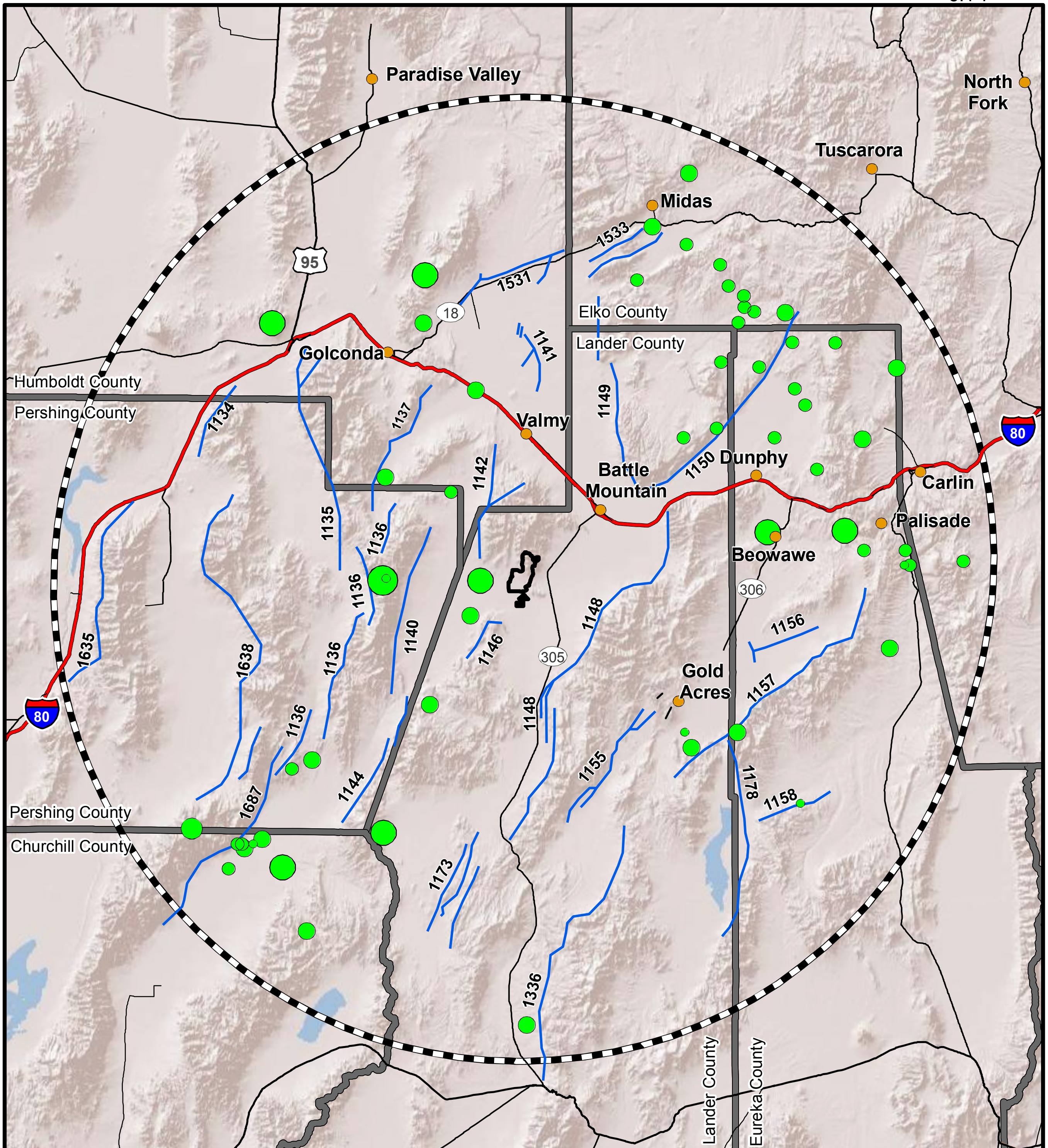
Fault Number[1]	Fault Name	Closest Distance to the Phoenix Mine (miles)	Estimated Maximum Magnitude Earthquake (M_w)[2]	Estimated Maximum Horizontal Acceleration at the Mine Site (g)[3]
1142	Battle Mountain fault	7	6.7	0.18
1146	Northern Fish Creek Mountains fault	7	6.4	0.15
1148	Shoshone Range fault zone	11	7.5	0.24
1140	Buffalo Valley fault zone	16	6.7	0.09
1149	Sheep Creek Range Western faults	19	6.9	0.08
1150	Southeast Sheep Creek Range fault	20	6.9	0.08
1136	Pleasant Valley fault zone	21	7.6	0.11
1155	Carico Lake Valley fault zone	23	6.9	0.07
1144	Jersey Valley fault zone	24	6.6	0.06
1141	Unnamed faults	25	6.6	0.05
1135	Grass Valley fault zone	26	6.9	0.06
1156	Crescent Valley faults	31	6.6	0.04

[1] Fault number from U.S. Geological Survey (USGS) (2004), and is the fault identifier used in **Figure 3.1-3**.

[2] M_w = moment magnitude.

[3] g = estimated ground motion in bedrock.

Source: Modified from Golder 2004.



Legend

- Proposed POO Boundary
- County Boundary
- Historic, Holocene, and Late Pleistocene Faults
- 100-km (62-mile) Radius Boundary
- City

Earthquake Magnitude

- < 3.0
- 3.0 - 3.9
- 4.0 - 4.9
- 5.0 - 5.9
- 6.0 - 6.9
- > 7.0

N

0 7.5 15 Miles

Source: Golder 2004.

Phoenix Copper Leach Project

Figure 3.1-3

Quarternary Faults and Historic Earthquakes within 100-km (62 miles) of the Phoenix Project

05/23/2011

Seismicity

The existing Phoenix Mine is located in a region that has experienced considerable seismic activity throughout history. Earthquake records indicate that 202 earthquake events greater than or equal to 4.0 Richter Magnitude have been recorded (USGS 1997) within a 100-mile radius of the Phoenix Mine between 1872 and February 11, 1997. **Figure 3.1-3** shows approximate locations and estimated magnitudes of the recorded seismic events relative to the Phoenix Mine. It is important to note that all 202 seismic events do not appear in **Figure 3.1-3** because where several events occurred in the same location, only the largest event is shown. For example, from August 8 to August 31, 1954, 25 events occurred in the same location; however, only 1 event appears on the figure. As shown in **Table 3.1-2**, the largest recorded earthquake to affect the region was a 7.8 Richter Magnitude event located approximately 19 miles west of the Phoenix Mine within the Nevada Seismic Belt. The closest recorded earthquake of magnitude 5.0 or greater occurred in 1946, was located approximately 6 miles from the Phoenix Mine, and measured 5.1 Richter Magnitude (USGS 1997).

Table 3.1-2 Recorded Earthquakes with Richter Magnitude of 5.0 or Greater Located Within a 60-mile Radius of the Phoenix Mine[1]

Year	Month/Day	Location (latitude, longitude)[2]	Approximate Distance from the Phoenix Mine (miles)	Estimated Magnitude	Estimated Peak Bedrock Acceleration[3]
1872	3/23	40.0,117.5	41	5.5	0.02
1873	11/5	40.0,118.0	58	5.5	0.01
1915	10/3	40.5,117.5	19	6.1	0.09
1915	10/3	40.5,117.5	19	7.8	0.22
1916	2/3	41.0,117.8	48	5.9	0.03
1916	8/15	41.0,117.5	38	5.0	0.01
1917	4/11	40.0,118.0	58	5.1	0.01
1945	9/18	40.6,116.5	33	5.1	0.02
1946	1/15	40.5,117.3	6	5.1	0.17
1954	12/20	40.0,118.0	58	5.0	0.01
1966	10/22	40.6,116.3	44	5.1	0.01
1968	7/6	41.1,117.4	42	5.5	0.02
1984	2/16	39.9,117.6	52	5.2	0.02

[1] Seismic data from USGS Earthquake Database (USGS 1997).
[2] Degrees north latitude and west longitude.
[3] Peak bedrock acceleration was estimated based on the plot by Idriss (1985).

3.1.2 Environmental Consequences

Issues related to geology and minerals include: 1) geologic hazards created or exacerbated by project development; 2) failure of or damage to critical facilities caused by seismically induced ground shaking; and 3) exclusion of future mineral resource availability caused by the placement of facilities.

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

- Moderate potential for impacts to the facility site or design caused by geologic hazards, including landslides, debris flows, ground subsidence, and active fault rupture;
- Moderate potential for structural damage or failure of a facility caused by seismic loading from design earthquakes;
- Limited future extraction of other known mineral resources because of facility location; or
- Alteration of the geologic terrain resulting in a geologic hazard.

3.1.2.1 Proposed Action

The design capacity for the proposed Phoenix Copper HLF is 150 MT. The proposed Reona Copper HLF would have a maximum design capacity of 8 MT of ore.

Direct impacts of the Proposed Action on geologic and mineral resources would include: 1) the generation and permanent placement of up to a maximum of approximately 158 MT of spent ore; and 2) the recovery of approximately 245 million pounds of copper.

The proposed project would result in approximately 902 acres of new surface disturbance (that has not previously been authorized under prior NEPA actions). Disturbance associated with the reclaimed heap leach pads and use of borrow material (Section 5 OUA and Section 15/16 Borrow Area) (totaling approximately 852 acres) would permanently alter the natural topographic and geomorphic features within the study area. Other temporary facilities (e.g., SX-EW Facility, ponds, transmission line, and pipeline corridors) would be reclaimed to pre-mining topography and would not permanently alter the natural topography or geomorphic features within the study area.

Geologic Hazards and Geotechnical Considerations

Potential geologic hazards in the area related to the regionally high seismic (earthquake) potential include active faulting and seismic ground shaking. There are no known active or potentially active faults or natural landslides in the immediate vicinity of the proposed facilities. Therefore, the risk of facility damage from fault rupture or land sliding is not anticipated.

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.

Potential risk associated with slope stability, foundation settlement, and earthquake ground motion effects on the proposed copper HLFs are addressed in the following paragraphs. The risk associated with possible erosion or damage to project facilities during flooding events is addressed in Section 3.2, Water Resources and Geochemistry.

Slope stability analyses for the proposed Phoenix Copper HLF were performed by SWC (2007). The minimum acceptable factors of safety under static loading conditions for these types of facilities are typically 1.3. The results of the slope stability analysis indicate that the static factors of safety for the facility were calculated to be 1.9 for a 300-foot-high leach pad. The analysis indicates that the heap should be stable under static loading conditions.

Pseudostatic and deformation analysis were conducted for the heap leach pad to evaluate the stability and potential deformation that could occur under seismic loading (i.e., earthquake) conditions. The operational basis earthquake is used as a lower level event that has a reasonable probability of occurrence during the operational life of the proposed project. Facilities generally are designed to remain functional, sustaining no more than repairable damage during an operational basis earthquake. The operational basis earthquake was determined to be an earthquake with a moment magnitude of 5.4 located approximately 9 miles from the study area with an estimated return period of 108 years (Golder 2004; SWC 2007). The results of the pseudostatic analysis using the operational basis earthquake indicate that the calculated factor of safety is 1.5 or greater. This indicates that the proposed Phoenix Copper HLF is expected to be stable during an operational basis earthquake design seismic event.

Pseudostatic analyses and deformation analysis also were performed to evaluate potential damage to the leach pad in the post-closure period resulting from a maximum design earthquake. The maximum design earthquake used for the project was a 6.6 moment magnitude event located approximately 5 miles from the study area. The maximum design earthquake is an earthquake event that has a 2 percent probability of exceedence in a 50-year period and estimated return period of 2,475 years. The results of the analysis indicate the factor of safety during the maximum design earthquake would be as low as 0.9 for critical sections. The deformation analysis indicates that the amount of movement would be negligible and likely would not result in damage to the liner system (SWC 2007). As a result, the probability of a catastrophic slope failure during the post-closure period is presumed to be low. Groundwater levels in the study area are greater than 100 feet below existing grades, and the sediments are dense to very dense. These unsaturated soils are not susceptible to liquefaction. The load of the facility is expected to result in an incremental settlement of the pad foundation; however, the amount of settlement is not expected to damage the liner system or affect the drainage system (SWC 2007).

Slope stability analyses for the proposed Reona Copper HLF were performed by SWC (2007). The results of the slope stability analysis indicate that the static factors of safety for the facility were calculated to be 1.6 for a 300-foot-high heap leach pad. The analysis indicates that the facility should be stable under static loading conditions.

Pseudostatic and deformation analyses were conducted for the leach pad to evaluate the stability and potential deformation that could occur under seismic loading (i.e., earthquake) conditions using the same assumed operational basis earthquake and maximum design earthquake described above for the proposed Phoenix Copper HLF. For the operational basis earthquake, the stability of the leach pad design calculated factors of safety of 1.1 or greater. This indicates that the HLF would be stable under an operational basis earthquake design.

For the maximum design earthquake, the results of the analysis indicate the factor of safety would be 0.7 or potentially unstable (SWC 2007); however, the deformation analysis indicates that the amount of movement likely would be on the order of approximately 6 inches and, therefore, likely would not result in damage to the liner system (SWC 2007). As a result, the probability of a catastrophic slope failure during the post-closure period is presumed to be low. Groundwater levels in the study area are greater than 100 feet below existing grades, and the sediments are dense to very dense. These unsaturated soils are not susceptible to liquefaction. The load of the facility is expected to result in an incremental settlement of the pad foundation; however, the amount of settlement is not expected to damage the liner system or affect the drainage system (SWC 2007).

Mineral Resources

Existing geologic and mineral resource information suggests the placement of the proposed facilities would not preclude future access to any known or inferred mineable ore.

3.1.2.2 Reona Copper Heap Leach Facility Elimination Alternative

The Reona Copper HLF Elimination Alternative would be similar to the Proposed Action, except that the Reona Copper HLF and associated infrastructure (i.e., solution pipelines) would not be developed. The Reona HLF (Gold) would continue to operate under current permitted authorizations. Under this alternative, the generation and permanent placement of up to a maximum of approximately 8 MT of spent copper leach ore; and the recovery of up to 15 million pounds of copper would not occur since the Reona Copper HLF would not be constructed. All other direct and indirect impacts associated with this alternative would be the same as the Proposed Action.

3.1.2.3 No Action Alternative

Under the No Action Alternative, the proposed Phoenix Copper Leach Project would not be developed and the related potential impacts to geologic and mineral resources would not occur. Under this alternative, the existing Phoenix Project would continue to operate under existing authorizations. Potential impacts associated with the existing operation previously were discussed and analyzed in the Phoenix Project Final EIS (BLM 2002a).

3.1.3 Cumulative Impacts

The CESA for geology and minerals is shown in **Figure 3.1-1**. Past and present actions and RFFAs are identified in **Table 2.8-1**; their locations are shown in **Figure 2.8-1**.

Mines within the CESA include the existing Phoenix Mine, Marigold Mine, Copper Basin Mine, Copper Queen Mine, Sunshine Mine, and Independence Mine. Mineral production within the CESA has included gold, silver, copper, gold placer, antimomy, lead, and manganese (Stager 1977). Surface mining activity affects geology and mineral resources through excavating, modifying, or covering natural topographic and geomorphic features and by removing mineral deposits.

Mining disturbance in the CESA has included exploration (drilling, sampling, and road construction); open-pit and underground mining; development of WRFs, HLFs, and ore stockpiles; ore milling and processing; and tailings disposal. For the purpose of this evaluation, “disturbed” area (or “geologic disturbance”) is defined to include mine components (e.g., 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 CESA include agricultural development and utilities/community development. For the purposes of this evaluation, agriculture and utilities/community development and wildfires are not considered to result in a geologic disturbance as defined above.

Past and present actions and RFFAs within the CESA have resulted, or would result, in the direct disturbance of approximately 12,606 acres of cumulative disturbance associated with mining-related activities. An unquantifiable portion of which has, or would, result in a permanent alteration of the natural topography. The Proposed Action would increase the cumulative “geologic disturbance” associated with mining-related activities by up to approximately 852 acres (i.e., maximum total areas of new disturbance for expansion of heap leach and borrow areas that would alter the topographic or geomorphic features in the area). Because gold mining is a major activity in this region, it is reasonable to assume that large-scale mining would continue to increase the cumulative disturbance acreage within the CESA.

Geologic hazards and geotechnical considerations would be local in nature and specific to individual facilities; therefore, no cumulative impacts associated with geologic hazards would occur. The proposed project would result in an incremental increase in the extraction and recovery of mineral resources within the CESA.

3.1.4 Monitoring and Mitigation Measures

No significant impacts to geology and mineral resources were identified; therefore, no additional monitoring and mitigation measures are recommended.

3.1.5 Residual Adverse Effects

No residual adverse effects to geology and minerals are anticipated as a result of the Proposed Action.